MAKING PREPARATION OF POULTRY AND EGGS SAFER FOR CONSUMERS: A FOCUS ON RECIPES AND TEMPERATURE

by

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B.S., Brigham Young University, 2008
M.S., Utah State University, 2011

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Human Nutrition
College of Human Ecology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2015

Abstract

Consumer food safety often is lacking, with many studies showing that we need to understand consumer behavior better and find new ways to provide information.

The objective of this research was to better understand consumer food safety behaviors, find possible avenues for communicating food safety instructions to consumers, and determine how those avenues could work for demonstrating food safety today.

Results from this research showed that two of the main potential avenues for communicating food safety instructions, namely recipes and cooking shows, were wholly lacking in good information and behaviors. A survey of egg dish recipes found that almost none contained temperature information, despite recommendations of food safety agencies. Observing celebrity chefs prepare food showed that every chef repeatedly had poor food safety practices which would lead to foodborne illness if followed by consumers at home.

Two consumer studies were done with observers watching consumers prepare poultry and egg items. In the first study, consumers were asked to prepare poultry and egg items using both stovetop and oven methods. This study demonstrated that consumers do not follow many food safety behaviors, such as hand washing and using thermometers, and that those who used a thermometer were not better at reaching a safe temperature than those who didn't use one. The second study had consumers prepare poultry items following a recipe, with half receiving food safety instructions on hand washing and thermometer use with their recipes. This study demonstrated that the

addition of food safety instructions dramatically improved food safety behaviors in consumers.

A separate study looked at the effect of changing lighting due to recent changes in efficiency regulations. This study found that some forms of modern lighting, such as LEDs, are more likely to make consumers think that poultry products are finished cooking before they are done, showing an even greater need for thermometer use.

These studies present a message for the industry: food safety information and behaviors are lacking in consumers, but simple efforts such as adding food safety instructions to recipes can make consumers more aware of appropriate behaviors and improve their food safety.

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Acknowledgements

As I reach the culmination of this project, I am incredibly grateful to all those individuals who have helped me complete it. There have been many who have supported me and helped me complete the research, through the donation of their time or expertise. Though not all who helped can be named here, there are a few specific individuals that I would like to express my thanks to.

First, I would like to thank my advisor, Dr. Edgar Chambers IV, for the knowledge he has shared, and the guidance and direction that he has given to both this project and to my education. I would be remiss if I did not acknowledge the positive influence he has had on my understanding of good sensory principles and practices.

I would also like to thank Dr. Delores Chambers for her positive attitude and energy, as well as her help in guiding the project. My other committee members also deserve my thanks, with Dr. Sandria Godwin providing insight into the world of food safety along with her friendship, and Dr. Kadri Koppel giving valuable revisions to the manuscript as well as insights to the projects.

My fellow graduate students at the Sensory Analysis Center also deserve my gratitude for making this project possible. Each of them donated of their time to help observe consumers and collect data for the projects, and I am thankful for their help as well as their friendship.

Finally, I am extremely thankful for a loving wife who has always supported me in my efforts to increase my education, and for my children who always manage to bring a smile to my face and give me much needed breaks from work.

Chapter 1 - Introduction

Food plays an important role in all of our lives. Beyond simple sustenance, it can provide well-being in a physical form, and even cause us to feel emotions such as pleasure and anxiety *(1, 4, 5)*. It is not surprising, therefore, that we seek to have high quality food in our society.

Food quality at a basic level can be defined in a couple of ways. One definition says that quality food simply means that the food has all the properties it is supposed to. As a counterpoint, another definition of quality food is that it has desirable qualities, whether those qualities are good sensory properties, convenience, or nutritious attributes *(3)*. Undoubtedly it means different things to different people, depending on their perception of the world. Whatever definition is used, at its basic level food must be *safe* to be of high quality.

Consumers themselves often think of quality and safety as overlapping terms. Though quality may be defined as having good taste, freshness, or being a good product, safety is perceived as having a strong relationship with quality *(6)*. At its core, safety implies a lack of risk or harmfulness, with a positive relationship to health, though other issues can come into play such as how "natural" a product is *(2, 3, 6)*.

As researchers, we want to make available information that allows for good quality food that can be prepared safely by consumers. More than that, we want this information to be used by consumers to change their habits and behaviors, so that foodborne illness can be reduced in the populace. As shown by previous research and throughout this dissertation, this is no small task. While many would agree that it is important to be conscientious of food safety, those same people probably do not give it a

second thought while preparing and eating food in their day to day lives. Beyond the occasional news report of a food recall or an outbreak of foodborne illness, it is unlikely to be at the front of their minds with any regular frequency, besides those habits that we already have. Changing consumer behaviors is a slow process, and there must be good reasons for them to change. Therefore, the overarching goal of this dissertation is to examine more in depth what information is available to consumers, what their behaviors are surrounding foodborne illness, and some strategies for improving their behaviors and lowering their chances of being subjected to foodborne illness.

This dissertation consists of 5 separate studies, each of which addresses a specific research goal oriented to understanding or improving food safety in consumers. The main focus of these studies is food safety behaviors in poultry and eggs, but the principles apply to other food and meat products as well. The studies included herein are summarized as follows:

The first study (Chapter 3) was designed to determine if current recipes contain food safety information. A wide range of egg dish recipes from both traditional print and online sources were gathered and analyzed for food safety content. The recipes were found to be lacking in food safety information, with only 2 of the 175 recipes containing the appropriate temperature information.

The second study (Chapter 4) looked at cooking shows to see if proper food safety behaviors were being demonstrated by celebrity chefs, who may be seen as behavior models by some consumers. This study found that celebrity chefs rarely demonstrated good behaviors, such as hand washing and thermometer use, and instead frequently

demonstrated behaviors that would lead to cross-contamination and foodborne illness if consumers followed those same behaviors at home.

The third study (Chapter 5) looked at the role that perception can play in food safety. Photographs of turkey patties cooked to different temperatures, some lower than the recommended safe temperature, were viewed by consumers under different lighting conditions. These lighting conditions included both traditional 60 watt lightbulbs, which as of 2014 can no longer be made or sold in the United States, and more efficient lightbulbs. Consumers were asked to rate how done they thought each sample was, as well as how likely they would be to eat them. Some modern day lighting, such as LED lightbulbs, were found to influence consumer perceptions and make them think the patties were more cooked than they would have thought under traditional lighting conditions. This gives researchers another way to help convince consumers to use a thermometer.

The fourth study (Chapter 6) was aimed at observing consumer behaviors while preparing poultry and egg dishes, specifically surrounding hand washing and thermometer use. The goal of the study was to see if the final temperature of the dishes was affected by thermometer use by the consumers. The observers found that food safety behaviors were poor, as expected, with minimum hand washing and thermometer use. They also found that those who used a thermometer were not more likely to cook their meat and eggs to a safe temperature, showing that just getting consumers to use a thermometer may not be enough to prevent foodborne illness.

The final study (Chapter 7) was inspired by the results of both the first study (Chapter 3) that showed recipes do not contain food safety information, and the fourth

study (Chapter 6) that showed consumers do not follow food safety when preparing poultry and eggs. This study again had consumers prepare poultry dishes, but this time half of the consumers received recipes that contained embedded food safety instructions regarding hand washing and thermometer use. The study found that those who received food safety instructions were much more likely to wash their hands at appropriate times, and use a food thermometer to check doneness.

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Chapter 2 - Literature Review

Food safety was first widely introduced as a concept to the general public of the United States with the introduction of the Federal Food, Drug and Cosmetic Act of 1908 *(137)*. Foodborne illnesses in the United States has been tracked since at least 1925, with the Public Health Service publishing summaries of outbreaks of gastrointestinal illness due to milk *(98)*. Since then, our methods and reporting have improved, as well as our understanding of foodborne illnesses *(65)*.

In our modern world, agencies such as the Food and Drug Administration (FDA), the Food Safety Council, and the United States Department of Agriculture (USDA) are responsible for maintaining food safety in our food supply. The goal of these agencies are to uphold proper food safety principles at each step of the food chain, from farm to fork, with the hope of preventing the majority of foodborne illnesses *(118, 139)*. Even with our strict regulations, it is virtually impossible to keep our food supply completely safe *(108)*. Examples of this can be seen in the history of our food supply, such as when large outbreaks of foodborne illness occur like the *E. coli* 0157:H7 outbreaks in 1998, well after regulations to prevent it were in place *(137)*.

Foodborne illness is a matter of public health throughout the world. Outbreaks can quickly affect a large group of people, and can enter the population through a number of avenues, including food manufacturers, restaurants, food markets, grocery stores, and the home itself. They can be devastating for those who are considered to have weaker immune systems, such as residents of nursing homes, hospitals, and schools *(2, 3, 78, 97, 122)*. For example, a school in England experienced an outbreak (38 known cases) of *E. coli* 0157 after a smaller contaminated group brought it to school, and spread it through

cross-contamination with their hands. Those that had the greatest burden of illness were those under 6 years old *(7).*

The most recent estimates from the Centers for Disease Control and Prevention (CDC) show that outbreaks continue to affect the population. For example, in 2013, an estimated 818 outbreaks occurred, responsible for 13,360 illnesses *(24).* Beyond just outbreaks, the CDC estimates that 48 million illnesses each year are from food sources, which is approximately 1 in 6 Americans. The impact of these foodborne illnesses extends beyond simply sickness, with large economical costs to society due to lost productivity, missed work, hospitalizations, and even death *(23).*

Efforts in the food industry have helped to bring about a large reduction in many of the major foodborne pathogens since 1996 *(23).* Despite these efforts, the rate of infections from *Salmonella* increased between 2006 and 2008, and the rate of infections today remains well above the national targets *(23).* Among the most common causes of foodborne illnesses today are *Norovirus*, *Salmonella* and *Campylobacter (24, 84).* These high incidence rates are the reason behind national health objectives targeted at reducing rates of *Salmonella* and *Campylobacter* infections by 25% and 33%, respectively *(126).*

Salmonella has been noted as being the largest source of foodborne illness in the United States, responsible for the highest monetary costs due to illness as well *(23).* Although *Salmonella* can be obtained from a number of sources, many of the outbreaks are associated with eating raw or undercooked poultry and eggs, or with cross-contamination of poultry products to other food items *(9, 84).* As evidence of this, the USDA found in a nationwide survey of chicken parts that up to 24% were contaminated

with *Salmonella* in 2012 *(130)*. Ground poultry has also been noted to have high levels of *Salmonella* and *Campylobacter*, more than any other poultry product *(27)*.

Many of these contaminated products are intended for use in consumer homes, where they could be responsible for causing foodborne illness if those consumers do not follow appropriate food safety behaviors *(69)*. Even simple acts such as not thoroughly cleaning a refrigerator can lead to survival of and cross-contamination from foodborne pathogens *(67)*. Foodborne pathogens can also be found on the exterior of meat packaging, which can be transferred to hands and other food items by unaware consumers *(101, 138, 140)*.

Consumer perceptions of food safety

Consumers are aware of and concerned about food safety issues, even though they are generally trusting of the US food supply *(13)*. The belief that the food supply is safe can come from trust in regulatory agencies and other players in the food industry *(40)*. This trust is a necessary component in helping regulatory agencies educate consumers on food safety issues, as it allows consumers to be influenced to change their behaviors *(26)*.

Trust in the food supply and regulatory agencies is lower today than it was in 2001 *(51, 124)*. This trust in the food supply tends to follow specific food safety incidents *(34)*. Even when they are aware of these incidents consumers generally believe that foodborne illnesses and recalls are more relevant to the general public than to themselves *(57, 93, 99)*.

An example of how that trust works can be seen in the debate surrounding genetically modified foods. As consumers have more trust in those in charge of food production, they associate less risk with trying new products such as those that are

genetically modified *(12)*. This same trust can help alleviate consumer concerns over food safety outbreaks *(50, 75, 83)*. It can also help consumers feel more confident about buying food that has either been subject to food safety issues previously, or that has a perceived risk *(33, 52)*.

Trust and educational efforts can serve an important role in helping consumers see where risks are in the home, and how best to handle them. Food recalls serve to demonstrate how communication can change consumer behaviors. With poor or limited communication, consumers may not have the necessary facts to know how widespread a recall is, and may begin avoiding all products of a similar nature, even if those products weren't affected *(57)*. In surveys by SteelFisher and others, they found that 70% of consumers completely stopped consumption of products associated with the most recent recalls in their memory, with some stopping consumption across the whole category *(121)*. When food products share similar characteristics, even though they are produced by separate companies than those affected by the recalls, sales often go down for all brands *(70)*. One recent example is the drop in sales of all jarred peanut butter sales after Peanut Corp. recalled their peanut butter for *Salmonella* in 2009 *(102)*.

Another example of this can be seen with an outbreak of *E. coli* 0157:H7 in spinach. The FDA initially announced that consumers should not purchase bagged spinach, which quickly expanded to all spinach. As a result, spinach was off the store shelves for five days. Once the FDA determined that the threat was over, consumers did begin buying spinach again, but even a year later bagged spinach purchases were down by 10% from what they were previously. The main positive note is that the purchasing of other green leafy vegetables did not suffer from decreased purchasing, meaning that the

FDA's initial message was clear as to the target of their warning, though they did not have to worry about specific brands in this case *(6)*.

The large incidence rate of foodborne illness can be reduced through efforts by both the industry and by consumers themselves. Improving education and adherence to food safety recommendations is, and should be, a high priority in the United States *(126, 133)*. Educational efforts can be successful in some situations, though many studies are limited in focus or duration, which also limits the evidence of their effectiveness *(44, 94)*. There is a need to understand avenues and sources of information that are currently available to consumers, or that could be used as informational sources if their messages were improved. Educators and industry must also understand what their current behaviors and attitudes towards food safety are.

Behaviors known to reduce foodborne illness

In the world of food safety, there is a standard repertoire of behaviors that are recommended for consumers. If followed properly, these behaviors will help prevent foodborne illness in the home. Recommended behaviors can be divided into four categories – clean, separate, cook, and chill *(100)*. In other words, having good personal hygiene, avoiding cross-contamination, cooking food adequately, and keeping foods at safe temperatures are essential to food safety *(92)*. Of these, the most likely to cause foodborne illness is poor personal hygiene, while the lowest incidence rates of foodborne illness are traced back to the keeping food at safe temperatures category; cross-contamination and cooking adequately lie in between in importance *(91)*. Improving behaviors such as hand washing, thermometer use, and reduced cross-contamination should be the priority for any educational program or message.

Good hygiene (or the "clean" step) typically refers to the practice of washing hands with warm water and soap for at least 20 seconds before and after handling foods *(100)*. Also included in this category are keeping food preparation surfaces clean. Avoiding cross-contamination (the "separate" step) includes any behaviors that can cause bacteria to spread from sources such as uncooked meat and eggs onto ready-to-eat foods. This can include behaviors such as keeping raw meat separate from produce, and washing cutting boards and knives that are used for meat before using them for any other food *(100)*. Adequate cooking generally means cooking meat and egg items to a temperature that is considered "safe," or that is high enough to kill foodborne pathogens. This behavior requires the use of a food thermometer to be followed correctly. Finally, keeping food at a safe temperature means avoiding the "danger zone," temperatures between 41°F to 140°F where pathogens will multiply much more rapidly. Behaviors in this category are in the "chill" step, and involve proper defrosting of meat and promptly cooling foods to refrigerator temperatures *(100)*.

Cooking guidelines exist for most meat products as well as egg products. Meat products all have recommended temperatures of doneness that correspond to the thermal death rate of the bacteria that are most likely found in those products *(132)*. Recommended cooking procedures by the USDA can be seen in Table 2.1 *(127)*.

Eggs are usually given cooking guidelines as well due to their high potential for *Salmonella* contamination *(11, 100)*. Egg recommendations usually consist of recommendations for eggs by themselves as well as egg dishes. For the eggs by themselves, no temperature guidelines are given, with a recommendation to cook them until both the yolk and whites are firm instead *(100)*. For dishes where eggs are a major

component, such as casseroles, the recommendation is to cook them until the internal temperature reaches 160°F, measured at the center of the dish. Pasteurized eggs are recommended for use where the eggs will receive no or little cooking, such as ice cream and salad dressing *(127, 128, 132)*.

Table 2.1 Summary of recommended cooking temperatures or procedures for meat and eggs. Source: USDA (*127)*

Product	Minimum Internal Temperature & Rest Time
Beef, Pork, Veal & Lamb (Steaks, chops, roasts)	145 °F (62.8 °C), rest for 3 minutes
Ground meats	160 °F (71.1 °C)
Ham, fresh or smoked (uncooked)	145 °F (62.8 °C), rest for 3 minutes
Fully Cooked Ham (to reheat)	Reheat cooked hams packaged in USDA-inspected plants to 140 °F (60 °C) and all others to 165 °F (73.9 °C).
All Poultry	165 °F (73.9 °C)
Eggs	160 °F (71.1 °C)
Fish & Shellfish	145 °F (62.8 °C)
Leftovers	165 °F (73.9 °C)
Casseroles	165 °F (73.9 °C)

One concern with eggs is that many common methods of cooking them fail to eliminate *Salmonella* in grossly contaminated eggs *(112)*. Hard-cooking, soft-cooking, and poaching eggs may potentially reduce *Salmonella* to an acceptable level, but cooking methods such as sunny-side-up, over-easy, and scrambling are insufficient to reduce bacterial to a safe level *(37, 59, 64)*. Another potential concern is that studies of *Salmonella* in eggs are generally focused on either whole or liquid eggs, without taking into consideration egg dishes such as casseroles and pies that could be insufficiently

cooked *(54)*. This means that survival rates of *Salmonella* in more complex dishes are unknown, nor is it known if those dishes are commonly undercooked by consumers.

Barriers to food safety

Consumers often believe that their actions at home won't affect their food safety. This comes from a belief they are invulnerable to food poisoning from foods that they prepare themselves, or that their behaviors and actions will not lead to foodborne illness *(110, 125)*. Although the industry strives to make food safer from their end, the consumer is ultimately still responsible for their own choices in regards to food safety *(74)*. This means that food safety efforts must extend all the way from farm to fork, taking into account both industry and consumer actions. Unfortunately, the oft repeated message that the food supply is safe can undermine opportunities to educate consumers, as many consumers may not believe they are at risk *(68)*.

Despite the relatively commonplace nature of foodborne illnesses, many believe that foodborne illness comes almost exclusively from outside the home, placing the blame on restaurants or food manufacturers *(8, 45, 80)*. While it is true that many of these illnesses can come from outside the home, a large amount still comes from improper food safety behavior within the home as well *(7, 116, 142)*. Educational efforts have been suggested as a means to increase consumer knowledge of correct food safety behaviors and consequences of poor food safety behaviors *(62, 79)*. While these efforts may help increase *knowledge* of correct behaviors, they are not always successful at actually changing the behaviors. Habits can dictate consumer behaviors, especially when consumers do not feel like there is a strong incentive for change *(45)*.

Retail workers have reported that some of the main reasons for not following food safety behaviors include time constraints, inconvenience, inadequate education, or inadequate resources *(63)*. These same reasons are seen in the home as well, as reported by studies that have attributed low adherence to food safety practices by consumers to lack of knowledge, inconvenience, and laziness *(76, 89)*. All of these attitudes may arise from the false perception of lack of risk or consequences for their behaviors *(29)*. Consumers will not fully adopt health related behaviors until they believe they are at risk to an illness with serious consequences, that their actions will reduce that risk, and that the benefits of the action outweigh the drawbacks to following the action *(25)*. Although media sources are good at sharing information about the risk of foodborne illness outbreaks, they are not usually focused on teaching everyday food safety behaviors to their viewers *(136)*. Consumers must also know what to do to reduce that risk and be confident in their ability to follow the requisite behaviors before they will successfully change their behaviors *(14, 15, 35, 105, 135)*.

Food safety behaviors among consumers

Studies on food safety behaviors of consumers approach the problem from a number of directions. In 2003, Redmond and Griffith *(108)* found that in the 25 years prior, 75% of research on consumer food safety had been done through survey techniques, 17% were observational studies, and 8% were focus groups. This shows that the most popular method of determining consumer behaviors is to use large surveys to determine attitudes and self-reported behaviors. From these surveys, we can gain insight into consumer perceptions, in not only what they believe they should do, but what they

think they are doing well. These surveys also give an insight into what general knowledge consumers have.

Some of these self-reported behavioral studies have indicated that consumers are more aware of safe food practice than they have been in the past. According to a study in 2008 by Levy and others *(82)*, safe food practices have increased in the United States in the decade prior. Similarly, Fein and others found that food safety practices increased significantly between 2006 and 2010, though risk perceptions did not change *(45)*.

Other surveys have also indicated that consumers practice some good behaviors, and are slowly improving in their food safety practices. Most consumers report washing their hands with soap for a full 20 s before food preparation *(4, 72)*. Even food thermometer use, one of the most notoriously difficult behaviors for consumers to adopt *(31, 127)*, has seen increases over time in self-reported surveys. One national web-based survey found that 62% of US adults owned a thermometer, with 73% of owners using it for large meats such as whole turkeys, though only a smaller amount (12-26%) reported using it for smaller cuts of poultry *(77)*. Another national telephone survey found that thermometer ownership increased from 49% to 70% in the decade prior to 2010 *(81)*. Additionally, those who owned a thermometer reported high usage in large meats such as roasts (82%), with smaller numbers using it for chicken parts (52%) and hamburgers (23%) as well *(81)*. Reported food safety behaviors are lower in young adults than in the older generation, with some evidence showing that young adults are more likely to engage in risky food handling *(1, 19, 20, 43)*.

One difficulty with studies that rely on self-reported behaviors is that consumers tend to underreport behaviors that they feel are not safe, such as lack of hand washing or

thermometer use *(103, 107, 115)*. This makes it difficult to study food safety behaviors based on surveys alone, which has led to some researchers combining data from self-reported behaviors with observational studies of food safety. Observational studies are not as common, as they can be more time consuming, expensive, and difficult to manage than surveys; however, they can add valuable and needed data for researchers *(108)*.

The main benefit of observational studies is that they do not rely on second-hand accounts, which may depend on the memory or interpretation of a consumer *(114)*. This means that any observed actions should more accurately reflect what the true behaviors of consumers are, rather than what the consumers think they are *(123)*. Observational studies can take place in either the home kitchen of the consumer, considered to be a more "natural" environment, or they can take place in a laboratory environment, considered to be a more "controlled" environment. There are proponents for each method, with some stating that the more natural environment will give a more realistic view of how a consumer behaves, since that is what they are used to *(32)*. Arguments for using a controlled environment state that the natural environment may have uncontrollable extraneous variables, which makes the data more ambiguous and less repeatable *(32)*. However, research by Redmond *(106)* has compared food safety behaviors in both locations, and found that key consumer behaviors remain consistent between locations.

Though there are fewer observational studies, they have almost universally shown that consumer behaviors are much worse than when they are self-reported. For instance, a large majority of participants in a survey by Dharod and others *(42)* reported that they followed food safety behaviors, but when 60 of the surveyed households were observed

preparing foods, only a fraction were seen to follow correct procedures, such as washing hands with soap for 20 seconds. Another research study showed that between 73-100% of participants who had reported washing their hands after handling raw chicken that was artificially contaminated with *Campylobacter jejuni* still had the bacteria on their hands, meaning their hand washing behaviors were inadequate to prevent cross-contamination *(39)*. DeDonder and others *(41)* likewise showed that although most participants reported washing their hands after handling raw poultry, 48% incorrectly washed their hands. Sneed and others *(119)* showed that although food safety messages helped improve some cross-contamination behaviors, bacterial cross-contamination was still high in an observed group of consumers preparing a meat dish with a ready-to-eat fruit salad.

A recent study by Mazengia and others *(87)* had 100% of participants report that they washed their hands before preparing a meal. When they were asked to prepare a meal while being observed, only 20% were observed washing their hands. The same participants were asked about their thermometer usage for poultry items, and 23% stated they used one on a regular basis, but only 5% actually did when observed. Bruhn *(16)* observed a similar rate of thermometer usage during an observational study at only 5%, while DeDonder and others *(41)* saw a rate of about 12%, many of which used it incorrectly. A study by van Asselt and others *(134)* showed cross-contamination in 71% of participants, only 34% washing their hands before preparing a chicken recipe, and 29-33% inadequately washing or changing cutting boards or knives. Similar results have been seen in other observational studies as well, with poor adherence to food safety principles *(5, 28, 41, 60, 71, 103, 109, 115)*.

One consistent throughout both the surveys and the observational studies is low thermometer use. Both types of studies typically report low thermometer ownership *(77)*, and even those that own a thermometer tend to not use one with smaller pieces of meat *(41, 88, 103, 115)*. Consumers prefer instead to rely on visual means instead, like cutting the meat open to check the color and see if it is done to their liking *(9, 111)*. One of the main limitations of using visual appearance alone to determine doneness is that humans are not able to determine if meat is cooked to the correct temperature by color or appearance alone *(85)*. Meat normally changes in color throughout the cooking process, with redness decreasing and lightness values increasing *(36, 58)*. However, numerous factors go into meat color that can throw consumer perceptions off, such as some meats experiencing premature browning. This can occur due to factors such as species, packaging conditions, freezing or thawing meat, and addition of other ingredients like salt *(73)*. Meats can also have pink colors present well after they are cooked to the appropriate temperature, depending on factors such as pH, packaging, thawing conditions, fat content, processing conditions, and added ingredients like nitrile *(73)*. This defect is most often seen in poultry, and is known as "pinking." This pink color is not harmful, but can cause consumers to continue cooking their food past the recommended temperature for safety, resulting in a loss of quality from being overcooked *(61, 117)*. Though this may not specifically be a safety issue, it can cause confusion in consumers as to what poultry color should be when properly cooked. Combined with the issue of premature browning, this illustrates that color alone is a poor indicator for doneness in meat products.

Appearance of meats can also vary depending on the environment and lighting conditions where the meat is prepared *(30, 49)*. Lightbulbs have changed over time, with acts such as the Energy Independence and Security Act of 2007 (EISA 2007) introducing new rules to limit the import or manufacture of what were deemed inefficient lightbulbs. The legislation took place from 2012-2014, and caused the removal of traditional incandescent lightbulbs from stores *(131)*. This change in lighting regulations means that consumers who previously relied on incandescent bulbs for lighting in their kitchens will be forced to replace them with newer, more energy efficient bulbs as the old ones burn out. Other consumers may simply decide to change to one of the newer, more energy efficient options to save energy and money. Either way, these changes in lighting conditions can change food color perceptions. Though consumers may argue that they have always used appearance to determine meat doneness and it has served them well enough, these changes may give a stronger message to consumers that visual appearance cannot be relied on for meat doneness.

Effective communication

To make food safety messages more effective, there are several qualities that the messages should have. The first step is to make sure the audience is appropriate, and that the message is targeted to that audience *(68)*. Understanding what it is that consumers know, value, and do is a vital step towards knowing what information is needed. For example, research has shown that Millennials are less likely to remember food safety issues, and more likely to overreact to those scenarios; in this case, understanding how to better deliver messages specifically to Millennials may help improve those behaviors in the younger population *(102)*. Knowing how to communicate information to the right

groups can help the appropriate messages be received by the target audience *(17, 46, 47, 95)*.

Another step in improving the message is to make sure the appropriate outlets are used for the target audience, including using the right type of media *(90)*. Outlets for messages can include simple sources such as cookbooks *(18)*, or more complex sources such as magazines, cooking shows, and websites *(120)*.

Sources of food safety information

Recipes are common sources of cooking information for consumers, and can come in a range of formats such as magazines, cookbooks, and internet blogs. Recipes have been reported by consumers as one of their major sources of food safety information in the past *(18)*, but a review of cookbooks found that only 20% contained any safety information *(56)*. Despite the current lack of information in cookbooks, consumers have still expressed a desire to have food safety instructions in their recipes *(48, 55)*.

One such cookbook with food safety instructions incorporated into the recipes was developed and tested by Godwin and others *(53)*. A sample of 258 older adults were given the cookbook and asked to evaluate it over a period of a few months, reporting their experiences at the end. The majority felt that they learned something new through the use of the cookbook, and over half of the participants reported changing their behaviors as a direct result of using the recipes *(53)*. This illustrates that understanding consumer needs and targeting food safety messages to the appropriate audience can bring about a change in behavior. Despite these promising results, an observational study had not been done to determine if there was a difference between the actual vs. self-reported behaviors as a result of consumers using these types of recipes.

Another source of food safety information could potentially come from cooking shows, especially those that demonstrate how to prepare dishes *(56)*. Television programming featuring celebrity chefs has gained popularity over the years and expanded to other avenues including the internet. These chefs act in some sense as role models for consumers *(104)*. As they prepare dishes and offer commentary on them, they help determine correct food preparation in the eyes of consumers, as well as what is acceptable in food dishes *(22)*. Even children, when asked to consider food preparation, are aware of these celebrity chefs, and have therefore likely been exposed to the behaviors of the chefs as well *(21)*.

Some would argue that television shows and celebrity chefs are merely for entertainment, rather than education. Certainly the producers of these shows are looking to maximize the entertainment value in the time they are allotted, and thus choose to show only what is the most entertaining to the viewers, which could lead to them leaving out any food safety information or behaviors. To that effect, studies have shown that celebrity chefs may not be influential in changing the eating behaviors of their viewers, at least on a conscious level *(22, 38, 113)*. Still, surveys of consumers still show that some consumers do rely on cooking shows for informational purposes, both on how to prepare food well, and how to prepare it safely *(129, 136)*.

The current modeled behaviors of celebrity chefs should be considered as well. From previous studies that have looked at their behaviors compared to known good food safety practices, celebrity chefs have demonstrated a lack of good food safety behaviors, instead showing many practices that would lead to foodborne illness if followed at home *(10, 66, 86, 141)*. Common behaviors seen in these chefs are similar to those seen in

observational studies of consumers, including lack of hand washing, cross-contamination, lack of thermometer use, and poor cooling procedures for the food *(10, 66, 86, 141)*. Studies of this nature often focus on the behaviors of a limited number of chefs *(66, 141)*, though Mathiasen and others *(86)* looked at a wider variety that were available in Canada. As more of the population uses internet to view television shows *(89, 96)*, it is also important to take into account shows that are available through online sources as well.

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Chapter 3 - Recommendations for determining doneness found in egg dish recipes

Abstract

Research has shown that many consumers do not follow recommended food safety practices for cooking egg dishes, potentially leading to foodborne illnesses such as Salmonellosis. The USDA recommends cooking egg mixtures until the center of the mixture reaches 160°F. The objective of this study was to determine what endpoint temperature information consumers receive when using egg dish recipes. Two hundred twenty-six egg recipes from 65 websites, 50 cookbooks, and 9 magazine titles (multiple issues of each) were analyzed. Recipe types included in decreasing order: pie, quiche, casserole, frittata, custard, strata, soufflé, omelet, cheesecake, pudding, and other. One hundred seventy-five recipes gave multiple indicators for determining the endpoint of the cooking process, 95 gave a single indicator in addition to time, 49 gave only a single indicator, and 2 gave neither a visual nor a time indicator. Time was the most frequently used indicator, given in 92% of the recipes, with 15% using only time. Other indicators included: product was set (89), browned (76), had a probe inserted and came out clean (60), was puffed (27), or jiggled (13), with bubbling, thickening, and other methods only seen in a few recipes. Thermometer temperatures were given in only two of the recipes. This review shows that consumers are not receiving information on endpoint temperatures recommended by USDA in recipes they likely use for cooking egg dishes.

Introduction

Foodborne illness continues to be a public concern, with large social and economic tolls due to hospitalizations, loss of productivity, and death *(2)*. Many of these illnesses can be prevented through education and adherence to food safety recommendations, such as proper food handling, preparation, and storage *(14)*. One of the most common foodborne illnesses is *Salmonella*. Although there have been decreases in many other foodborne illnesses, *Salmonella* rates have remained steady *(9)*. The U.S. Food and Drug Administration (FDA) estimates around 142,000 illnesses each year are due to consumption of improperly prepared eggs that contain *Salmonella (13)*, making eggs the principal risk factor for some strains of *Salmonella (1, 8)*.

There are no temperature recommendation for eggs when cooked by themselves; instead guidelines state only that they should be cooked until the yolk and white are firm, not runny *(10)*. For dishes that include raw or undercooked eggs, such as ice cream, and salad dressing, it is recommended that pasteurized egg products be used *(10, 12)*. Those same sources recommend that egg dishes such as casseroles be cooked until the internal temperature reaches 160 °F.

Common methods of egg cooking do not completely eliminate *Salmonella* in grossly contaminated eggs *(11)*. Although hard-cooking, soft-cooking, and poaching eggs have been shown to reduce *Salmonella* to a potentially safe level, other methods such as sunny-side-up, over-easy, and scrambling egg cooking do not adequately reduce bacteria levels *(3, 7)*. Studies that have looked at *Salmonella* survival rates in eggs have typically been done with either whole or liquid eggs, and have not looked at more

complicated dishes, such as casseroles and pies that might be the source of illness in the home *(5)*.

One potential source of information on consumer food safety is recipes. Consumers have expressed that one of their preferred sources of food safety information was cookbooks and other print recipes *(15)*. A study by Godwin et al. showed that cookbooks with food safety information could alter the safety behaviors of consumers *(4)*. Unfortunately, food safety information has not been common in cookbooks *(6)*.

The objective of this study was to determine what recommendations concerning determination of doneness consumers receive when using egg dish recipes found in cookbooks and internet sources. A comparison of this information to the recommendations given by regulatory agencies, such as the FDA and USDA, will demonstrate any gaps between what information consumers are being exposed to through recipes, and what information can potentially be added in to recipes to improve food safety information for consumers.

Materials and Methods

Recipes

Recipes were selected from multiple sources used by consumers, both online and in print. Sources included retail locations (including supermarkets and kitchen supply stores), blogs (both professional and personal, where recipes were the main focus), nonprofit (government, university extension sites, and organizations that promote eggs), magazines, cooking shows, traditional cookbooks, and local cookbooks (from local community organizations in Nashville, TN). The number and types of recipes used from each source are shown in Table 3.1.

In total, two hundred twenty-six egg recipes were analyzed for this study. Recipes where eggs were one of the critical components, and where those could potentially be undercooked were chosen. These recipes came from 65 websites, 50 cookbooks, and 9 magazine titles (with multiple issues of each). Recipe types included for analysis were (in decreasing order of frequency): pie, quiche, casserole, frittata, custard, strata, soufflé, omelet, cheesecake, pudding, torte, and other.

Table 3.1 Sources of recipes used in the study, along with types of recipes from each source.

Source	Type	# of Recipes	Pie	Quiche	Casserole	Frittata	Custard	Strata	Souffle	Omelet	Cheesecake	Pudding	Torte	Other
Internet	Retail	**23**	18	13	4	11	9	3	7	5	1	1	-	2
	Blogs	**14**	26	3	13	1	4	1	1	-	4	2	1	1
	Nonprofit	**14**	12	10	-	-	-	1	-	-	-	-	-	-
	Magazines	**10**	1	1	-	1	1	2	-	-	-	1	2	-
	Cooking Shows	**9**	3	4	1	-	-	2	-	-	-	-	-	-
Print	Traditional Cookbooks	**74**	3	8	1	1	-	-	1	-	-	-	-	-
	Local Cookbooks	**57**	3	7	2	2	-	-	-	-	-	-	-	-
	Magazines	**25**	8	4	3	4	1	1	-	-	-	-	-	4
TOTAL		**226**	**74**	**50**	**24**	**20**	**15**	**10**	**9**	**5**	**5**	**4**	**3**	**7**

Pies included in these recipes were mostly custard and cream type pies, such as pumpkin, lemon, custard, and coconut. When recipes fell into two categories, such as a custard put into a pie, the category where the final cooking of the eggs happened was

selected. Recipes in the Other category included those where only one recipe was found that didn't fall into another category, such as egg tacos, macaroons, and Shaksouka.

Analysis

The directions of each recipe were categorized by what method was recommended to the consumer for determining when the dish was finished cooking. The majority of the recipes gave more than one method for determining the doneness of the product, so an overall count of indicator type was used. Where recipes used different wording to describe the same method, they were combined into a single category; for instance, "browned," "golden brown," and "light brown" were all combined into one category, as were the variations of utensils, including using a fork, knife, or toothpick. Directions such as "cooked through," "edges pull away," and "clumped" were placed in the Other category. Categorization of the recipes was done by two separate researchers, and then compared for accuracy and consistency. Any differences were resolved by a third researcher.

Results and Discussion

Recipes gave one (22%), two (46%), three (27%), or four (5%) indicators of doneness. Only two recipes gave no indicator of doneness. Of those recipes that gave only one indicator, the most common (78%) was time.

Indicators used by the recipes in order of frequency included cooking time (92%), being "set" (39%), brownness (34%) , having a probe or utensil come out clean (27%), puffiness (12%), reduced jiggling (6%), other (5%), thickening (3%), bubbling (3%), final temperature (1%), and raw eggs (1 recipe). Time (or a range of time) was by far the most common indicator given, found in 92% of the recipes. Those recipes that gave no

other method of determining doneness other than time could be especially difficult for consumers who were not familiar with preparing the product and knowing when to stop cooking the items. This could result in undercooked items that carry an increased risk of leading to foodborne illness.

Approximately 40% of recipes used the word "set" as a doneness indicator with over half (54%) stating only "until set," and others specifying what part of the dish should be set, whether sides (27%), top (9%), center (6%), or bottom (4%). The bottom being set was used in recipes such as frittatas where the eggs were undisturbed during the cooking process. It is important to note that those that gave a location other the center could have resulted in a center that was not set or cooked completely.

Only two of the recipes, both from commercial sources, gave an endpoint temperature for the egg dish and both recommendations met USDA minimum temperature guidelines. One, a strata with ham, recommended that the thermometer inserted in the center read 170 °F, while the other, a custard pie, recommended 160 °F as a cooking temperature for the custard before baking the pie. Both still used time as the primary method for determining doneness, with temperature as a secondary means of checking the product if a thermometer was used.

Conclusion

Almost all of the indicators of doneness found in these recipes were based on methods that were either visual (color, set, or a probe coming out clean) or time based. Almost none of the recipes even gave a temperature to reference during the cooking procedure. This shows that consumers are not receiving the information on endpoint

temperatures recommended by the USDA in the recipes that they likely use for preparing egg dishes.

Efforts to educate consumers on egg safety should emphasize that recipes may not give adequate endpoint indicators. In addition, those who develop and publish recipes should be encouraged to include relevant temperature information in recipes to help consumers determine appropriate doneness for egg and potentially other dishes. Due to the wide variations found in cooking appliances, time is surely insufficient as an indicator, and visual methods can also be highly subjective and dependent on the consumer's own understanding of the product. This may leave consumers vulnerable to foodborne illnesses from undercooked eggs.

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Chapter 4 - Food safety behaviors observed in celebrity chefs across a variety of programs

Abstract

Background Consumers obtain information about foodborne illness prevention from many sources, including television media. The purpose of this study was to evaluate a variety of cooking shows with celebrity chefs to understand their modeling of food safety behaviors.

Methods Cooking shows (100 episodes) were watched from 24 celebrity chefs preparing meat dishes. A tabulation of food safety behaviors was made for each show using a checklist.

Results Proper modeling of food safety behaviors were limited, with many incidences of errors. For example, although all chefs washed their hands at the beginning of cooking at least one dish, 88% did not wash (or were not shown washing) their hands after handling uncooked meat. This was compounded with many chefs who added food with their hands (79%) or ate while cooking (50%). Other poor behaviors included using not using a thermometer (75%), using the same cutting board to prepare ready-to-eat items and uncooked meat (25%), and other hygiene issues such as touching hair (21%) or licking fingers (21%).

Conclusions This study suggests that there is a need for improvement in demonstrated and communicated food safety behaviors among professional chefs. It also suggests that public health professionals must work to mitigate the impact of poorly modeled behaviors.

Introduction

An estimated 48 million Americans, or about 1 in 6, are exposed to foodborne illnesses each year in the United States[1]. These illnesses often result in a huge cost, both economic and social, as those affected experience loss of health or even life[2]. As a source of illness that can be prevented through improved behaviors, many efforts by regulatory and educational institutions have been made towards the prevention of these illnesses. Many of these efforts focus on improving food safety behaviors in the populace with the aim of increasing the hurdles these bacteria or viruses must overcome to ultimately affect a consumer[3,4].

Foodborne illnesses are a matter of public health, as outbreaks can quickly affect a large group of people, and can be especially harmful to those who already have weaker immune systems such as residents of nursing homes, hospitals, or schools[5-8]. Foodborne illnesses find their way into the populace through a number of avenues, including restaurants, grocery stores, and the home itself. Despite the relatively commonplace nature of these illnesses, many consumers erroneously believe that foodborne illness comes almost exclusively from outside the home[9,10]. On the contrary, the home can be a large source of foodborne illness, and can even result in outbreaks of foodborne illness in the community[5,11,12].

Consumers get food safety information from a variety of sources, whether learned in the home, in an educational setting, from government agencies, and through media. However, this knowledge has been shown to be fairly limited[13], and observational studies have shown poor practices of these food safety behaviors[14-18]. Studies have shown that

educational efforts in communities can increase knowledge of appropriate food safety behaviors[19,20].

Unfortunately, even when consumers have this knowledge, they may not change their behaviors to reflect this knowledge[21]. People are habitual creatures, and often times will choose to follow the practices they are familiar with rather than adopting safety recommendations[9]. This makes it difficult to change behaviors in consumers to prevent foodborne illness.

Increased media exposure to food safety issues has been suggested as an avenue to increase consumer awareness and practices of food safety practices[10]. One potential source of information for consumers is cooking shows[22]. Although some studies have shown that cooking shows may not be overly influential in changing how or what people eat[23-25], they still may be able to influence food safety among their viewers[26].

Celebrity chefs have risen in popularity throughout the years, and can serve as a type of role model for consumers[27]. Their position allows them to be influential in determining food preparation and what is acceptable in food[24]. Their prevalence in our society is so ingrained that even children have been shown to be aware of, and thus potentially influenced by, celebrity chefs[28]. However, food safety practices have been shown to be poorly followed on some television shows[26,29-31].

The purpose of this study was to evaluate the behaviors modeled by chefs across a wide variety of cooking programs found on television and online. The focus of this study was also on recipes which contain meat as it is relatively easy to cross-contaminate the bacteria from meat during its preparation, and meat, including poultry and fish, may be one of the main sources of foodborne illness [32].

Methods

A total of 100 episodes of cooking shows were watched during the period of January to October 2015. Shows were randomly chosen that were available through either cable or a variety of online services, such as Hulu, Netflix, or Amazon. Each show was analyzed with respect to their adherence to common food safety practices.

The questionnaire developed for this study relied both on expert food safety knowledge and on prior studies of this nature[26,29,30]. Behaviors in the observational sheet followed the recommended practices from the Fight Bac! Program, including *Clean, Separate, Cook,* and *Chill* [33]. The questionnaire consisted of a list of food safety behaviors, and an option to tally the number of times each behavior was observed during the episode, as well as a free response question to capture anything not included on the sheet. Both positive and negative food safety behaviors were included for observation.

Additional information about each show was also collected, including show duration and episode, number of dishes prepared, and chef. Shows were chosen that contained meat dishes, as the likelihood for contamination is greater when preparing meat. Data was collected, tabulated and analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA).

Results

A total of 100 episodes of cooking shows were watched by the reviewers for this study. These episodes were hosted by 24 different chefs, and covered 30 unique series. Episodes varied between approximately 20 – 40 minutes in length. The series that were watched for this review are listed in Table 4.1.

Table 4.1 Cooking shows analyzed for food safety behaviors, with their respective celebrity chefs.

Name of TV Show	Celebrity Chef
Avec Eric	Avec Eric
Barefoot Contessa	Ina Garten
Brunch @ Bobby's	Bobby Flay
Cooking for Real with Sunny Anderson	Sunny Anderson
Easy Chinese	Ching-He Huang
Emeril's Table	Emeril Lagasse
Fresh with Anna Olson	Anna Olson
From Martha's Kitchen	Martha Stewart
Giada at Home	Giada De Laurentiis
Good Eats	Alton Brown
Gordon Ramsay's Home Cooking	Gordon Ramsay
Gordon Ramsay's Ultimate Cooking Course	Gordon Ramsay
Gordon Ramsay's Ultimate Home Cooking	Gordon Ramsay
Guy's Big Bite Backyard	Guy Fieri
Jamie at Home	Jamie Oliver
Jamie Oliver's Comfort Food	Jamie Oliver
Jamie's 15 Minute Meals	Jamie Oliver
Kelsey's Essentials	Kelsey Nixon
Kimchi Chronicles	Jean-Georges Vongerichten
Lidia's Italy	Lidia Bastianich
Marry Berry's Absolute Favorites	Mary Berry
Nigellissima	Nigella Lawson
Rachel Ray's 3 in the bag	Rachel Ray
Real Food Real Kitchens	Fernando Desa
Surfing the Menu	Ben O'Donoghue, Curtis Stone
Symon's Suppers	Michael Symon
The Essence of Emeril	Emeril Lagasse
The Occasional Cook	James Reeson
The Pioneer Woman	Ree Drummond
Throwdown with Bobby Flay	Bobby Flay

Table 4.2 Food safety behaviors or lapses exhibited by television chefs. Data reported as number of episodes containing the behavior (% of episodes watched). Italicized behaviors were noted as "positive" food safety behaviors.

	Alton Brown	Anna Olson	Avec Eric	Curtis Stone	Bobby Flay	Ching-He Huang	Emeril Lagasse	Fernando Desa	Giada De Laurentiis	Gordon Ramsay	Guy Fieri	Ina Garten
CLEAN												
Washed hands before cooking	4 (50)	2 (100)	2 (100)	13 (100)	4 (100)	11 (100)	3 (100)	3 (75)	2 (67)	6 (100)	1 (100)	5 (100)
Washed hands after touching raw meat	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (33)	2 (50)	1 (33)	0 (0)	0 (0)	0 (0)
Rinsed hands only	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)	1 (9)	1 (33)	1 (25)	0 (0)	0 (0)	0 (0)	1 (20)
Didn't wash hands after handling meat	5 (63)	0 (0)	2 (100)	13 (100)	4 (100)	10 (91)	1 (33)	2 (50)	2 (67)	6 (100)	1 (100)	4 (80)
Licked fingers	0 (0)	0 (0)	0 (0)	8 (62)	1 (25)	0 (0)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Touched head/hair	0 (0)	0 (0)	0 (0)	1 (8)	0 (0)	1 (9)	0 (0)	0 (0)	0 (0)	1 (17)	0 (0)	0 (0)
Washed produce or RTE items before use	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (33)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)
SEPARATE												
Sampled (ate) food with hands	0 (0)	0 (0)	0 (0)	10 (77)	1 (25)	3 (27)	1 (33)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)
Added food with hands	0 (0)	1 (50)	1 (50)	10 (77)	4 (100)	11 (100)	2 (67)	1 (25)	2 (67)	0 (0)	0 (0)	1 (20)
Ate while cooking	0 (0)	0 (0)	0 (0)	6 (46)	2 (50)	2 (18)	1 (33)	1 (25)	0 (0)	2 (33)	0 (0)	1 (20)
Washed meat before cooking	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)
Raw & RTE items were shown touching	0 (0)	0 (0)	0 (0)	2 (15)	3 (75)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Cutting board/surface washed or changed	0 (0)	0 (0)	0 (0)	0 (0)	2 (50)	6 (55)	2 (67)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)
RTE items were cut on same cutting board	0 (0)	0 (0)	0 (0)	3 (23)	0 (0)	0 (0)	0 (0)	0 (0)	1 (33)	1 (17)	0 (0)	0 (0)
COOK												
Used time as indicator	8 (100)	0 (0)	1 (50)	10 (77)	0 (0)	9 (82)	2 (67)	2 (50)	1 (33)	6 (100)	1 (100)	5 (100)
Used color as indicator	3 (38)	0 (0)	2 (100)	8 (62)	3 (75)	9 (82)	3 (100)	2 (50)	2 (67)	3 (50)	1 (100)	3 (60)
Used texture as indicator	1 (13)	1 (50)	1 (50)	1 (8)	3 (75)	3 (27)	0 (0)	2 (50)	1 (33)	0 (0)	1 (100)	0 (0)
Used thermometer as indicator	1 (13)	1 (50)	0 (0)	0 (0)	0 (0)	1 (9)	2 (67)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)
CHILL												
Incorrect cooling procedure shown or mentioned	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Appropriate storage procedures shown/mentioned	5 (63)	1 (50)	0 (0)	0 (0)	0 (0)	1 (9)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AVG # of behaviors / episode: negative (positive)	**2.9**	**4.5**	**5.5**	**7.5**	**6.8**	**6.5**	**10.3**	**7.8**	**5.0**	**10.0**	**7.0**	**5.4**
AVERAGE # of positive behaviors / episode	**1.3**	**1.5**	**0.0**	**0.2**	**1.3**	**0.9**	**5.3**	**2.3**	**0.3**	**0.2**	**1.0**	**0.0**

	James Reeson	Jamie Oliver	Jean-Georges Vongerichten	Kelsey Nixon	Lidia Bastianich	Martha Stewart	Mary Berry	Michael Symon	Nigellissima	Rachel Ray	Ree Drummond	Sunny Anderson
CLEAN												
Washed hands before cooking	2 (100)	4 (100)	3 (100)	2 (100)	8 (100)	4 (100)	1 (100)	2 (100)	1 (100)	1 (100)	7 (100)	1 (100)
Washed hands after touching raw meat	0 (0)	2 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)	1 (14)	1 (100)
Rinsed hands only	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	0 (0)
Didn't wash hands after handling meat	1 (50)	3 (75)	3 (100)	1 (50)	8 (100)	4 (100)	1 (100)	2 (100)	0 (0)	1 (100)	7 (100)	0 (0)
Licked fingers	0 (0)	1 (25)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Touched head/hair	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	1 (100)
Washed produce or RTE items before use	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
SEPARATE												
Sampled (ate) food with hands	1 (50)	1 (25)	0 (0)	1 (50)	1 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Added food with hands	2 (100)	2 (50)	3 (100)	1 (50)	5 (63)	1 (25)	0 (0)	1 (50)	1 (100)	1 (100)	1 (14)	0 (0)
Ate while cooking	0 (0)	2 (50)	1 (33)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	1 (100)
Washed meat before cooking	1 (50)	0 (0)	0 (0)	0 (0)	1 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Raw & RTE items were shown touching	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)
Cutting board/surface washed or changed	0 (0)	1 (25)	0 (0)	1 (50)	0 (0)	0 (0)	0 (0)	1 (50)	0 (0)	0 (0)	1 (14)	0 (0)
RTE items were cut on same cutting board as meat	0 (0)	1 (25)	0 (0)	0 (0)	2 (25)	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)
COOK												
Used time as indicator	1 (50)	4 (100)	3 (100)	2 (100)	7 (88)	4 (100)	0 (0)	2 (100)	1 (100)	1 (100)	6 (86)	1 (100)
Used color as indicator	1 (50)	2 (50)	2 (67)	1 (50)	5 (63)	1 (25)	1 (100)	1 (50)	1 (100)	1 (100)	5 (71)	1 (100)
Used texture as indicator	2 (100)	2 (50)	1 (33)	0 (0)	1 (13)	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)
Used thermometer as indicator	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	0 (0)	0 (0)	0 (0)	0 (0)
CHILL												
Incorrect cooling procedure shown or mentioned	1 (50)	0 (0)	0 (0)	1 (50)	0 (0)	0 (0)	0 (0)	1 (50)	1 (100)	0 (0)	1 (14)	0 (0)
Appropriate storage procedures shown/ mentioned	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	0 (0)
AVERAGE # of negative behaviors / episode	**9.0**	**19.8**	**7.3**	**5.5**	**5.4**	**3.5**	**6.0**	**6.0**	**30.0**	**8.0**	**6.4**	**7.0**
AVERAGE # of positive behaviors / episode	**1.0**	**0.3**	**0.0**	**0.5**	**0.0**	**0.5**	**0.0**	**1.0**	**1.0**	**0.0**	**0.3**	**1.0**

All of the episodes featured at least 1 meat dish, with some episodes containing up to 5 meat dishes. The shows varied in how they handled the preparation of the meat dishes, with the majority of episodes (84%) preferring to focus on one dish at a time, though some did focus on one dish while occasionally checking on another (12%), and the remainder prepared more than one dish simultaneously. Preparing one dish at a time, especially when meat is involved, may help prevent cross-contamination to other dishes that will not be fully cooked.

The most common type of meat that was prepared during the shows was beef (40% of episodes had at least one), followed by seafood (36%), chicken (32%), pork (22%), and lamb, goat, or other game (11%). Of the meat that was prepared, the cuts that were most often used were pieces such as breast or steak (75% of episodes), followed by whole meats such as an entire turkey (22%), ground meat (16%), cured meat such as bacon or sausage (11%), and the remaining as liver or other organ meats. Finally, it is important to note that although many meats were cut on the show (45% of episodes), other dishes were either pre-cut or no cutting was needed such as in ground meat.

The complete list of observations by chef can be seen in Table 4.2, while Figure 4.1 shows the number of incidences of each behavior across all chefs, along with the percent of chefs who displayed that behavior at least once. All of the chefs that were included in this study washed their hands at the beginning of at least one of the dishes they prepared. However, after handling meats only some of the chefs (7 of the 24) were shown washing their hands, and not after every time they touched the meat. By contrast, almost all of the chefs (21 of the 24) were seen handling uncooked meat without washing their hands during an episode.

The most common behavior in the separate category, exhibited by 19 of the chefs (79%), was adding food using their hands when the food would not be cooked further. Half of the chefs also ate while cooking at some point during their programs, and 38% of the chefs sampled the food using their hands either during or after cooking. Combined with the lack of hand washing shown after touching raw meat, this could lead to foodborne illness if consumers followed the example of the chefs.

Safe cutting board use only demonstrated by about 33% the chefs, with the chefs either changing or washing the cutting surface after cutting uncooked meat. Some of the chefs (25%) were shown cutting ready-to-eat (RTE) items on the same cutting board as the meat, though none of the chefs who changed or washed their cutting board were shown to do that. Ready-to-eat items were also shown touching uncooked meat items in some cases (21% of chefs). Either of these behaviors can lead to cross-contamination of the RTE items, leading to foodborne illness[34].

The method that the chefs used to determine if the meat was finished cooking was tracked, as the recommended method by the USDA and other agencies is to use a thermometer[35]. Temperature was only given by 6 of the chefs (25%), for a total of 4 poultry recipes, 4 beef recipes, 3 pork recipes, and 1 seafood recipe. Almost all (96%) of the chefs indicated that color was a good method to use to determine doneness, followed closed by time (88% of the chefs). This is an area for improvement, as consumers may not know what temperature to cook an item to, and recipes typically do not contain that information[22].

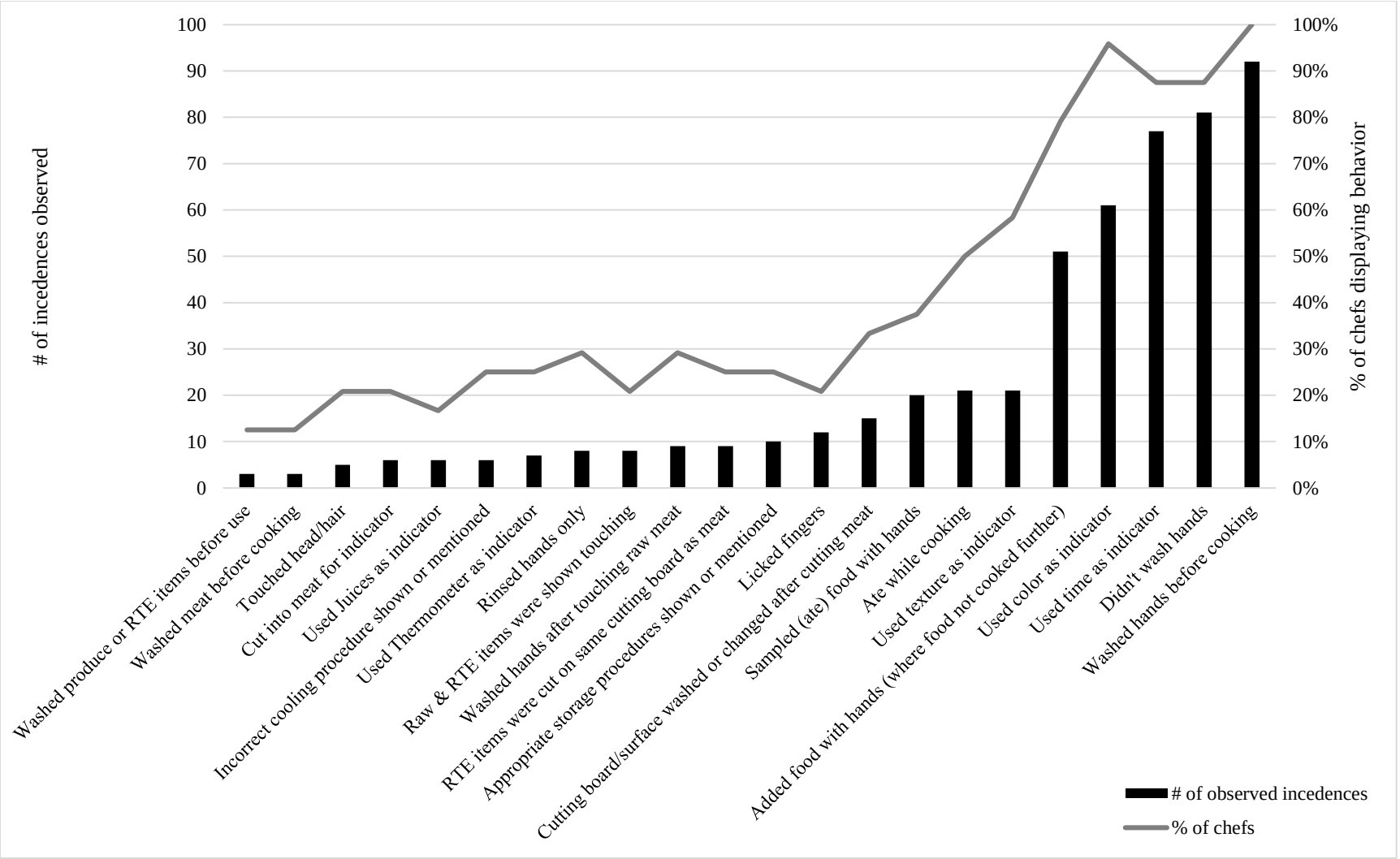

Figure 4.1 Total number of food safety behaviors observed across all episodes (displayed as bars), with percent of chefs displaying the behavior at least once while preparing a dish (displayed as a line).

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Discussion

Main findings of this study

Celebrity chefs across a variety of programming did not demonstrate proper food safety behaviors. Worse, they often displayed behaviors that would lead to cross-contamination among those cooking. Behaviors most commonly seen included handling raw meat without hand washing, sampling and handling ready-to-eat foods with hands, and not giving appropriate indicators for meat doneness.

The behaviors modeled by the chefs could lead to incidences of foodborne illness, especially among those who mimic their behaviors at home. As potential educators of appropriate cooking behaviors, these chefs instead either ignore food safety, or at best demonstrate only very limited positive behaviors. As consumers observe this behavior at home, it could lead them to believe that the food safety behaviors they know are not that important, or that the poor behaviors are acceptable practice[26].

What is already known on this topic

Observational research has previously been done on a limited selection of celebrity chefs, and their demonstration of food safety behaviors. Celebrity chefs often do not demonstrate appropriate food safety behaviors during their cooking programming. Poor hand sanitation, prevalent cross-contamination, and inappropriate cooking and cooling procedures have been shown on those programs that have previously been observed[26,29-31].

What this study adds

This study included a more broad view of cooking shows available in the United States, including content that was available both on cable networks and online and with a wide variety of chefs. Previous studies have focused on either a very limited number of shows[26,29], or have focused only on what is available through cable television[30]. With the rise of internet viewership of television, it is important to take into account shows that are still available to public through online means[36,37]. Our results suggest that the problem with modeling poor food safety behaviors is widespread among cooking shows across a variety of networks and sources. This suggests that 1) chefs need to better model behavior and 2) that, in the absence of that modeling, public health workers must not only promote positive behaviors, but caution against modeling behaviors based on television celebrities.

Conclusion

The purpose of this study is not to put the blame on any individual chef, but to show that there is a larger problem present with our food television culture. Whether a chef's behaviors are different on the air than they would be elsewhere, or whether their

good food safety behaviors are simply edited out due to time, their "tedious" nature, or other reasons, celebrity chefs are simply not demonstrating good food safety behaviors, and are more often demonstrating poor food safety behaviors. Although some viewers may recognize those poor behaviors and choose not to follow them, others may think that a behavior is fine, or not that important because they see that behavior modeled by someone who is more experienced than they are. This is an issue that must be addressed in a larger public health education context.

Television shows that demonstrate cooking to a home audience are in a perfect position to demonstrate and discuss good food safety habits. The idea of "good food" should remain inseparable from safe food, and the knowledge of proper food safety behaviors is crucial to making both happen. This study shows that there is a large gap that needs to be bridged to help our society improve its food safety behaviors.

It is important to realize that these behaviors can affect the populace who look at television for both entertainment and education. Though the producers of these shows may consider them as simply entertainment, and thus not focus on the food safety aspect, consumers still rely on cooking shows for food safety information, as well as information on food preparation[38,39]. It is therefore essential that those who produce cooking shows include basic food behaviors and information or that public health educators of food safety help those they reach realize that the shows likely demonstrate poor behaviors. In addition, public health advocates should push television shows to help education by modeling appropriate food safety behaviors.

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Chapter 5 - Changes in lighting conditions can negatively affect perception of doneness and likelihood to eat turkey samples

Abstract

Undercooked poultry is a potential source of foodborne illnesses like *Salmonella* and *Campylobacter*. The best way to avoid undercooked poultry is with the use of a food thermometer, which consumers often forego in favor of visual appearance only. Visual appearance relies on many factors, including lighting conditions. This study evaluated the effect of lighting sources and endpoint temperature on consumer perceptions of doneness and likelihood to eat. Consumers (n=104) evaluated photographs of turkey patties cooked to different endpoint temperatures (135°F, 155°F, 160°F, 165°F, 170°F, and 175°F) and rated how the level of doneness and how likely they were to eat each sample, using a 7-point Likert type scale. This was repeated under different lighting sources, including 60 watt incandescent, 43 watt halogen, compact fluorescent, LED, and daylight LED. Lighting changed the perception of doneness and the likelihood to eat the samples, with some of the more modern options such as LED and 43 watt halogen making samples appear as more done, and increasing their likelihood to eat those samples. This included underdone samples at 160°F, potentially increasing risk of consumption of underdone meat. This study shows that recent changes in lighting regulations can affect perceptions of meat color, lending strength to the message of using food thermometers at home.

Introduction

Two of the most common foodborne pathogens in the United States are *Salmonella* and *Campylobacter,* with *Salmonella* responsible for the largest amount of infections *(3)*. The most common pathway for transmission of these pathogens to humans is widely considered to be through contaminated raw or undercooked poultry and poultry products *(1)*. Poultry has been rated as having the highest significant disease burden due to contamination of both *Salmonella* and *Campylobacter (1)*. Ground poultry in specific has been noted to be more likely to be contaminated with *Salmonella* and *Campylobacter* than other poultry products *(5)*.

Despite the push by food safety agencies for consumers to use food thermometers, many studies have reported that only a small percentage of consumers both own and use a food thermometer *(14)*. Observational studies have shown that even when consumers say they use a thermometer when preparing poultry products at home, in practice they rely more on visual methods or time to determine the meat is fully cooked *(7, 16, 18, 23)*. This is especially true for smaller cuts of meat and ground meat *(16)*.

Many consumers of ground meat use appearance, specifically color, to determine their meat is finished cooking *(2, 20)*. Even when they have an understanding of the danger of foodborne illness and a knowledge of proper food safety practices, consumers often do not change their behaviors enough to prepare their meat safely *(17, 19)*. Undercooked poultry can lead to an increased risk of foodborne illnesses from *Salmonella* and *Campylobacter (2)*.

Part of the limitation to using visual appearance to determine doneness are the differences in cooking environments that consumers use, including lighting conditions.

The Energy Independence and Security Act of 2007 (EISA 2007) introduced legislation in the United States to limit the import or manufacture of inefficient lightbulbs. Specifically, it called for lightbulbs to consume less wattage for the amount of light produced, meaning traditional incandescent lightbulbs could no longer be used. The regulations were phased in from 2012-2014 *(27)*.

This change in lighting standards in the United States means that households will likewise gradually change the lighting used throughout the home, including in the kitchen. It is unknown how these new lighting sources will affect color perception. With the large amount of consumers using color to determine that their meat is finished cooking and safe to eat, this could potentially add yet another message to consumers of the importance of not using visual methods during meat preparation.

Meat color can be affected by a number of factors, such as the content and state of myoglobin, the pH level of the raw meat, the fat content, and freezing and thawing of the meat *(9)*. In general, as endpoint temperature increases during the poultry cooking process, redness decreases and lightness increases *(6, 10)*. However, there are defects and other factors that can affect what the final color of the poultry will be when cooked.

Persistent pinking and premature browning are two issues that prevent the use of color as an indicator of doneness in meat products. Persistent pinking refers to a pink color remaining in the meat even after it has reached a safe temperature from a food safety perspective. This pink color can result in consumers believing that poultry is undercooked and unsafe to eat well after it has reached the appropriate cooking temperature *(11, 24)*. Although this may not be a problem from a food safety

perspective, this issue does illustrate that color is not a reliable indicator of doneness in poultry products.

Premature browning has the opposite effect on ground meat products. In beef products, this browning can cause the meat to appear to be done well before it has reached a safe temperature to consume from a microbial standpoint *(24)*. Many factors can affect the final color of the cooked meat, including oxygenated packaging, freezing and reheating, muscle source, pH, and genetics of the animal itself *(13, 15)*.

Meat color can be determined through various methods, including instrumental means, consumer studies, and trained sensory panels *(21, 22, 25)*. In addition, photographs have also been validated as a method for assessing preference for meat doneness in steaks *(4)*. Typically these studies are done under fixed lighting conditions with a fixed light source, but the effect of changing lighting on meat doneness perception has not been evaluated.

The purposes of this study were to determine the effect of lighting on perception of ground poultry doneness levels, as well as to assess perceptions of poultry doneness based on endpoint cooking temperatures. Ground poultry was chosen as the meat source for this study because of the lack of thermometer use that has been shown in ground meat preparation, and because color preference for cooked poultry has not been widely studied.

Materials and Methods

Sample Preparation

Ground turkey (93% lean) was purchased at a local grocery store the day before cooking. The raw meat was formed into ¼ lb. (113 g) patties that were 1 cm thick and approximately 10 cm in diameter. Patties were cooked on a double-sided grill set at

375°F (model HE400CG, Calphalon, Toledo, OH), with the lid closed 10 s after placement on the grill. A type K thermocouple was inserted from the side into the center of the patty to monitor internal temperature (model 15-077-968, Fisher Scientific, Pittsburgh, PA). Immediately upon reaching the desired endpoint temperature, the cooked patties were removed, sliced in half, and photographed (or served to the descriptive panelists).

Patties were cooked to one of six endpoint temperatures chosen to show a range of colors while including temperatures below, at, and above the recommended cooking temperature for poultry, including: 135°F, 155°F, 160°F, 165°F, 170°F, and 175°F. Samples were cooked to each temperature three times and photographed, apart from the 135°F and 175°F samples which only had one photograph from each temperature. For the photographs, the patties were cut in half with the halves placed on top of each other to maximize the view of the internal surface area, and the photograph was taken directly facing the exposed interior of the patties.

Lighting

To evaluate the effect of lighting conditions, booths were set up with each of the most common lighting sources available. Booths were made using white trifold poster boards (Elmer's, Westerville, OH) with desktop lamps (Hamilton Beach, Southern Pines, NC) placed 30 cm directly above the viewing area, with a white cutting board placed on the surface of the table to provide a white background for viewing. Booths were arranged such that each lamp was the only lighting source for the sample, and overhead lighting was turned off during evaluation.

Light bulbs (General Electric, Cleveland, OH) were chosen from the most commonly available standard bulb types, including traditional incandescent (60 watt – no longer available for sale), incandescent replacements (halogen - 43 watt), compact fluorescent (CFL, 13 watt), LED (10.5 watt), and daylight LED (14 watt). With the exception of the daylight LED, all lightbulbs were soft white, 60 watt equivalent lights.

Photographs

The cooked patties were photographed using a Canon EOS Rebel T4i equipped with an 18-135mm lens (f/3.5-5.6 IS STM Lens, Canon, Melville, NY) mounted on a stand. The patties were placed inside a light booth (ProMaster, Photographic Research Organization, Fairfield, Connecticut) with two external 5500K light bulbs. The camera was placed perpendicular to the sample with a focal distance of 35 mm. The camera was set to manual mode with 1/20 shutter speed, F8 aperture size, and ISO 400. An 18% grey reference card was included in the shots to assist with white balance. Raw images in the CR2 format were adjusted in Adobe Photoshop CS4 (Adobe, San Jose, CA) for color accuracy.

Six highly trained panelists from the Sensory Analysis Center, Kansas State University (Manhattan, KS) evaluated the photographs for accuracy compared to meat samples cooked to the corresponding temperatures. Each panelist had completed over 100 hours of training in sensory evaluation of foods, and had a minimum of 2000 h of testing experience of food products.

The photographs were assigned a random 3-digit code and placed in random order under each of the booths with different lights. Turkey patties were likewise cooked to each of the temperatures being tested in random order, assigned a 3-digit code, and

served to the panelists. The descriptive panelists were asked to go to a specific booth where they would visually look at the patty under those lighting conditions, and choose the photograph by consensus that most closely matched that sample. The process was repeated until all cooking temperatures had been seen under all lighting conditions by the panelists. Using this process, the photographs were verified as behaving similarly to the actual meat samples under the different lighting conditions. At the end of the process, 14 total photographs were chosen, with three pictures each from 155°F, 160°F, 165°F, and 170°F, and an additional picture from 135°F and 175°F. Replicates were used due to the occurrence of pinking in some of the samples, to ensure there was an accurate representation of both samples with and without the pinking phenomenon. Pictures at 135°F and 175°F were included to show the extremes of the scale, but were not included in the analysis.

Consumer Study

Consumers (n=104) were recruited from the local community to participate in the study. To participate, consumers needed to be between the ages of 18-64 and to have prepared or eaten ground poultry within the past month. Consumers were asked to evaluate the photographs of the cooked turkey patties under each of the different lighting conditions, though they were not told what type of meat it was beyond poultry.

The consumers were asked to look at each picture under each lighting condition, and evaluate the photograph for both doneness and their likeliness to eat a patty that was cooked to that same doneness. Doneness was evaluated using a 7-point scale, from 1=extremely undercooked, 4=just about right, and 7=extremely overcooked. Likeliness to eat was also evaluated using a 7-point scale, with 1=very unlikely to eat, 4=undecided,

and 7=very likely to eat. No additional questions about the photographs were asked due to the large amount of photographs that were seen by each participant.

Each consumer started at a random booth with one of the lighting sources, evaluated all 14 photographs under that light, and then moved to another random booth. Booth order was randomized and balanced in a complete block design for all participants. Each photograph within a booth was also viewed in a random order by each participant, with unique 3-digit blinding codes used for each photograph. As they moved between booths, participants were shown the same photographs in a new randomized order, with different blinding codes given on each picture. In total, the participants evaluated 70 total photographs in the session including the replications between light sources.

Demographics

Of the recruited participants, 24% were male and 76% were female. Age ranges of the participants included 17% between 18-29 years, 21% between 30-39 years, 14% between 40-49 years, and 47% between 50-65 years. The majority (85%) of participants were Caucasian, with the remaining split between Asian, Hispanic/Latino, American Indian/Alaska Native, and Black or African American.

All of the consumers were familiar with poultry, with 19% having consumed it within the past month, and 81% having consumed it within the past week. Ground meat consumption was high as well, with 73% consuming ground meat once a month or more.

Consumers were also asked about how they checked doneness in meat at home by means of a check-all-that-apply (CATA) list. As seen in Figure 5.1, the most commonly chosen option was internal meat color (84% of participants), while only 34% used a food thermometer. Participants were then asked to choose which of the options was most

frequently used. The majority (58%) stated it was internal meat color, with only 15% stating food thermometers were their most frequently used option.

Due to the nature of the study with lighting, participants were asked about the type of lighting they used in their home kitchen. Half of the participants (50%) stated they used traditional light bulbs, with the next most popular option being compact fluorescent lighting (27%), followed by fluorescent tube lighting (19%), with the remainder split between LED and Halogen (16% combined). It is unknown whether those who chose traditional light bulbs had switched to the incandescent alternatives that meet modern regulations or not.

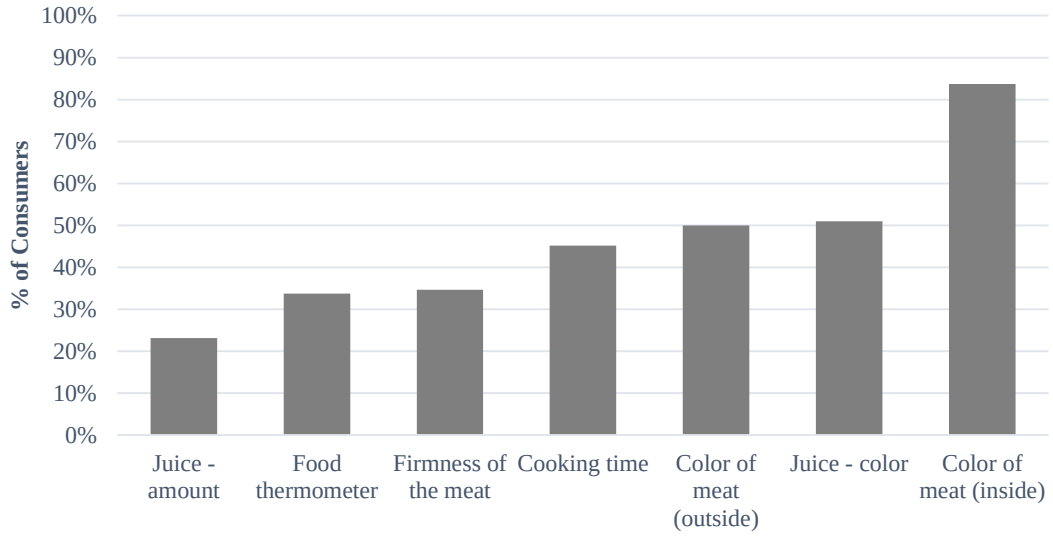

Figure 5.1 Self-reported methods used by consumers to determine meat doneness.

Analysis

All data were collected using Compusense Cloud (Compusense, Guelph, Ontario). Analysis of variance (ANOVA) was performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA). ANOVA models were generated using the PROC GLIMMIX function with the Satterthwaite degrees of freedom method. A randomized

block model was used with participant and replicate as random factors, and bulb and temperature as treatment factors. The ANOVA Pair-wise differences were assessed using Fisher's LSD. A one-way t-test using PROC TTEST was used to determine if the mean of each treatment combination was significantly different from just-about-right (JAR), or 4. $p < 0.05$ was used as the level of significance for all tests.

Results and Discussion

Perception of doneness and likelihood to eat

The analysis on the ANOVA model showed that there was an interaction between lighting and temperature ($P<0.0001$). The interaction of the two effects is shown in 5.1. As shown in the plot, the general trend was for perception of doneness to increase as temperature increased, along with the likelihood to eat the samples. This confirms that the photographs were successfully able to show the difference between the final endpoint temperatures to the consumers.

Lighting source

Lighting source by itself significantly changed the perception of doneness in the samples (Table 5.2). The soft white LED and the newer 43 watt incandescent replacement bulbs increased the perception of doneness the most, though the traditional 60 watt incandescent bulbs were not significantly different than the 43 watt bulbs. The CFL and daylight LED bulbs both had the lowest doneness scores.

Likelihood to eat followed the trends for the light bulbs, with the soft white LED and 60 watt bulbs giving the highest scores, though the 43 watt bulb was not significantly different from the 60 watt bulb. CFL and daylight LED bulbs were again the lowest scoring for likelihood to eat. Taken together with the doneness scores, lighting does have

5.1 Perception of doneness and likelihood to eat, as influenced by lighting source and endpoint temperature. Samples at 135°F and 175°F were only seen once and not included in the ANOVA model.

Temperature	Lighting	Doneness	Likelihood to eat	% likely to eat	Sig different from JAR
135°F	43w	1.54	1.57	4%	<
	60w	1.57	1.63	7%	<
	CFL	1.60	1.63	3%	<
	Day	1.34	1.34	2%	<
	LED	1.48	1.52	3%	<
155°F	43w	2.19^{g}	2.26^{i}	9%	<
	60w	2.13^{gh}	2.26^{i}	10%	<
	CFL	1.99^{i}	2.06^{ij}	7%	<
	Day	2.04^{hi}	1.97^{j}	6%	<
	LED	2.08^{ghi}	2.09^{ij}	8%	<
160°F	43w	3.33^{e}	3.96^{efg}	46%	<
	60w	3.21^{ef}	3.89^{fgh}	46%	<
	CFL	3.22^{ef}	3.86^{hg}	45%	<
	Day	3.09^{f}	3.66^{h}	41%	<
	LED	3.32^{e}	4.09^{ef}	50%	<
165°F	43w	3.62^{d}	4.16^{e}	51%	<
	60w	3.74^{cd}	4.55^{cd}	57%	<
	CFL	3.71^{d}	4.47^{d}	55%	<
	Day	3.65^{d}	4.42^{d}	55%	<
	LED	3.95^{ab}	4.80^{ab}	63%	=
170°F	43w	4.03^{a}	4.84^{ab}	68%	=
	60w	3.95^{ab}	4.86^{a}	68%	=
	CFL	3.75^{cd}	4.42^{d}	55%	<
	Day	3.88^{bc}	4.62^{bcd}	59%	<
	LED	3.98^{ab}	4.75^{abc}	62%	=
175°F	43w	4.19	5.67	88%	>
	60w	4.25	5.56	85%	>
	CFL	4.20	5.38	82%	>
	Day	4.22	5.38	81%	>
	LED	4.34	5.49	82%	>

Means with a common superscript within a column were not significantly different. All treatment effects were significant at $p < 0.001$. < = > indicates if the sample means was significantly lower than, equal to, or higher than 4 (or Just-about-right) on the doneness scale.

an effect on consumer perceptions of meat doneness, with especially the LED soft white bulbs increasing a consumer's perception of how done the meat was. This could mean that as consumers transition to more modern lighting sources such as LED bulbs, they may be even more likely to undercook their ground poultry, especially if they rely on color alone.

Table 5.2 Perception of doneness and likelihood to eat, as influenced by lighting source and endpoint temperature when treatment effects are separated.

		Doneness	Likelihood to eat
Lighting Source	LED	3.33^{a}	3.93^{a}
	43 watt	3.29^{ab}	3.81^{bc}
	60 watt	3.26^{b}	3.89^{ab}
	CFL	3.17^{c}	3.70^{cd}
	Day LED	3.16^{c}	3.67^{d}
Temperature	155°F	2.09^{d}	2.13^{d}
	160°F	3.23^{c}	3.89^{c}
	165°F	3.73^{b}	4.48^{b}
	170°F	3.92^{a}	4.70^{a}

Means with a common superscript within a column were not significantly different at $p<0.05$.

Endpoint temperature

Increasing the endpoint temperature also increased the perception of doneness and the likelihood to eat (Table 5.2). Although this was expected, it does illustrate that there is a definite color change occurring as the poultry is cooked that is noticeable to the consumers. The samples cooked at 135°F and 175°F, though not included in the analysis due to lack of replicates, followed the same trend, with 135°F having an average of 1.50 for doneness, and 175°F having an average of 4.24 for doneness.

Perhaps more interesting is to look at where the mean scores lie for each temperature in terms of safety. At 160°F, the mean score for doneness was at 3.23, which on the scale provided would put it at "slightly undercooked." Looking at the raw

data, however, shows that one of the replicates was rated with a median score at "moderately undercooked," while the other two replicates had a median score at "just-about-right" (JAR). In the same manner, the sample that was rated as undercooked received a median score at "very unlikely" to eat, while the other two had median scores at "somewhat likely" to eat. The sample that received the lower scores was mostly likely subject to the pinking phenomenon; this same pattern occurred in one of the samples at 165°F that was rated higher than the other two photographs, and one sample at 170°F which was rated as lower than the other two in doneness.

In addition to the mean scores, the percent of consumers that stated they would be likely to eat each sample (giving the sample a score of 5 or above on the 7-point likelihood to eat scale) are included in 5.1. A one way t-test was also used to determine if the mean score of each treatment combination was significantly different from 4, which is the level of just-about-right on the scale. As can be seen from the table, at 160°F (below the temperature recommended by the USDA) from 41% to 50% of consumers would have eaten the sample. This shows a large percent of consumers would potentially eat undercooked ground poultry at home if they were relying on color alone, exposing them to any foodborne illnesses that might be present.

Curiously, the percent of consumers likely to eat the samples at 165°F, which is considered a safe temperature for consumption, ranged from only 51% to 63%, depending on lighting. Only the sample at 165°F with LED lighting was equal to JAR on the scale, with the other lighting conditions rated as significantly lower than JAR. At 170°F, two of the samples (day and CFL) were significantly lower than JAR, while the others were equal to JAR. At 175°F, 82% to 88% were likely to eat the sample, though

all samples were significantly higher than JAR. Even though all participants indicated they ate ground poultry on a regular basis, they seemed unsure of when exactly the poultry was cooked based on color alone. Though from a food safety perspective there are no inherent issues with overcooking poultry, it serves as a further reminder that consumers really are not good at determining doneness in ground poultry based on color alone.

With the two factors together, it can also be noted that the likelihood to eat score increased faster than the perception of doneness (5.1). Looking at the data from each photograph (not shown) makes it evident that the photographs that have a median doneness score of slightly undercooked (2 of the photos at 165°F and 1 photo at 170°F) split the consumers, with about half giving a score above undecided, and the other half giving a score below undecided. This could signify that consumers are likely to eat poultry that they consider underdone since some of the samples that were "just-about-right" were not cooked to the recommended temperature.

Conclusions

From a food safety perspective, the results of this study can be concerning in some ways. For two of the samples cooked to 160°F, below the recommended temperature for poultry, consumers thought they were "just-about-right," meaning they would potentially eat a patty that was undercooked at home if judging by color alone. Up to half of the consumers stated that they would eat the samples cooked to 160°F if they were judging on color alone. Second, the variation seen in the photographs and meat samples shows that color variation is inherent in ground poultry, adding weight to the argument for the use of a thermometer *(8, 12, 26)*. Finally, the effect of lighting on

perception of doneness can be concerning, especially with some of the more modern lighting such as LED lights having the biggest impact. This means that a consumer who was relying on internal color alone would be more likely to undercook their poultry when preparing it under more modern lighting conditions.

Industry and regulatory agencies have sought to improve food safety in poultry products for many years, with varying success. Many consumers simply follow what they have always done, and are unwilling or unable to change their behaviors when it comes to food safety *(19)*. This study adds another potential message to the food safety campaign, which is that modern day lighting has the potential to change food color perception and make it even more difficult to determine doneness by color alone, making food thermometer use essential.

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Chapter 6 - Food handling behaviors observed in consumers when cooking poultry and eggs

Abstract

Previous research has shown that many consumers do not follow recommended food safety practices for cooking poultry and eggs, which can lead to exposure to *Salmonella* and *Campylobacter*. Past research has been done through surveys and interviews, rather than observation. The objective of this project was to determine through observation if consumers follow food safety guidelines. One hundred and one consumers divided between three locations (Manhattan, KS; Kansas City, MO area; Nashville, TN) were observed as they prepared a baked whole chicken breast, a pan fried ground turkey patty, a fried egg, and scrambled eggs. The endpoint temperature for the cooked products was taken (outside the view or consumers) within 30 seconds after the consumers indicated they were finished cooking. Thermometer use while cooking was low in all of the products; only 37% of consumers used a thermometer for the chicken breasts and only 22% for the turkey patties. No one used a thermometer for fried or scrambled eggs. Only 77% of the chicken and 69% of the turkey was cooked to a safe temperature (165°F), and 77% of scrambled and 49% of fried eggs reached a safe temperature (160°F). Safe hand-washing was noted in only 40% of respondents after handling the chicken breast and 44% after handling the ground turkey patty. This decreased to 15% after handling raw eggs for fried eggs, and 17% for scrambled eggs. These results show that there is a high prevalence of unsafe behaviors (undercooking and poor hand-washing technique) when cooking poultry and eggs, and a great need for improvement in consumer behavior with poultry and eggs.

Introduction

Every year an estimated 1 in 6 Americans (about 48 million people) are affected by foodborne illness. Of those affected, approximately 128,000 people are hospitalized and 3,000 die *(7)*. These foodborne illnesses not only affect individual lives, but are a burden on public health, contributing to the cost of health care. As a result, many guidelines for public health have targeted increasing the proportion of consumers who follow food safety practices as part of their goals *(33, 34)*.

Retail meats and poultry are a significant source of pathogens in the food supply; because of this, consumers need to be aware of the risk and practice good food safety behaviors *(32, 37)*. Many foodborne illnesses occur in the home, and can be prevented through proper food handling *(5)*. Medeiros and others *(26)* found that there were 5 pathogen control factors that could be improved in consumers, including: practice personal hygiene, cook foods adequately, avoid cross contamination, keep foods at safe temperatures, and avoid food from unsafe sources.

There are some indications that food safety behavior is slowly improving among consumers *(16)*. Most consumers report that they wash their hands with soap for the required full 20 s before preparing food *(2, 20)*. A nationally representative telephone survey found that the percentage of consumers who owned a food thermometer had increased from 49% in 1998 to 70% in 2010. Of those who owned a thermometer, 82% said they used it for roasts, 53% said they used it for chicken parts, and 23% said they used it for hamburgers *(23)*. A separate large web-based survey of US adults similarly found that 62% of adults owned a food thermometer. Of those who owned a

thermometer, 73% used it for whole turkeys, but only 12-26% used it for smaller cuts of poultry *(22)*.

Cody and Hogue *(10)* indicated that increasing thermometer use among consumers presented the greatest potential positive change in the US population. The lack of use of a thermometer may be attributed to lack of knowledge, inconvenience, and laziness *(21, 25)*. Understanding consumer beliefs and behaviors may help with the development of better materials for improving food safety. According to the Health Belief Model, consumers will adopt health related behaviors when they believe they are susceptible to that condition, that it would have serious consequences, that an action will reduce their susceptibility to or severity of the condition, and believe that the benefits of taking action outweigh the costs of the action *(8)*.

Although the reported increase in hand washing and thermometer ownership is a good thing, there is still evidence that consumers are not following food safety practices as much as they report. For example, between 73-100% of those participants who reported washing their hands after handling raw chicken in a research study were found to still have *Campylobacter jejuni* on their hands *(12)*. Dharod and others *(14)* observed 60 households in the US and found that even though a large majority of the participants reported following safe behaviors, such as washing their hands while using poultry, only a fraction were found to actually follow correct procedures when they were observed. Food safety studies with young adults have found although many are willing to practice food safety and have positive food safety beliefs, their self-reported behaviors were less than ideal *(6, 15)*. Young adults also failed to exhibit many safe food-handling behaviors when they prepared a meal under observation *(1, 4)*.

A recent study also found disagreement between reported and observed food-handling practices. For example, even though 100% of participants reported that they washed their hands before meal preparation, only 20% were observed to do so. Similarly, 23% reported that they used a thermometer for poultry items, but only 5% were observed to do so *(24)*. Other studies have also shown that reported behaviors do not agree with observed behaviors, with consumers underreporting behaviors that they believe are "bad" *(28, 29, 31)*. This disconnect between self-reported and observed behaviors makes it difficult to evaluate current food safety behaviors in the home, especially when there are relatively few observational studies *(3, 9, 13, 17, 19, 24, 28, 30, 31)*.

The objective of this study was to study observed food safety behaviors among consumers when cooking poultry and eggs and measure the final endpoint temperature achieved in those items.

Materials and Methods

Subject Recruiting

An observational study to observe consumer food safety behavior with poultry and eggs was conducted at three locations, including Manhattan, KS; Kansas City, MO area; and Nashville, TN. A convenience sample of 101 consumers divided equally among the test sites was used. To participate in the study, consumers had to do more than 40% of the cooking at home, had to have previously cooked each of the items they would cook in the test using the same method of cooking as that used in the study, and could not have taken formal cooking classes. Other demographics were not used to

determine if a participant qualified. Participants were told they were part of a study examining how people cook.

Cooking and Observation

Participants were asked to prepare four items, including a baked whole chicken breast, a ground turkey patty on the stove top, a fried egg, and scrambled eggs. Home style kitchens were used at each of the locations, and the participants were asked to prepare each item as they would at home. A variety of ingredients and equipment was supplied, but the consumers were not given any specific instructions as to what supplies or ingredients to use apart from the overall method of cooking (e.g., in the oven or stovetop). Prior to cooking, the participants were given time to orient themselves in the kitchen and the location of all of the items. A calibrated standard dial type food thermometer was provided in a drawer with the rest of the utensils, but the thermometer was not pointed out by the observer. The items were prepared one at a time to prevent the participants from being distracted with a separate item. Participants were observed as they cooked the products, and food safety behavior including hand washing and thermometer use in each of the products was noted. Each participant was instructed that once they had finished cooking each item, they should leave it in the pan or dish it was cooked in, place it on a hot pad, and notify the observer that they were finished cooking that item.

Once the participant removed the product from the heat source and stated they were finished, the product was immediately taken from the participant, hidden from view, and the temperature was measured by the observer. The temperature was measured using a high accuracy thermometer with a Type K probe attached (Fisher Scientific Traceable

Thermometer model 15-077-968). For the poultry dishes, the probe was inserted from the side of the poultry with the tip extending into the center of the thickest part of the meat. The probe was inserted into the center of the yolk for the fried egg, and into the center of several pieces for the scrambled egg, with the lowest temperature recorded. This was usually completed within 30 seconds after removing the product from the heat source, though it occasionally took longer if the participant measured the product's temperature with a thermometer or otherwise took longer to determine it was done to their satisfaction.

Survey and Interview

A brief survey was given to the participants about their cooking abilities and where they got their cooking information. They also were interviewed to assess how similar the preparation of the item was compared to what they would do at home, if they thought the items they cooked were "done," how they determined the item was finished cooking, and whether it was the same method they would use at home to check if the product was done. The survey and interview were given to the participants after they completed cooking all items to avoid biasing their food safety behaviors during their observation.

Statistical Analysis

The data were compiled and summarized with basic statistics (including means, standard deviations, and percentages) in Microsoft Excel (Microsoft Corporation, Redmond, WA). Pearson's chi-squared tests were calculated using R (R Core Team, Vienna, Austria).

Results

Demographics

From April 23rd to May 23rd, 2014, 101 subjects participated in the study. There were 65 females and 31 males who participated. For the ages of the subjects, there were 54% in the 25-44 age range, 39% in the 45-64 age range, 5% in the 18-24 range, and 3% over 65 years old. The majority of the participants were Caucasian (67%), with 20% African American, 7% Asian, 4% mixed, and 2% Hispanic/Latino. Household annual income was fairly evenly distributed, with 27% earning less than $30,000; 31% earning between $30-45,000; 21% earning between $60-90,000; and 21% earning above 90,000. The demographics between the different locations were fairly similar in most respects. The largest difference between them was the annual income. The respondents in Olathe, KS had a largest amount of participants that earned more than $90,000 annually, with 19 respondents (56%) compared to 7 in Manhattan, KS and 5 in Nashville, TN. Due to the convenience sampling used to recruit for the study, the participants may not represent the general public.

Cooking Ability

Although the subjects had to state that they knew how to cook (and had previously cooked) each type of item to participate in the study, they were also asked how often they cooked each item at home to ascertain their familiarity with the items and their cooking process. As seen in Figure 6.1, the majority of participants cooked all of the items at least occasionally, with the least familiar item being the turkey patty. For those who stated they "Never" or "Rarely" cooked the turkey patty, all of them said they were familiar with cooking a ground beef patty (hence why they qualified for the study),

and that they used the same method to determine it was done as they would have if it was ground beef. For those who stated they never cooked fried eggs, they did state that they had cooked them in the past. Some also stated that although they did not normally fry eggs for themselves, they would prepare them for another person in the household.

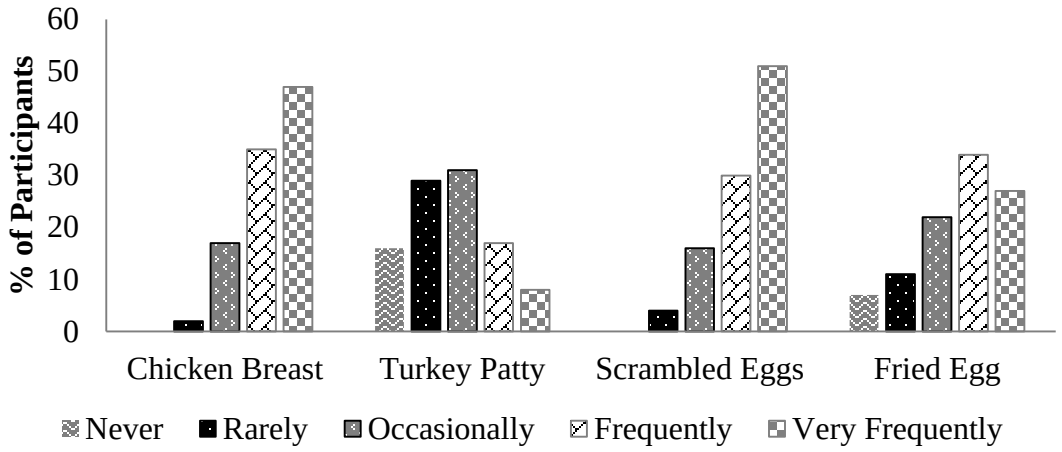

Figure 6.1 Self-reported frequencies of item preparation by the participants.

As part of the questionnaire (

Table 6.1), subjects also rated their own cooking abilities, with 11% rating themselves as novice or having basic skills, 42% rating themselves as having average abilities, and 46% having better than average abilities.

Cooking Information

The most common sources of cooking information reported in the questionnaire were friends and family (88%), internet – written (78%), cookbooks (66%), magazines (53%), TV (40%), and internet – video (24%). Subjects were also asked how often they watched cooking shows, with 21% never watching, 25% watching once a month, 32% watching once a week, and 23% watching daily. The discrepancy between those who reported using the TV as a source of cooking information (40%) and those who watched cooking shows at least once a month (85%) was due in part to the type of cooking shows

Table 6.1 Consumer responses to questionnaire

Question	Responses	% Responses (n=101)
1. How would you rate your cooking abilities?	Novice	1
	Basic skills	11
	Average	42
	Better than average	44
	Expert	2
2. Where do you get your cooking information? (choose all that apply)	Friends & Family	88
	Internet (written)	78
	Cookbooks	66
	Magazines	53
	TV	40
	Internet video (YouTube, etc.)	24
3. How often do you watch cooking shows?	Never	21
	Once a month	25
	Once a week	32
	Daily	23
4. Do you think organic chicken is more healthful than non-organic chicken?	Yes	59
	No	41
5. Do you think organic chicken is safer than non-organic chicken?	Yes	65
	No	35
6. When do you normally dispose of your eggs?	I always finish the carton	44
	At the expiration date	23
	After the expiration date	14
	Based on appearance	12
	Based on smell	5
	Other	9

the respondents watched. This information shows that although many of the participants watched cooking shows, they didn't necessarily use them to get cooking advice. The subjects also reported the names of the TV shows watched, with many of the shows being more entertainment type food shows rather than instructional shows (i.e., with recipes), such as Iron Chef; Diners, Drive-ins & Dives; and Hell's Kitchen.

Organic Chicken

As markets have seen an increase in popularity of organic poultry, there is also a perception that purchasing organic poultry leads to a safer and more nutritious product, though this added safety has not been shown in previous research *(35, 36)*. The subjects in this study expressed some of these same views, with over half (59%) responding that they believed organic chicken was more healthful, and 65% responding that they believed organic chicken to be safer than its non-organic counterpart.

Egg Disposal

Forty-four percent of respondents reported that they always finished their egg carton, regardless of other factors such as age of the eggs. In contrast, 23% disposed of eggs at the expiration date, 14% disposed of them after the expiration date, 17% used either smell or appearance, and 9% used other methods to determine when they should dispose of the egg.

Hand Washing

Proper hand washing was defined as washing hands with soap for a minimum of 20 seconds immediately after touching the raw product without touching anything else. During the preparation and cooking process, 40% of the participants correctly washed their hands after handling the chicken, 46% correctly washed their hands after handling

Table 6.2 Observed food safety behaviors in participants.

Food-handling behavior	% Observed (Overall %)	χ^2 (df =1)	p-value
Chicken Breast			
Washed Hands	39.6 (39.6)		
Used Thermometer	36.6 (36.6)		
Correct Thermometer Use	70.3 (25.7)		
Final Temperature ≥ 165°F	76.2 (76.2)		
≥ 165°F, Used Thermometer	78.4 (28.7)	**0.02**	**0.8873**
≥ 165°F, Did Not Use Thermometer	75.0 (47.5)		
≥ 165°F, Occasionally Prepare	73.7 (13.8)	**0.00**	**1**
≥ 165°F, Regularly Prepare	76.8 (62.4)		
Turkey Patty			
Washed Hands	43.6 (43.6)		
Used Thermometer	21.8 (21.8)		
Correct Thermometer Use	72.7 (15.8)		
Final Temperature ≥ 165°F	68.3 (68.3)		
≥ 165°F, Used Thermometer	77.3 (16.8)	**0.58**	**0.4462**
≥ 165°F, Did Not Use Thermometer	65.8 (51.5)		
≥ 165°F, Occasionally Prepare	68.4 (51.5)	**0.00**	**1**
≥ 165°F, Regularly Prepare	68.0 (16.8)		
Fried Eggs			
Washed Hands	14.9 (14.9)		
Used Thermometer	0.0 (0.0)		
Final Temperature ≥ 160°F	48.5 (48.5)		
Scrambled Eggs			
Washed Hands	16.8 (16.8)		
Used Thermometer	0.0 (0.0)		
Final Temperature ≥ 160°F	76.2 (76.2)		

the turkey, 15% correctly washed their hands after handling the fried egg, and 14% correctly washed their hands after handling the scrambled egg (

Table 6.2).

Thermometer Use

As seen in previous studies, actual thermometer use was low for all items. For the chicken breast 37% used a thermometer, 22% used one with the turkey patty, and none of the eggs (either fried or scrambled) had their temperature measured. If a participant used a thermometer, they either used it with both poultry items, or with just the chicken breast; there were no participants who used a thermometer with only the turkey patty. Thus, the percentage of participants that used a thermometer for any item was 37%.

In the one-on-one interview after the cooking was completed, the participants were asked if they used the same methods at home as they did during the observation to check if an item was done. The vast majority stated they would have used the same methods at home, with 89% stating they used the same methods for the poultry items, 95% stating they use the same methods for fried eggs, and 99% stating they used the same methods for scrambled eggs at home.

The observers also recorded if the thermometer was used correctly by the participant, meaning they inserted it from the side with the tip extending into the center of the thickest part of the meat. Of the participants who used a thermometer, about one-third (36%) did not use it correctly in either the chicken breast, the turkey patty, or both.

Final temperature

As measured by the observer, 76% of the chicken and 68% of the turkey was cooked to a safe temperature (above 165°F), while 76% of the scrambled eggs and only 47% of the fried eggs were cooked to a safe temperature (above 160°F).

Interestingly enough, the use of thermometer didn't improve the ability of the participants to reach the correct endpoint temperature (

Table 6.2). For the chicken breast, 78% of those who used a thermometer reached a final temperature above 165°F, compared to 75% for those who didn't use a thermometer. In the turkey patty, 77% of participants using a thermometer reached at least 165°F, while 66% of participants who didn't use a thermometer reached at least 165°F.

Determination of Doneness

Participants in the study used a variety of techniques to determine that each product was done cooking, with over half of the participants using more than one technique for the poultry items, and over 40% using more than one technique for the egg items. Observers recorded any methods that they saw the participants using, and the participants were also asked during the one-on-one interview what methods they used to determine doneness for each item to ensure accuracy. Observational data generally agreed with the interview results, with the interview often clarifying what exactly the participant was looking for to determine each product was done.

For the chicken breast (**Error! Not a valid bookmark self-reference.**), the most common method used to determine it was done was cutting into the chicken (50%), followed by color (33%) and thermometer use (33%). Of the 33% that used color, about half (15% of the total) did not cut into the chicken, meaning they only used external color. For the turkey patty, the most common indicator used was color (39%), followed by cutting into it (30%), using a thermometer (22%), and looking at the juices (18%). Of the 39% that used color for the turkey patty, two-thirds (26% of the total) used only external color. For the egg products the methods mainly relied on visual appearance. In the fried egg, for example, the main determinant used was the overall appearance (43%),

followed by the yolk consistency (31%), overall color (20%), texture (19%), and opaque/clear whites (17%). The main indicator for scrambled eggs was the amount of liquid left in the eggs (51%), followed by overall appearance (44%), overall texture (27%), puffiness/fluffiness (17%), and color (11%).

Table 6.3 Methods used by participants to determine the poultry and egg items were cooked.

	Chicken Breast % of participants	**Turkey Patty** % of participants
Cut into	50	30
Thermometer	33	22
Color	33	39
Time	20	9
Juices	11	18
Texture	8	10
Visual only	6	22
Used probe (fork, spatula)	6	16
Smelled	1	1
Multiple Techniques	56	54
	Fried Egg	**Scrambled Egg**
Appearance only	43	44
Color	25	11
Yolk consistency	31	.
Amount of Liquid	20	51
Texture	19	27
Opaque white	17	.
Time	3	1
Puffy/Fluffiness	.	17
Multiple Techniques	43	42

Discussion

This study looked at known risk factors for cooking both poultry and egg dishes, quantifying them and relating them to the final endpoint temperature of the products. This was done through observation, a questionnaire, and a one-on-one interview. Combining observations with the self-reported behaviors allowed us to avoid some of the inconsistencies that have been seen in previous studies that only look at self-reported behaviors while still gaining insight into their thought processes *(20, 24, 28, 29)*.

Cooking Ability

As seen in Figure 6.1, the majority of participants cooked the items on a somewhat regular basis. Although the turkey patty was the least commonly cooked item, all participants stated that they were familiar with cooking ground patties (usually beef). This shows the participants were familiar with cooking the items, and therefore familiar with determining doneness based on their own criteria. The subjects were grouped into two categories, with the "occasionally prepares" group including those in the first 3 categories (never, rarely, and occasional) and "regularly prepares" group including those in the second 2 categories (frequently, very frequently), to see if their familiarity with the items affected whether or not they used a thermometer. A chi-squared test for each individual item showed that there was no difference between those who cooked the item occasionally and those who did on a regular basis in their ability to cook an item to the correct temperature (

Table 6.2).

A similar chi-squared test was also run by grouping the participants according to their self-assessed level of cooking abilities. By grouping those who stated they had better than average or above cooking abilities together, and those who stated they were average or lower in their cooking abilities in another group, a statistical test showed there was no difference in their use of a thermometer, in their ability to cook an item to the correct temperature, or in their hand washing. The one exception to this was in the chicken breast, where those who considered themselves above average in cooking skill were more likely to cook the chicken breast to the appropriate temperature ($p=0.052$). Even so, this suggests that neither frequency of preparation of an item or self-assessed skill level played a critical role in a person's ability to safely cook an item at the correct temperature.

Cooking Information

In the survey, the subjects responded that they got their cooking information from a variety of sources. The majority of the subjects (85%) used more than one source for their cooking information, with the most common source being friends and family, followed by written internet sources. The source of cooking information can be useful to know if food safety educators want to have the greatest impact on a wide range of people. As the second most common source of cooking information was from the internet, this media should be used more for safe food handling information. Incorporation of that information into websites where cooking information is found as well as food safety sites is needed.

Hand Washing

Hand washing was low among the participants, as seen in previous studies *(14, 24)*. Although only "correct" hand washing is shown in

Table 6.1, the number who washed their hands incorrectly (e.g., rinsed with water only) was still not as high as would be hoped. Even among those who did wash their hands correctly *at some point during the study*, there was potential for cross-contaminate of other items before washing their hands if not done immediately after handling. Many subjects simply rinsed their hands after touching the raw items, or didn't wash them at all, choosing instead to simply wipe them on a paper towel. Hand washing in eggs was especially low, and much lower than in the poultry items, showing that many people are unaware of the potential bacteria on raw egg shells and the need to wash their hands after touching them *(18, 27)*. Simply put, many do not consider eggs (specifically their shells) to be a risk in food safety. Despite efforts by safety and regulatory agencies to promote hand washing when handling raw food, there is still a need for improvement among consumers, as seen in this and other studies.

Thermometer Use

Although thermometer use is the only reliable method to determine the final cooked temperature of an item, the observed usage in this study was low for all items. For this study small items were chosen for the participants to cook, because of frequency of cooking and because this is typically where the lowest level of thermometer use is seen among consumers *(22, 23)*. In addition, a whole muscle item (chicken breast) and a ground meat item (turkey patty) were chosen, as each presents a different challenge for safe preparation. The two cooking methods (baking and frying) were also chosen to see how the participants would handle the different methods when checking for endpoint temperature. Thermometer use for the poultry items in this study was higher than in some observational studies *(24)*, but lower than some of the self-reported surveys *(22,*

23). These numbers were verified during the one-on-one interview, where 89% reported that they would use the same method to check doneness when cooking the item at home. Still, with only 37% percent using a thermometer for the chicken and 22% using a thermometer for the turkey, there is considerable room for improvement.

For the turkey patty, the participants were allowed to form their own patties after seasoning them. They were initially given ¼ pound of turkey, and many of their patties were fairly thick instead of spreading them out more. This could partially explain why a large number of participants did not reach the recommended cooking temperature as well, since if they were simply going by appearance the outside of the patty could have been overcooked, while the interior was still undercooked.

Perhaps more concerning than the lack of use of a thermometer for the poultry items is the final temperature reached for the items. As measured by the researchers, 24% of the baked chicken breasts and 32% of the turkey patties were not cooked to at least 165°F. Furthermore, a chi-squared test showed there was no statistical difference between those who did and did not use a thermometer in achieving an endpoint temperature of at least 165°F, in both the chicken and the turkey items. Much of the message of food safety is aimed at getting people to simply *use* a food thermometer. If using a food thermometer does not improve a consumer's ability to cook items to the correct temperature, due to improper use or to lack of knowledge as to what the final temperature should be, then perhaps more focus needs to be placed on teaching consumers *how* to use a food thermometer in addition to simply owning one.

Although it was not expected that any of the participants would use a thermometer for either the fried egg or the scrambled eggs, it is worth noting that their

final temperatures were often below the recommended safe temperature for cooking eggs. Scrambling and frying eggs have been found to be inadequate to destroy bacteria such as *Salmonella (11)*. During the one-on-one interview the majority of the participants said they cooked the egg according to what their personal preferences were, looking at it from an appearance or texture point of view, as opposed to a safety point of view that is common in poultry items. Those who like their eggs with a runny yolk, or to be more "wet" when scrambling them will be unlikely to ever reach the recommended safe temperature of 160°F. This was reflected in the 51% who said their fried eggs were done when they were still below 160°F.

Determination of Doneness

The data showed that the subjects relied on multiple methods to determine when their items were fully cooked. Consumers still relied mainly on visual and textural cues to determine if a product is fully cooked. Even those who used a thermometer would check the poultry items using other methods, such as cutting them open or looking at the juices before they decided it was done. Thus, it appears that color and appearance are key aspects of determining doneness. For the poultry items, thermometer use was higher in the chicken breast than in the turkey patty. It may be that there is a different level of risk associated with either the turkey or with patties by the consumers, since even some of those who used a thermometer with the chicken did not use it with the turkey patty. Based on the one-on-one interviews, it is likely that the subjects saw the turkey patties as being the same as hamburger patties in terms of cooking, which have typically had very low levels of thermometer use *(23)*.

It also is apparent that the consumers considered the egg products to be lower risk than the poultry products, as evidenced by their lack of thermometer use and their much lower rates of hand washing when preparing the eggs.

These observations showed that there is still a great need for improvement in food safety education for consumers with regard to poultry and eggs. Although some participants did use a thermometer to measure the end temperature of the chicken and turkey, some did not use it properly, and the use of a thermometer did not improve their final endpoint temperatures. For the poultry products, many of the participants either washed or rinsed their hands after handling the raw products, but many did not wash their hands until after they had contaminated other areas of the kitchen by touching objects such as spices, utensils, or cooking surfaces. They were also more conscientious about washing their hands after touching the chicken and turkey than after touching the eggs. No participants used a thermometer to determine if their eggs were properly cooked and many used alternative methods such as color and texture appearance to judge doneness of all four poultry/egg products cooked. Future education efforts with consumers should focus on not only using a thermometer, but how to use a thermometer properly. Efforts should also be made to make consumers more aware of the risk of bacterial contamination with eggs, and the necessity of cooking their eggs to a safe temperature.

Acknowledgments

This research was funded in part through a grant from the Agriculture and Food Research Initiative Competitive Grants Program (Grant No. 2012-68003-19606) from the U.S. Department of Agriculture, National Institute of Food and Agriculture.

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Chapter 7 - Recipe modification improves food safety practices during cooking of poultry

Abstract

Many consumers do not practice proper food safety behaviors when preparing food in the home. Several approaches have been taken to improve food safety behaviors among consumers, but there still is a deficit in actual practice of these behaviors. The objective of this study was to assess whether the introduction of food safety instructions in recipes for chicken breasts and ground turkey patties would increase consumers food safety behaviors during preparation. A total of 186 consumers in two locations (Manhattan, KS and Nashville, TN) were asked to prepare a baked chicken breast and a ground turkey patty following recipes that either did or did not contain food safety instructions, while being observed for hand washing and thermometer usage. Participants who received food safety instructions demonstrated significantly improved food safety behaviors as they prepared their items. In addition, the majority of consumers stated that they thought the recipes were easy to use, and that they would be likely to use similar recipes at home. This study showed that recipes could be a good source of food safety information for consumers, and have the potential to improve behaviors and reduce foodborne illness.

Introduction

Improving food safety to prevent foodborne illness is an important public health priority. Each year nearly 1 in 6 Americans (or 48 million people) get sick, 128,000 are hospitalized, and 3,000 die from food related diseases *(4).* These illnesses are a burden on public health and contribute significantly to the cost of health care *(32).* Foodborne illness is a preventable problem, and can be reduced in the home by improving proper food handling, preparation, and storage among consumers *(32).* Guidelines for public health from the United States Department of Agriculture (USDA) and the Department of Health and Human Services have both incorporated improving food safety among consumers as part of their goals *(30, 32).*

Two of the most common pathogens in the food supply are *Salmonella* and *Campylobacter*, both of which are found in poultry and poultry products such as eggs *(22).* Although a variety of other sources contain these pathogens, most of these illnesses are associated with eating raw or undercooked poultry or eggs or with cross-contaminating of other foods by these items *(4).* A nationwide survey of chicken parts in 2012 by the USDA revealed an estimated 24% of chicken parts are contaminated with *Salmonella (31).*

Based on FoodNet data, there have been large, statistically significant reductions in six key foodborne pathogens since 1996 *(4). Salmonella* infections, however, increased between 2006 and 2008, and in 2010, the incidence of *Salmonella* infections was nearly three times the 2010 national health objective target *(4).* New national health objectives target a 25% reduction in *Salmonella* infections and a 33% reduction in *Campylobacter* infections by 2020 *(30).*

Consumer food safety studies generally rely on surveys and self-reported behaviors *(10)*, which have been shown to underreport consumers' actual behaviors *(27)*. For example, most consumers report that they wash their hands with soap for 20 seconds as recommended by the USDA *(1, 18)*. In contrast, an observational study by Dharod et al. *(8)* found that even though the majority of consumers reported washing their hands after handling poultry, only a small portion actually followed correct procedures, such as washing for 20 seconds, when they were observed. Dedonder et al. *(7)* showed that of the 90% of participants who self-reported washing their hands after handling raw poultry, 48% incorrectly washed their hands. A study by Mazengia et al. *(23)* similarly found that although all participants stated they washed their hands before preparing a meal, only 20% actually washed their hands before meal preparation when observed.

Self-reported thermometer use in food safety studies have shown that consumers are less likely to use a food thermometer when preparing smaller pieces or parts of poultry. A nationwide telephone survey in 2010 found that 70% of consumers reported owning a food thermometer *(21)*. Although 82% of those who owned one said they used it for large cuts of meat such as a roast, only 53% said they used it for chicken parts, and only 23% said they used it for ground meats such as hamburgers. Another web-based survey by Kosa et al. *(20)* found that 62% reported owning a thermometer, and of those that owned one 73% used it for whole turkeys, but only 12-26% used it for smaller cuts of poultry.

Thermometer use in poultry products is even lower when observed than when self-reported, especially when consumers prepare smaller cuts or parts. Mazengia et al. *(23)* found that although 23% reported using a thermometer for smaller poultry items,

only 5% used a thermometer during an observational study. Bruhn *(3)* also reported that 5% of respondents used a thermometer with poultry without being asked. DeDonder et al. *(7)* found that even though 20% of participants reported using a thermometer to check small poultry items such as breaded chicken products, only 12% actually used one, and many used it incorrectly. Other studies have confirmed that self-reported behaviors do not agree with observed behaviors, with those behaviors that are considered incorrect by consumers being the most underreported *(23, 25, 27, 28).*

Unsafe food handling practices, such as improper hand washing, can result in transferring pathogens such as *Salmonella* and *Campylobacter* to ready-to-eat (RTE) foods *(5, 10, 16, 26, 27, 33, 34*). In an observational study by van Asselt et al. *(33)*, 71% of participants cross-contaminated, with 29 to 33% failing to adequately wash or change cutting boards and knives, and 66% failing to properly wash their hands before preparing a recipe with raw chicken. Other researchers *(29, 34)* found that consumers transferred *Campylobacter* from artificially contaminated chicken to RTE foods during the preparation process via contaminated hands, cutlery, and cutting boards.

Current food safety behaviors in the home can be difficult to estimate because of the relatively few observational studies *(2, 5, 7, 15, 17, 23, 27, 28)*; however, it is evident that there is still room for improvement. One of the biggest potential improvements to food safety would be to increase thermometer use among consumers, thus reducing the amount of viable pathogens after cooking *(6)*. Increased hand washing would also reduce the number of pathogens that are commonly spread by cross-contamination during food preparation. There are a number of obstacles to improving food thermometer use in

consumers, such as lack of knowledge, inconvenience, and laziness *(19, 24)*. The easiest obstacle to overcome from an educational perspective is lack of knowledge.

Recipes, as found in magazines, cookbooks, internet, and other sources, are common sources of cooking information for consumers. These recipes have the potential to incorporate food safety information for consumers, but one study *(12)* found that only 20% of cookbooks have been found to contain any safety information. Still, surveys of consumers have pointed to a desire by consumers to have this information, and expressed interest in incorporating the food safety information into sources such as cookbooks *(11, 13)*.

A study by Godwin et al. *(14)* gave a cookbook with food safety instructions incorporated in the recipes to 258 older adults, and had them evaluate it over a period of a few months. The majority of participants found that the recipes were informative and taught something new. Over half reported changing how they prepared their food as a result of using the cookbook. This shows that recipes with food safety messages can potentially alter food safety behavior, but an observed study with consumers has not been done to determine the extent of those changes.

The goal of this study was to determine if the addition of food safety behaviors in recipes leads to improved consumer behaviors and to assess consumers' opinions and attitudes towards recipes that include safety information. Consumers were asked to prepare two poultry dishes, including a baked chicken breast and a ground turkey patty, following a recipe that was given to them.

Materials and Methods

Subject Recruiting

Two locations were used to observe consumers during this study, including Manhattan, KS and Nashville, TN. A convenience sample of 155 consumers was recruited for the study, with 103 participants at the Manhattan location, and 52 participants at the Nashville location. Participants were recruited from databases available to researchers in those communities, and were asked to take a screener to ensure they qualified. To participate in the study, consumers had to do more than 40% of the cooking in their homes, had to have experience cooking each type of item using the same method of cooking that would be used in the study, and could not have taken formal cooking classes or food safety classes.

Test Groups

Participants in the study were randomly assigned to one of 2 possible groups: a control, with no food safety instructions or a test group, with food safety instructions. In total, 155 consumers each completed the recipes with and without food safety instructions, with approximately half of the consumers in each location receiving instructions or not.

Cooking and Observation

Participants were asked to prepare two poultry items following a recipe they were given: a baked whole chicken breast and a ground turkey cooked patty on the stove top. The recipes used can be seen in Figure 7.1. Each of the locations contained home style kitchens, meaning that each kitchen contained an oven, a stove (or stove top if ovens were separate), cookware, utensils, and a simple dial type thermometer that could be

found in a normal home kitchen. All of the necessary ingredients to prepare each item also were supplied to the consumers. Prior to cooking, the participants were given time to orient themselves to the kitchens and the location of all of the items. Participants were asked to prepare the items as they would in their own home as if they had been given the recipes by a friend.

The participants were instructed to prepare one item at a time to prevent distractions from switching back and forth between recipes. As the participants prepared each item, they were observed for food safety behaviors, especially for hand washing and thermometer use. Observers also noted the length of hand washing, if there was cross-contamination before hands were washed, and if the thermometer was used, and if so, was it inserted correctly into the center of the thickest part of the item. Each participant was instructed to put the item on a clean plate once they were finished cooking.

Recipes

The recipes used for the study were chosen to include a small poultry piece, a ground poultry item, and a raw egg (used in the preparation of the chicken breast), foods that typically showed some of the lowest adherence to using a thermometer and hand washing. Recipes were initially selected for ease of preparation and ability to be prepared within the allotted time frame, and were edited for clarity. Food safety instructions were added to the recipe mainly to emphasize hand washing and thermometer use. Recipes also included basic instructions on how to use the thermometer.

Survey

A brief survey was given to the participants after the completion of cooking both items. The survey included questions to assess the ease of use and information provided in the recipes, what their opinion on the included safety instructions were, and how often they normally used a food thermometer at home. Participants who did not see the food safety instructions while preparing their items were shown a copy of the recipes with food safety instructions before they were asked their opinion on the food safety items. The survey was given to the participants after they completed cooking all items to avoid biasing their food safety behaviors during their observation.

Statistical Analysis

The data were compiled and summarized with basic statistics (including means, standard deviations, and percentages) in Microsoft Excel (Microsoft Corporation, Redmond, WA). Pearson's chi-squared tests were calculated using R (R Core Team, Vienna, Austria).

MUSHROOM TURKEY BURGER

1. **Wash your hands with soap and warm water before you begin this recipe.**
2. **Run cold water over the mushroom while rubbing gently with your fingertips. Use a paper towel to dry.**
3. Remove the stem from the mushroom and chop using a cutting board.
4. Spray a medium sauté pan with cooking spray. Preheat pan over medium high heat.
5. Remove the wrapper from the ground turkey. Place the ground turkey into a medium bowl.
6. **Wash your hands with warm soap and water after handling the ground turkey.**
7. Add the chopped mushroom, soy sauce, onion powder, salt and pepper to the ground turkey. Mix with hands or a wooden spoon. Once mixed thoroughly form into a burger patty and place into the preheated pan.
8. **Wash your hands with soap and warm water after placing the patty into the pan.**
9. Cook the patty for 5 minutes on each side.
10. **Using a spatula, tilt the patty up and insert the cooking thermometer into the side of the burger, with the tip extending into the center. If the temperature is less than 165°F, return the patty to the pan and continue cooking until the internal temperature reaches 165°F.**
11. **If you touched the turkey when checking the temperature, wash your hands with warm soap and water.**
12. Place the turkey patty on a plate when finished cooking.

PARMESAN SESAME CHICKEN

1. **Wash your hands with soap and warm water before you begin this recipe.**
2. Preheat oven to 350°F. Spray a small baking dish with cooking spray and place it onto the counter.
3. In a shallow dish combine bread crumbs, Parmesan cheese, and sesame seeds.
4. Break egg into a small bowl and beat.
5. **Wash your hands with soap and warm water after handling the raw egg.**
6. Remove the wrapper from the chicken and dip the breast into the beaten egg. Be sure to coat both sides of the breast. Then dredge the breast in the bread crumb mixture.
7. Place the coated breast on the baking dish.
8. **Wash your hands with soap and warm water after handling the coated chicken breast.**
9. Bake **until the internal temperature reaches 165°F,** about 20 to 30 minutes, *until juices run clear.* **To check the temperature, remove the baking dish from the oven and use clean tongs to grip the chicken. Insert the stem of the cooking thermometer into the side of the chicken, with the tip of the thermometer extending into the center of the thickest part of the chicken.**
10. **If you touched the chicken when checking the temperature, wash your hands with soap and warm water.**
11. Place the chicken on a plate when finished cooking.

Figure 7.1 Recipes used for the study. Bolded instructions were only seen by the group that received safety instructions.

Results and Discussion

Behavior Observations

Participants who received recipes that contained food safety instructions demonstrated improved food safety behaviors overall. For hand washing, the proportion of participants who washed their hands before cooking and after handling raw poultry products was significantly higher among those with the food safety instructions (

Table 7.1). An exception was the equal proportion of hand washing after mixing ingredients into the raw turkey. This was expected and probably was because the majority of participants mixed the ground turkey with their hands, and likely felt they needed soap to remove the mixture from their hands.

Participants also were significantly more likely to use a thermometer if they received recipes with food safety instructions. For the chicken recipe, 85% of participants used a thermometer when they had food safety instructions, compared to only 30% of those who did not have the recipes with food safety instructions. Similarly, during preparation of the turkey burger recipe, 86% of consumers used a thermometer when given food safety instructions, compared to only 20% who used one when they didn't receive food safety instructions.

In addition to increasing thermometer use, the food safety instructions also improved how the consumers used the thermometer. For those who did not have the food safety instructions in the recipe, only 16% (4 consumers) of the 25 people who used a thermometer inserted the thermometer from the side into the center of the chicken. For those who did have the food safety instructions, 58% (42 consumers) of the 62 people who used a thermometer inserted the thermometer correctly into the chicken. Likewise,

Table 7.1 Hand washing & thermometer use during the preparation of poultry items.

	With food safety instructions (n=73)	Without food safety instructions (n=82)	χ^2 (df =1)	p-value
Parmesan Sesame Chicken				
Washed hands before cooking	90%	59%	18.56	**<0.0001**
Washed hands after handling raw egg	63%	22%	25.20	**<0.0001**
Washed hands after putting chicken on sheet	84%	56%	12.37	**0.0004**
Used a thermometer with chicken	85%	30%	44.30	**<0.0001**
Mushroom Turkey Burger				
Washed hands before cooking	63%	39%	7.957	**0.0048**
Washed hands after putting in bowl	53%	20%	17.95	**<0.0001**
Washed hands after mixing ingredients	79%	79%	0.00	**1**
Used a thermometer with turkey	86%	20%	66.29	**<0.0001**

the turkey patty recipe had 13% (2 consumers) insert the thermometer from the side who did not have instructions, while 76% (38 consumers) inserted the thermometer correctly who did have the safety instructions.

These results show that the addition of basic food safety instructions to recipes has the potential to positively alter consumer behaviors. The addition of the written safety instructions significantly improved food safety behaviors for hand washing, use of

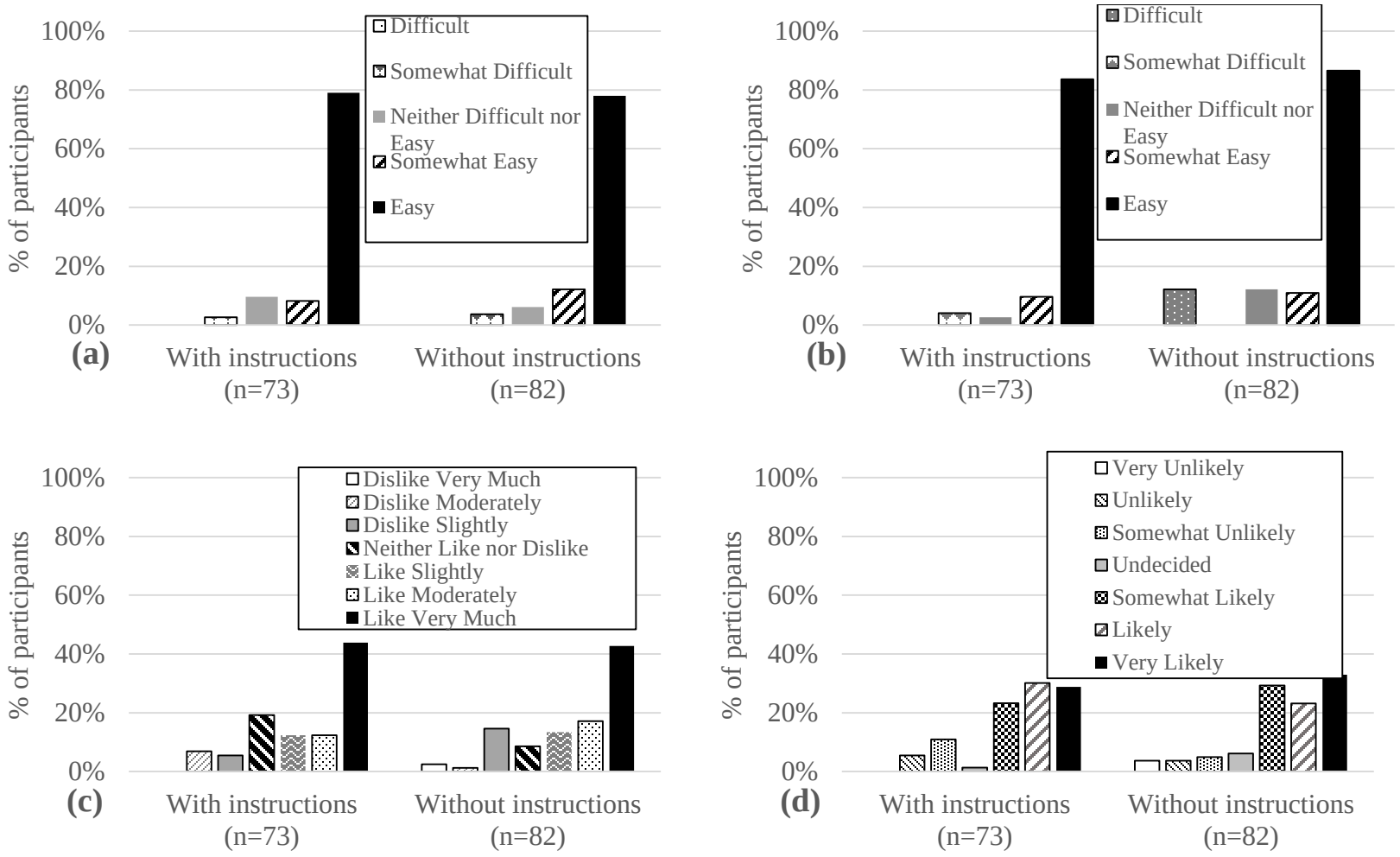

Figure 7.2 Responses from survey after completion of cooking, including (a) ease of use of chicken recipe, (b) ease of use of turkey recipe, (c) liking of food safety instructions, and (d) likelihood of future food safety instruction usage.

a thermometer and proper insertion of the thermometer. Improving these behaviors can reduce the risk of cross contamination during the cooking process.

Survey

Upon completion of cooking, consumers were asked about the ease of use of the recipes. Most consumers (over 78%) responded that the recipes were easy to follow, regardless of which set they were given (Figure 7.2a: chicken recipe, Figure 7.2b: turkey recipe). The majority of the participants also liked the recipes that contained the food safety instructions, including those who cooked with the traditional recipes only (Figure 7.2c). Furthermore, consumers also stated that they would use similar recipes if they were available (Figure 7.2d). This shows that consumers appear to be open to having food safety instruction added to their recipes.

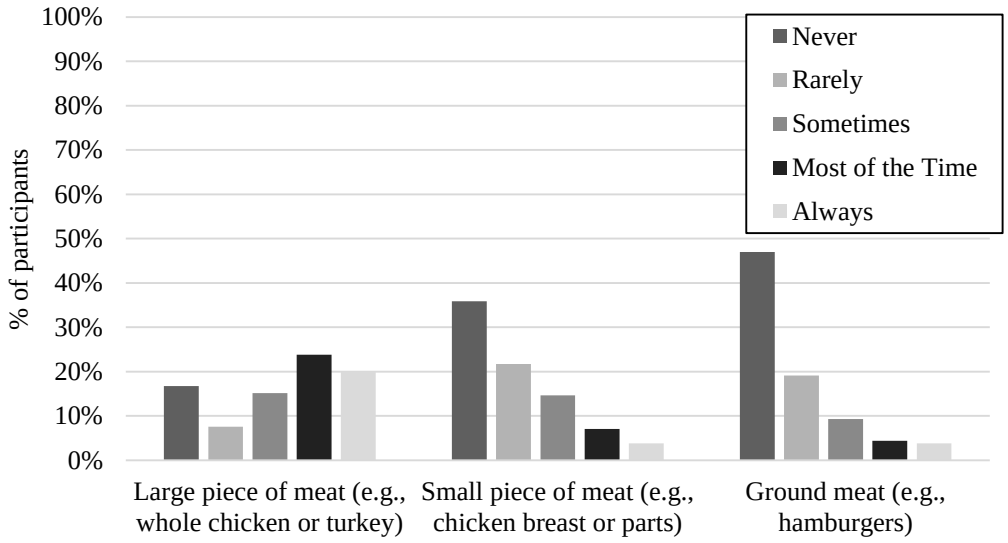

Figure 7.3 Self-reported food thermometer use at home by type of meat.

Of the participants in the study, 63% reported that they owned a food thermometer, with the remaining stating they did not own one (35%), or were not sure (2%). Of those who owned a thermometer, 54% stated they owned a dial type

thermometer, 42% owned a digital thermometer, and 4% were not sure. Reported use of a thermometer at home largely depended on the type of meat (Figure 7.3). Participants were the most likely to use a thermometer when cooking a large piece of meat, with 52% stating they used one either most of the time or always. For small pieces of meat and ground meat, this dropped to 15% and 13% respectively, confirming the poor thermometer usage in smaller pieces of meat seen in previous studies.

Consumers were also asked various questions about food thermometers to gauge their perceptions about potential benefits of thermometer use (Figure 7.4). Those who owned a thermometer were more likely to agree with the statements, especially concerning the importance of thermometer use in small items (71% vs 36% for those who don't own one), the convenience of a food thermometer (64% vs 33%), and the ease of use of a thermometer (82% vs 59%). Similar to the self-reported behaviors, large items were viewed as more important for thermometer use than small or ground meat items, even among those who owned a thermometer. Those who used a thermometer were also slightly more likely to believe that thermometer use can give better quality food (64% vs 53%). The belief by more than half of consumers that thermometer use can improve quality may indicate a potential focus that could entice more people to use a thermometer. These results show there is a lack of awareness of the importance of thermometer use, especially in smaller and ground meat items.

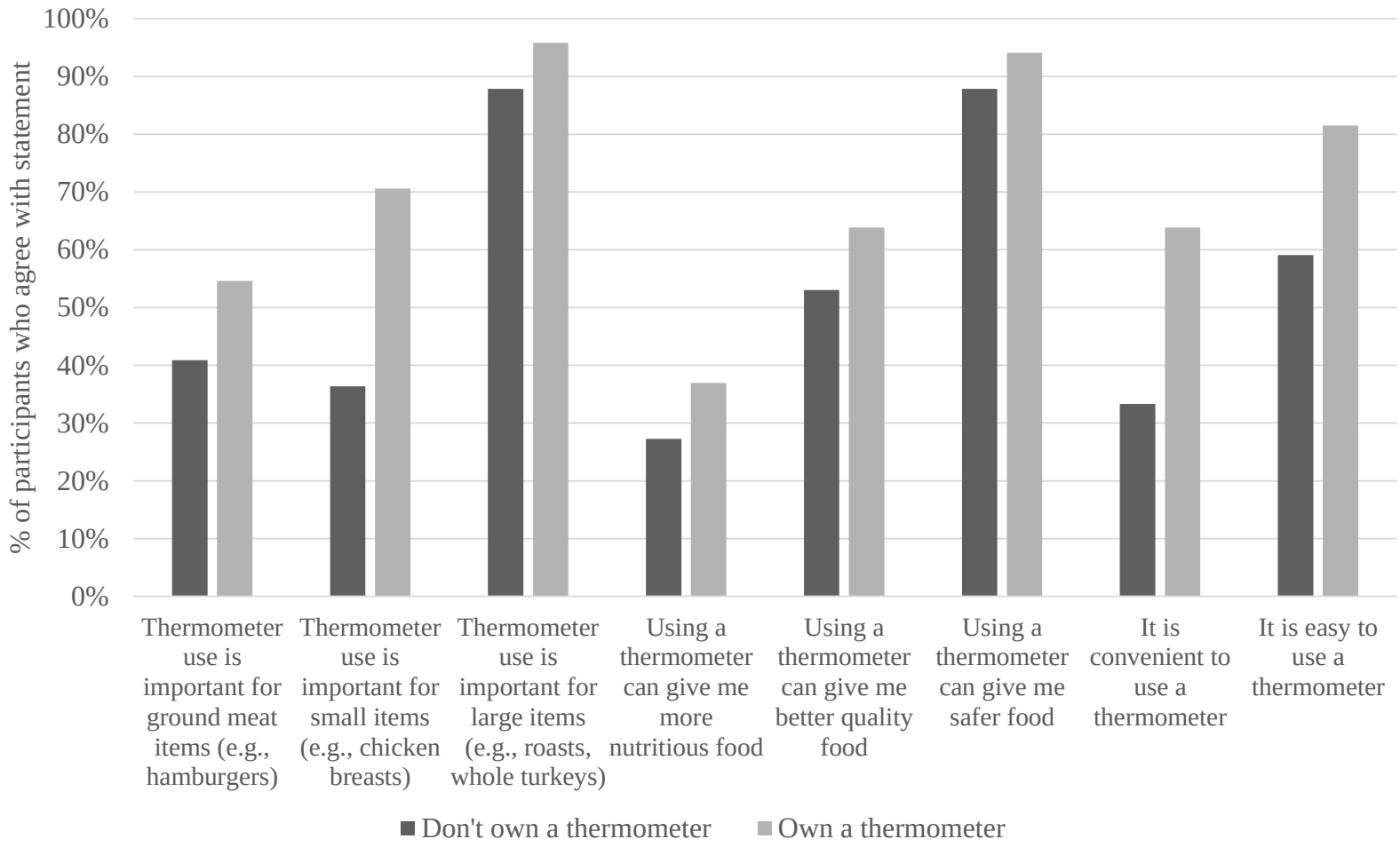

Figure 7.4 Consumer perceptions relating to food thermometer use.

Conclusions

In previous studies consumers exhibited risky food safety behaviors. This study showed that food safety behaviors can be significantly improved through the addition of food safety instructions related to hand washing and thermometer use within the preparation steps of recipes. The majority of consumers reacted positively to these additions, stating they were easy to use and that they liked having them. Because properly cooked meat may exhibit improved sensory quality (flavor, tenderness, juiciness) there is an opportunity for food safety educators to emphasize that using a food thermometer can improve food quality, by preventing overcooking while maintaining safety.

Although it was uncertain if consumers would continue to demonstrate improved behaviors when preparing recipes that incorporate food safety instructions, the responses to the survey indicate that the majority of consumers would use similar recipes at home if they were available. Common sources of recipes such as publishers, online repositories, and government and commodity groups could incorporate these and other food safety instructions into their own recipes. As consumers are more aware of appropriate food safety measures, they can improve their food safety behaviors, and potentially decrease their risk for foodborne illness.

Acknowledgments

This research was supported, in part, by a grant from the United States Department of Agriculture, GRANT 10980553, Project #TENX-2011-06512 titled "Development and evaluation of science-based messages to improve consumers' storage handing and preparation of poultry and poultry products."

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Chapter 8 - Conclusions

Throughout the studies presented in this dissertation, some common themes emerged with respect to consumer food safety behaviors when preparing poultry and eggs. Potential sources of food safety information were found to be lacking. The environment was found to have an effect on consumer perceptions. Finally, consumers were consistently shown to be lacking in the knowledge and behaviors necessary to avoid foodborne illness.

In the initial study on egg recipes, the importance of temperature information in egg recipes was reviewed. The survey of egg recipes revealed that almost no egg recipes (1% of 175 recipes reviewed) contained temperature information, which is the recommended method for determining doneness. Instead, time was the most common method given. This study showed that although recipes can be a good source of information, they currently do not contain the information needed by consumers for safe food preparation.

In a following study on food safety information sources, cooking shows were viewed and analyzed for food safety behaviors. Celebrity chefs rarely showed or mentioned good food safety behaviors, which could be due to editing done in the interest of entertainment. However, they also frequently demonstrated poor food safety behaviors that would lead to cross-contamination if followed at home. This study showed that either celebrity chefs need to change their behaviors to reflect appropriate safety procedures, or those who are responsible for educating consumers need to ensure that the general populace is aware that celebrity chefs are not good role models for food safety.

The effect of lighting conditions on consumer perception of doneness was the next area of study discussed. Lighting was shown to change perceptions of doneness in photographs of turkey patties cooked to different temperatures. About half of the consumers (n=104) said they would be willing to eat a patty that was cooked to 160°F when viewed under LED lighting, higher than any other type of lighting. This was under the recommended temperature for safety for turkey. The message from this study was that consumers need to be reminded that appearance alone is insufficient for determining meat doneness, especially with the introduction of new lighting.

An observational study viewed consumers (n=101) preparing poultry and eggs using different preparation techniques, while evaluating their food safety behaviors. This study found that most consumers did not follow food safety behaviors (namely hand washing and thermometer use), many of which would prevent foodborne illness. More unexpectedly, those who did use a thermometer cooked their poultry dishes to a wide range of temperatures, and thermometer use was not shown to have a significant impact on their ability to cook the poultry to a safe temperature. This showed that educators need to not only emphasize the importance of thermometer use, but they also need to ensure consumers know how to use a thermometer and what temperatures are appropriate for what items.

Finally, a separate observational study had consumers (n=186) prepare a baked chicken breast and ground turkey patty following recipes, half of which contained information on proper hand washing and thermometer use for those items. This study showed that those who had the food safety instructions demonstrated significantly better food safety behaviors than those who did not have recipes. Additionally, the majority of

consumers stated that they would be likely to use similar recipes in the future if they had access to them.

Taken together, these studies showed that while potential sources of food safety information are not being utilized properly, they could improve food safety behaviors among consumers. Incorporating food safety information into sources such as recipes and cooking shows may be a simple yet effective step to easing the burden of foodborne illness among consumers. Food safety agencies, industry, and educators can incorporate these findings in their messages to consumers, and hopefully give them the additional information and motivation they need to keep themselves safe.

Appendix A - Observational Guide for Television Shows

(Chapter 4)

Cooking Show Observations

1. Name of TV Show

2. Episode # and/or Name

3. Number of meat dishes shown in this episode

4. How were the recipes presented?
   - Only one dish at a time was prepared
   - Only one dish at a time was prepared, but chef went back to check on a dish that had been cooking for awhile
   - Multiple dishes were prepared together at once (chef went back and forth constantly)

5. Type of Meat Dish(es) Prepared
   - Poultry
   - Beef
   - Pork
   - Lamb, Goat, Game
   - Seafood
   - Egg

6. Cut(s) of Meat Prepared
   - Whole (e.g. whole turkey)
   - Ground
   - Pieces (breast, steak, etc.)
   - Cured (sausage, bacon, cold cuts)
   - Liver or organ meats

7. Hand-washing with soap

	Enter # of times					
	Shown no contamination	Shown with contamination	Rinsed only	Used gloves	Mentioned, not shown	Not shown or mentioned
Before Cooking						
After touching raw meat						
Other						
Other						

8. Additional Cross-contamination

	Enter # of times	
	Shown	Mentioned
Licked Fingers		
Touched Head or Hair		
Washed produce or other RTE items before use		
Sampled (ate) food with hands		
Added food with hands		
Ate while cooking		
Washed meat before cooking		
Raw & Ready-to-eat items were shown touching		

9. How was meat preparation handled?
   - ☐ Meat was pre-cut & prepared
   - ☐ Meat was cut on show
   - ☐ Meat was not cut, but whole muscle was used (i.e., turkey, steak, chicken breast)

10. Cutting Board/Surface (skip if meat was not cut on show)

	Enter # of times	
	Shown	Mentioned
Cutting board was washed before cutting other items		
Different cutting board was used for other items		
Ready-to-eat items were cut on the same cutting board		

11. How was the meat item determined to be finished cooking?

	Shown	Mentioned
Time	☐	☐
Color	☐	☐
Texture	☐	☐
Cut into	☐	☐
Juices	☐	☐
Thermometer	☐	☐
Other	☐	☐

12. Was the temperature given correct for the item being cooked?

- ☐ Yes (type temperature) _____
- ☐ No (type temperature) _____

13. Time-Temperature: Food left out for > 2 hours

	Shown	Mentioned
Refrigerated food left for long duration	☐	☐
Cooked food left out for long duration	☐	☐
Incorrect serving temperature (food kept between 41-140 F)	☐	☐
Incorrect cooling procedure	☐	☐
Appropriate storage of potentially hazardous foods	☐	☐

14. Additional Observations:

Appendix B - Interview Questions for Poultry and Egg Preparation (Chapter 5)

Participant #: _____ **Date: _____**

1. **Chicken Breast questions**
    a. How similar was the preparation of the chicken breast you did today to the way you would prepare it in your own kitchen?

    b. If you had cooked this at home, would you say it was underdone, just about right, or overdone?

    c. How did you decide the chicken breast was done?

    d. Why did you use that method to decide the chicken breast was done?

    e. Is this the same method you would use at home (to check if it was done)?

2. **Turkey Patty on the Stove**
    a. How similar was the preparation of the turkey patty you did today to the way you would prepare it in your own kitchen?

    b. If you had cooked this at home, would you say it was underdone, just about right, or overdone?

    c. How did you decide the turkey patty was done?

    d. Why did you use that method to decide the turkey patty was done?

    e. Is this the same method you would use at home?

3. **Fried Egg questions**
    a. How similar was the preparation of the fried eggs you did today to the way you would prepare it in your own kitchen?

    b. If you had cooked this at home, would you say it was underdone, just about right, or overdone?

    c. How did you decide the fried egg was done?

    d. Why did you use that method to decide the fried eggs were done?

    e. Is this the same method you would use at home?

4. **Scrambled Eggs**
    a. How similar was the preparation of the scrambled eggs you did today to the way you would prepare it in your own kitchen?

    b. If you had cooked this at home, would you say it was underdone, just about right, or overdone?

    c. How did you decide the scrambled eggs were done?

    d. Why did you use that method to decide the scrambled eggs were done?

    e. Is this the same method you would use at home?

5. **Overall**
    a. Thermometer use: Choose which question applies

        i. You used a thermometer for some items and not others, why?

        ii. You did not use a thermometer for any items, in what situation if any do you use a thermometer?

        iii. You used the thermometer for all the items; do you commonly use your thermometer at home? How did this habit start?

6. Is there anything else you would like to tell us about the way you cook poultry or eggs?

Appendix C - Survey Questions for Poultry and Egg Preparation (Chapter 5)

Participant Number: _____ Date: _____

1. How often do you prepare these items at home?
    a. Chicken Breast
        □ Never □ Rarely □ Occasionally □ Frequently □ Very Frequently

    b. Turkey Patty
        □ Never □ Rarely □ Occasionally □ Frequently □ Very Frequently

    c. Scrambled Egg
        □ Never □ Rarely □ Occasionally □ Frequently □ Very Frequently

    d. Fried Egg
        □ Never □ Rarely □ Occasionally □ Frequently □ Very Frequently

2. Where do you get your cooking information?
    a. Magazines
    b. Internet (written)
    c. Internet video (YouTube, etc.)
    d. TV
    e. Friends & Family

3. How often do you watch cooking shows?
    a. Daily
    b. Once a week
    c. Once a month
    d. Never

4. What cooking shows do you watch, if any?

5. Have you taken any cooking classes?
    a. Yes
    b. No
        i. If yes, what classes have you taken?

6. How would you rate your cooking abilities?
    a. Novice
    b. Basic skills
    c. Average
    d. Better than average
    e. Expert

7. Do you think organic chicken is more healthful than non-organic chicken?
    a. Yes
    b. No

8. Do you think organic chicken is safer than non-organic chicken?
    a. Yes
    b. No

9. When do you normally dispose of your eggs?

☐ At the expiration date	☐ Based on smell
☐ After the expiration date	☐ I always finish the carton
☐ Based on appearance	☐ Other: _____

Appendix D - Observational Checklist for Recipe Preparation (Chapter 7)

Turkey Burger Final Temperature: _____

Turkey Burger Handwashing	Cross-contam. before	Didn't wash	Rinsed only	Soap < 20 sec	Soap > 20 sec	Was behavior mentioned? Positive	Negative	Don't know why
Washed hands before cooking	☐	☐	☐	☐	☐	☐	☐	☐
Washed hands after putting in bowl	☐	☐	☐	☐	☐	☐	☐	☐
Washed hands after mixing ingredients	☐	☐	☐	☐	☐	☐	☐	☐
	Didn't wash	**Rinse only**	**Rubbed dirt off**			**Positive**	**Negative**	**Don't understand**
Washed mushroom	☐	☐	☐			☐	☐	☐
	Didn't Use	**From top**	**From side**	**Reached center**		**Positive**	**Negative**	**Don't understand**
Used thermometer	☐	☐	☐	☐		☐	☐	☐
Other behaviors	Yes					Positive	Negative	
Cut open	☐					☐	☐	
Squished/poked (w/o puncturing)	☐					☐	☐	
Licked fingers	☐					☐	☐	
Touched head/hair	☐					☐	☐	
Tasted food	☐					☐	☐	

Parmesan Sesame Chicken Final Temperature: _____

Parmesan Sesame Chicken Handwashing	Cross-contam. before	Didn't wash	Rinsed only	Soap < 20 sec	Soap > 20 sec	Was behavior mentioned? Positive	Negative	Don't understand
Washed hands before cooking	☐	☐	☐	☐	☐	☐	☐	☐
Washed hands after handling raw egg	☐	☐	☐	☐	☐	☐	☐	☐
Washed hands after putting chicken on sheet	☐	☐	☐	☐	☐	☐	☐	☐
	Didn't Use	**From top**	**From side**	**Reached center**		**Positive**	**Negative**	**Don't understand**
Used thermometer	☐	☐	☐	☐		☐	☐	☐
Other behaviors	**Yes**					**Positive**	**Negative**	
Cut open	☐					☐	☐	
Squished/poked (w/o puncturing)	☐					☐	☐	
Licked fingers	☐					☐	☐	
Touched head/hair	☐					☐	☐	
Tasted food	☐					☐	☐	

Appendix E - Questionnaire After Recipe Preparation

(Chapter 7)

A. Study administrator: Before beginning the survey please fill out the information on this page, and then allow the participant to fill out the rest.

B. Which of the recipe sets did the participant see?
   - With food safety instructions
   - Without food safety instructions
   - With food safety instructions & think aloud

C. Location of testing?
   - KSU
   - TSU

D. Please enter the participants number (should match the number on their observation worksheet):

1. How would you rate the ease of use of the MUSHROOM TURKEY BURGER recipe?
    - Very Difficult
    - Difficult
    - Somewhat Difficult
    - Neither Difficult nor Easy
    - Somewhat Easy
    - Easy
    - Very Easy

2. How would you rate the amount of information given in the MUSHROOM TURKEY BURGER recipe?
    - Far too Little
    - Too Little
    - Neither too Much nor too Little
    - Too Much
    - Far too Much

3. How much do you like the instructions given in the MUSHROOM TURKEY BURGER recipe?
    - Dislike Extremely
    - Dislike Very Much
    - Dislike Moderately
    - Dislike Slightly
    - Neither Like nor Dislike
    - Like Slightly
    - Like Moderately
    - Like Very Much
    - Like Extremely

4. How would you rate the ease of use of the PARMESAN SESAME CHICKEN recipe?
    - Very Difficult
    - Difficult
    - Somewhat Difficult
    - Neither Difficult nor Easy
    - Somewhat Easy
    - Easy
    - Very Easy

5. How would you rate the amount of information given in the PARMESAN SESAME CHICKEN recipe?
    - Far too Little
    - Too Little
    - Neither too Much nor too Little
    - Too Much
    - Far too Much

6. How much do you like the instructions given in the PARMESAN SESAME CHICKEN recipe?
    - Dislike Extremely
    - Dislike Very Much
    - Dislike Moderately
    - Dislike Slightly
    - Neither Like nor Dislike
    - Like Slightly
    - Like Moderately
    - Like Very Much
    - Like Extremely

7. Please choose the response below that best represents how you feel about the use of a food thermometer when cooking.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
It is easy to use a food thermometer	❍	❍	❍	❍	❍
It is convenient to use a food thermometer	❍	❍	❍	❍	❍
Using a food thermometer can give me safer food	❍	❍	❍	❍	❍
Using a food thermometer can give me better quality food	❍	❍	❍	❍	❍
Using a food thermometer can give me more nutritious food	❍	❍	❍	❍	❍
Food thermometer use is important for large items (e.g., roasts, whole turkeys)	❍	❍	❍	❍	❍
Food thermometer use is important for small items (e.g., chicken breasts)	❍	❍	❍	❍	❍
Food thermometer use is important for ground meat items (e.g., hamburgers)	❍	❍	❍	❍	❍

8. Do you own a thermometer used to check food during cooking?
    - Yes
    - No
    - I'm not sure

9. What type of thermometer do you own?
    - Dial
    - Digital
    - I don't know

10. How often do you use a thermometer when cooking the following items?

	Never	Rarely	Sometimes	Most of the Time	Always
Large piece of meat (e.g., whole chicken or turkey)?	❍	❍	❍	❍	❍
Small piece of meat (e.g., chicken breast or parts)?	❍	❍	❍	❍	❍
Ground meat (e.g., hamburgers)?	❍	❍	❍	❍	❍

11. In your own estimation, how well did you follow the recipe directions when preparing the food today?
    - I did not follow them
    - I followed one or two of them
    - I followed some of them
    - I followed most of them
    - I followed all of them

12. The following is the recipe for Parmesan Sesame Chicken that you prepared today, with food safety instructions added. Please read through the recipe, then answer the following questions. **(See Figure 7.1)**

13. How much did you like the food safety instructions included within the recipes?
    - Dislike Extremely
    - Dislike Very Much
    - Dislike Moderately
    - Dislike Slightly
    - Neither Like nor Dislike
    - Like Slightly
    - Like Moderately
    - Like Very Much
    - Like Extremely

14. How likely would you be to follow food safety instructions that were included in recipes in the future?
    - Very Unlikely
    - Unlikely
    - Somewhat Unlikely
    - Undecided
    - Somewhat Likely
    - Likely
    - Very Likely

15. Is there any other information that you would like us to know concerning these recipes?

16. Please answer the following questions about yourself. These results will be kept anonymous.

17. Which of the following categories best describes your age?
    - Under 18
    - 18 - 24
    - 25 - 44
    - 45 - 64
    - 65+

18. What is your gender?
    - Male

- Female

19. How much of the cooking for your household are you responsible for?
    - Less than 40%
    - About 40-60%
    - More than 60%