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Consumer and sensory perceptions of black bone discoloration in broiler chickens

by

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Abstract

Consumers and Canadian poultry processors were interviewed to understand the overall perception of bone-in chicken meat and to gain insight on the defect of black bone discoloration, a color defect that appears in cooked bone-in chicken. Through the consumer science technique of laddering, food safety, eating quality, price, health and convenience were revealed as the most important values associated with chicken meat. Poultry processors agreed upon the importance of food safety. Black bone discoloration did not greatly influence consumer acceptance of broiler meat, nor did it appear to negatively impact the poultry industry as complaints were reported rarely. Modifying broiler bone growth rate through dietary treatments did not significantly ($P>0.05$) alter the sensory properties of the meat or reduce the incidence of discoloration. Overall, black bone discoloration is not perceived as a major problem for the poultry industry in Canada. In order to maintain consumer demand, poultry producers should focus on the food safety aspect of their products.

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Chapter 1: Introduction and literature review

This thesis provides a broad overview of the issue of black bone discoloration in bone-in chicken from both the consumer and industry standpoints in Canada. It also examines the effects of altering broiler growth rates via diet modifications on the incidence of black bone discoloration and the overall sensory quality of bone-in chicken thighs. The collaboration of consumer science and sensory techniques used in this research along with the thoroughness of the design provide a unique dimension to consumer research on poultry meat.

Chapter 1 is a literature review that illustrates the current trends in chicken consumption, the effects of production and other factors associated with black bone discoloration, factors influencing consumer preference and perception of meat quality as well as a detailed overview of the qualitative consumer research method of laddering.

Chapter 2 describes a two-part research study where Part 1 entailed using the laddering technique to understand the underlying motivations behind consumers' choice for bone-in chicken as well as to elicit their overall perception of black bone discoloration. Based on the results of Part 1, a structured interview was developed to interview poultry processors to gain their perspective of the industry's perception of these issues compared to those of consumers (Part 2). This chapter was written and formatted for publication in the *Journal of Food Science.*

Chapter 3 describes the second research study in this thesis; a consumer panel investigation of the impact of broiler growth rate using modified diets on the sensory quality of bone-in chicken thighs and the incidence of discoloration. Instrumental color measurements were also made on the femur to determine the association between bone color and consumer evaluations. This chapter was written and formatted for publication in *Poultry Science.*

1.1. Canadian chicken production and consumption trends

Chicken as a food commodity has been growing steadily in the past several years (Agriculture and Agri-Food Canada, 2009). North America is currently ranked as the second leading producer of chicken following Asia, with the United States ranked in first place and Canada ranked at 13th (Chicken Farmers of Canada, 2009). Canadian chicken production has increased dramatically over the past few decades. In 2008, Canadian production of chicken was estimated at 1.01 billion kilograms, almost twice the amount that was produced in the 1990s (Agriculture and Agri-Food Canada, 2009).

There are several possible factors contributing to this growing demand for chicken, which includes population growth in Canada as well as increased preference for chicken. In 2005, per capita chicken consumption had increased by 136% since the 1970s and current reports show that chicken is the most consumed meat per capita in Canada, rising above beef, which has been the meat of choice in the past (Agriculture and Agri-Food Canada, 2009). In 2009, Canadian consumption was 31.7kg per person and it is estimated to rise by another 1.85% by 2015 (Chicken Farmers of Canada, 2009).

1.1.2. Factors affecting consumer preference for poultry

The competitive edge of poultry production has allowed it to dominate in the meat market over other meats such as beef and pork in Europe and North America (Magdelaine et al., 2008; Haley, 2001). Chicken in particular has been the most successful of poultry meats to accommodate the changing demand of today's consumers (Magdelaine et al., 2008). Chicken is considered to be a product that is easy to prepare and its versatility contributes to its popularity as it is featured in dishes worldwide (Vukasovic, 2009). There are several factors that influence consumer preference for chicken, which can be explained, in part, by the changes seen in consumer lifestyles and values with regard to food consumption. Among these changes are the importance of convenience foods in the modern day lifestyle and the growing concern for personal health.

1.1.2.1. Convenience

Convenience has been cited in several studies as an important element in consumer lifestyles (Grunert et al., 2004; Resurreccion, 2004; Grunert and Bech-Larsen, 2005; Magdelaine et al., 2008; Vukasovic, 2009). Important differences in today's society compared to 20 years ago include the increased number of women in the work force as well as the growing proportion of consumers living in single member households who manage a more convenience-oriented way of living (Issanchou, 1996; Resurreccion, 2004). As consumers today are leading busier lifestyles, meal choices are largely based on time availability as well as on-hand ingredients (Resurreccion, 2004). Therefore, last minute meal planning has become more common in households, especially those where both men and women are in the work force (Resurreccion, 2004; Grunert, 2006). In addition, it appears that consumers' knowledge of cooking has decreased as well. Consumers not only seek foods that require less cooking time, but they also rely on foods that are easy to prepare (Issanchou, 1996). One of the ways the poultry industry has met the need for convenient foods was by producing more value-added products such as cut-up chicken parts, patties, fillets and nuggets (Resurreccion, 2004)

1.1.2.2. Healthy eating

Another change in consumer lifestyles is the growing focus on healthy eating and balanced diets (Vukasovic, 2009). With increased emphasis by media and health authorities to reduce dietary intakes of saturated fats and cholesterol in attempts to prevent obesity, consumers are choosing to eat leaner meats (Haley, 2001; Resurreccion, 2004; McCarthy et al., 2004). One of the main advantages of poultry meat is that it is lower in fat compared to other meats (Magdelaine et al., 2008). Studies have shown that poultry is perceived to have health benefits whereas beef appears to have a negative association with health (Issanchou, 1996; Verbeke and Viaene, 1999). Furthermore, chicken has been perceived to have fewer health-related risks compared to both beef and pork (da Conceição et al., 2008).

1.2. Effects of production methods on broiler chicken growth

The increase in consumer demand for leaner meat has influenced the poultry industry to develop new strategies to improve the efficiency of chicken production while maintaining superior meat quality. One strategy is the use of genetic selection to increase the feed efficiency and muscle growth of broiler chickens (Williams et al., 2000; Schmidt et al., 2009). However, poultry researchers have observed that rapid increases in muscle growth in broiler chickens can cause imbalances in the development of other parts of the bird, particularly in its bone development and maturity (Rath et al., 2000; Williams et al., 2000). With rapid muscle growth, skeletal development fails to keep up with the overall growth of the bird and consequently, causes excess stress and physical load on the bone (Rath et al., 2000). As a result, these birds tend to be more susceptible to bone deformity and fragility (Rath et al., 2000). In addition, Williams et al. (2000), who compared the skeletal development of modern birds raised under commercial conditions to slow growth birds, found that the bones of fast-growing broilers are also more porous than slow-growing broilers. Bone porosity in broilers is important because it is thought to be the most important factor associated with a dark color defect that appears in bone-in broiler chickens, often referred to as 'black bone discoloration'.

1.2.1 Factors affecting black bone discoloration

Black bone discoloration is characterized as a dark burgundy or black stain that appears in bone-in chicken after it has been cooked (Smith and Northcutt, 2004). It is predominantly found in the thighs of broiler chickens on the inner surface of the meat that is adjacent to the femur (Smith and Northcutt, 2004). This discoloration is prevalent in broiler chickens worldwide (DSM Nutritional Products Ltd, 2010), however, little is known about the actual cause of this discoloration. The most accepted cause of this color defect suggests that the dark discoloration is created when blood leaches out from the bone marrow of birds onto the surrounding meat surface and the affected area then darkens as the meat cooks (Koonz and Ramsbottom, 1947). It has been suggested that porous bones

cause birds to become more susceptible to the discoloration, however, other factors have also been associated with this problem such as the gender of the bird, age, and the impact of freezing bird carcasses during post-slaughter storage (Koonz and Ramsbottom, 1947; Brant and Stewart, 1950; Li et al., 1969).

1.2.1.1 Gender

Skeletal growth and bone strength often differ among male and female broilers, which have been explained by the natural differences in their size and hormones where male broilers tend to grow larger bones at a faster rate than females (Rath et al., 2000; Rose et al., 1996). Rath et al. (1999) found that the diasphyseal diameters of broilers differed between genders of the same age. Female broilers were found to have consistently smaller diasphyseal diameters than their male counterparts (Rose et al., 1996; Rath et al., 1999). However, despite a smaller diasphyseal diameter, the tibiae of female broilers are also found to be less porous, more mineralized and have a higher bone density overall compared to males (Rose et al., 1996; Rath et al., 1999). Previous research studies indicate that bone mineralization begins at the thinnest part of the diaphysis, at the area subjected to the highest level of stress (Dillaman et al., 1979; Landis et al, 1995). As female broilers have smaller and thinner bones, they are usually subjected to a higher level of stress, which induces mineralization (Rose et al., 1996). Therefore, the mineralization rate is usually higher in females. Furthermore, with similar quantity of bone tissue, female broilers tend to have thinner, more condensed tissue in their bones compared to male broilers who have larger, wider bones that are more porous (Rose et al., 1996). The reduced porosity in female bones counterbalances the thinness of the bones and therefore, female broilers usually have stronger bones than males (Rose et al., 1996). These studies might suggest that female broilers are less likely to develop black bone discoloration due to their stronger bone development.

1.2.1.2 Age

Another factor that contributes to black bone discoloration is the age of the bird. A study by McCoy et al. (1996), who investigated chickens with osteoporotic bones, found that bone strength was age-dependent such that older chickens had stronger bones. Younger birds are thought to have less developed bones that are less calcified, making them more porous than those from older birds (Koonz and Ramsbottom, 1947). Consequently, the bones of younger birds are thought to be more susceptible to hemoglobin leakage from the inner marrow that causes discoloration (Koonz and Ramsbottom, 1947).

1.2.2 Post-slaughter freezing on black bone discoloration

Lastly, the freezing and thawing of bone-in chicken has been shown to impact the occurrence of black bone discoloration. Earlier studies have found that freezing chicken meat prior to cooking resulted in darker meat than chicken that was not frozen (Spencer et al., 1961; Lyon et al., 1976). Similarly, bone-in meat was darker than boneless (Lyon et al., 1976). Freezing raw bone-in chicken has been found to increase bone porosity, which contributes to the discoloration of the meat (Brant and Stewart, 1950). This is because the cavities of the bones in young chickens contain red bone marrow which is rich in hemoglobin (Brant and Stewart, 1950) and freezing bone-in chicken meat hemolyzes the erythrocytes, thereby, allowing hemoglobin to be released from the inner bone marrow (Hatch and Stadelman, 1972). Furthermore, freezing accelerates the development of methemoglobin in hemoglobin-containing bones causing these bones to become darker more quickly as it defrosts (Koonz and Ramsbottom, 1947). Consequently, the bone and surrounding tissues become dark upon cooking. Although these factors have been linked to the cause of black bone discoloration, more research is required to further confirm these factors and their effects on discoloration.

One of the concerns with discoloration is that often times consumers mistaken the redness in chicken as a sign of undercooked meat, which is undesirable to consumers (Fletcher, 2002). Also, bone darkening that is associated

with pre-frozen products is considered a defect in cooked poultry products (Fletcher, 2002). Furthermore, Smith and Northcutt (2003) noted that severe discoloration in cooked chicken meat might lead to consumer complaints and ultimately, rejection of the product. Thus, consumer research is important to maintain consumer acceptance of chicken products.

1.3. Understanding consumers through consumer research

It is well known that consumer acceptance is the key to food product success (van Kleef et al., 2005); therefore, it is crucial to understand consumer attitudes and perceptions in order to meet their needs. In the past, research on consumer acceptance has focused mainly on product liking and purchase intent using quantitative methods such as hedonic scales and questionnaires. However, in recent years, a more holistic approach to consumer research has ensued, driven by product developers (Lundahl, 2006). It draws upon the concept that understanding consumer motivation for choosing products involves understanding the emotions and perceptions that consumers develop during the actual product experience in addition to external factors such as product features and functionality. Previous research has shown that emotions are a significant motivator of consumer behavior and that consumers develop emotions towards products. Lundahl (2006) proposed that the emotions that consumers develop during their product experience influence their overall attitude about the product and motivation for future purchase intention. This concept has brought a greater awareness of the importance of incorporating consumer experiences to add "the voice of the consumer" into product development.

1.3.1. Consumer perception of meat quality

The perception of food quality is largely based on the beliefs and attitudes that consumers have about a product (Issanchou, 1996). These beliefs and attitudes are mostly driven by cultural backgrounds; however, the overall perception of quality is thought to be dependent on the person and the product (Issanchou, 1996). Information that is presented to consumers by media and food

companies regarding food products can also influence consumer perceptions of quality but the way in which this information is interpreted can be easily influenced by social, personal or psychological factors (Issanchou, 1996). It is also important to note that perceptions of quality can change across the course of a consumer's experience with the product before, during or after consumption.

The concept of meat quality is multidimensional. Molnar (1995) described these dimensions as food safety, sensory qualities, nutritional value and convenience. The perception of meat quality is thought to be formed from the inferences that consumers make about the quality cues that are available to them (Becker et al., 2000; Barrena and Sánchez, 2009). In the past few years, the term 'meat quality' has evolved in terms of what consumers consider to be 'quality' (Becker et al., 2000). Since meat is typically an unbranded and unlabelled product, consumers often experience difficulty when evaluating meat quality (Grunert, 2006). As a result, intrinsic quality cues have been the primary source for consumers to evaluate quality in the past (Grunert, 2006).

1.3.1.1. Intrinsic quality cues

Intrinsic quality cues are the physical characteristics of a product such as the sensory properties of the product like the appearance, juiciness, and leanness of meat (Becker et al., 2000). Intrinsic quality cues are often associated with experiential attributes that are only present to consumers during consumption (Becker et al., 2000). The appearance of meat has been known to be an important element of meat evaluation by consumers and can greatly influence consumer purchase behavior (Resurreccion, 2004; Fortomaris et al., 2006). The most important appearance features include the visible fat and color quality of the meat product (Resurreccion, 2004). It has been well established that the color of red meats is often used as a cue to indicate meat freshness (Jeremiah et al., 1972). Meat color has also been found useful for evaluating the leanness and overall quality of pork chops (Glitsch, 2000). Furthermore, color and fat have also been used as an indicator for taste and tenderness of meat (Grunert, 2005). Although intrinsic quality cues have been known to serve as important indicators of quality,

several researchers have mentioned the rising importance of extrinsic cues on consumer perception of meat quality in present times (Becker et al., 2000; Bernues et al., 2003; Grunert, 2006).

1.3.1.2. Extrinsic quality cues

Extrinsic quality cues include characteristics that are not physically part of the product but are typically provided by the producers, such as brand labels, place of origin and price (Khachaturian and Morganosky, 1990; Becker et al., 2000). Among the different types of extrinsic cues, credence quality cues in particular have become increasingly important to consumers. Credence qualities include those features that provide no cues for the consumer during the purchasing process, such as the food safety and healthiness aspects of the product (Becker et al., 2000). Consumers cannot experience these qualities directly.

Past outbreaks of diseases such as BSE and avian flu have placed a toll on consumer confidence in meat. This is important as it has been stated that it is the 'perceived' safety of meat that is critical to consumer perception of meat quality (Cardello, 1995; Issanchou, 1996). da Conceição et al. (2008) found that the greater the concern for a given attribute, the smaller the intent to increase the consumption of that meat. As consumers are becoming more aware of food safety issues, there is a greater interest in the processing techniques that may affect the safety of their meat and overall health (Grunert, 2006). As a result, there is a greater demand to provide credence quality information, which can only be determined through extrinsic cues.

1.3.1.3. International perception and preference

Research regarding consumer preferences for meat has not been well established in North America. However, studies in various countries (Ireland, Brazil, Belgium, Norway) have shown that meat perception differs among populations as well as for the type of animal consumed. Overall, consumer perception of poultry tends to be associated with positive attitudes. Most notably, poultry is considered to be healthier than beef and pork in the four countries

previously mentioned (Verbeke and Viaene, 1999; Kubberød et al., 2002; McCarthy et al., 2004; da Conceição et al., 2008). In Ireland, poultry was also perceived to be tastier and less expensive compared to pork (McCarthy et al., 2004). Furthermore, poultry meat was perceived to have the highest quality in attributes including good quality, good taste, leanness and tenderness when compared with beef and pork in Belgium (Verbeke and Viaene, 1999).

Negative associations pertaining to poultry have been related to the safety aspects and animal welfare. Irish consumers believed that poultry was less safe to eat than pork products whereas another study with Belgian consumers perceived poultry to be the safest. In this study, safety referred to the addition of 'hormones' or 'harmful substances' and trustworthiness. On the other hand, consumers in Brazil indicated no differences in the safety aspects when comparing poultry, beef and pork (da Conceição et al., 2008). The only negative aspect of poultry mentioned by Belgian consumers was the animal friendly element in which poultry scored lower than beef and pork (Verbeke and Viaene, 1999).

1.4 Qualitative methods to understand consumer perceptions of food products.

There are several methods for conducting consumer research. However, the method that is used depends on the overall objective of the research. Qualitative methods are often used for understanding consumer perceptions and have been found to be particularly useful during the product development stage (van Kleef et al., 2005; Ares et al., 2008). One method in particular that has been effective for understanding consumer motives is the consumer science technique called "laddering". Laddering was first developed by Hinkle (1965) as a method for understanding the underlying motives that influence consumers' choice and behavior (Costa et al., 2004; Russell et al., 2004; Grunert, 2005). It is based on the Means-End Chain (MEC) theory that links consumers' knowledge about product attributes to personal knowledge about the consequences and values (Zanoli et al., 2002).

The means-end chain theory indicates that consumers are attracted to certain product attributes because they associate these attributes to personally relevant consequences. Furthermore, consumers believe that these consequences will ultimately lead them to fulfill a certain personal value. Thus, the concept of a means-end chain is that product attributes signify the 'means' of the product and the values represent the 'ends' of those means. In other words, the values elicited through the laddering technique are essentially the underlying motives that consumers have for choosing the product.

The means-end chain theory has two basic assumptions. The first assumption is that consumers evaluate products based on the perceived level of self-relevance (Costa et al., 2004). The second assumption is that consumers make voluntary choices in their behavior in order to produce the best outcome. Thus, not only do consumers choose products that are relevant to them personally, they also choose products that will provide the greatest benefit (Costa et al., 2004). In other words, consumers are only interested in the personal rewards that are associated with choosing the product.

One advantage of laddering over other qualitative techniques is that its focus is on understanding consumers at a personal level to provide results closely related to consumer preferences and behaviors (Grunert and Grunert, 1995). Consequently, the results obtained through laddering may provide a more accurate representation of consumers to better target their needs than could be obtained through other qualitative techniques. Another advantage of laddering is that the technique allows respondents to reply in a natural flow of speech with little restriction which may result in a broader span of responses (Zanoli et al., 2002).

1.4.1. The technique of laddering

Laddering is an in-depth, one-on-one, semi-structured interview that aims to reveal the underlying associations made between three levels of abstraction; attributes (A), consequences (C) and values (V), that consumers make about a product (Russell et al., 2004). There are two phases to the laddering technique. The first phase is the elicitation phase where respondents are asked to generate

relevant attributes that they associate with a given product (Costa et al., 2004; Barrena and Sánchez, 2009). In the second phase, the interviewer uses a series of direct probing questions such as "Why is that important to you?" in order to reveal the underlying associations made between the A-C-V (Costa et al., 2004; Barrena and Sánchez, 2009). The technique of using 'why'-probed questions help guide the respondents 'up' the A-C-V ladder, to reveal in-depth information about the connections that may otherwise be in the subconscious of the respondent (Russell et al., 2004).

1.4.1.1 Data analysis

The results obtained through Laddering are represented through a graphical map known as a Hierarchical Value Map (HVM). It is essentially a graphical outline of the ladders that were elicited from consumers representing the underlying motives for choosing a product. It illustrates not only what the most important values are for choosing the product, but also which attributes are perceived to be the most important to help fulfill these values.

1.4.1.2. Content analysis

There are several steps taken to create HVM. The first step is content analysis, which entails combining similar patterns of meaning into one single concept in order to reduce the bulk in the raw data (Gengler et al., 1995). Basically, in this step, the researcher analyzes the raw data of each interview by highlighting specific words or phrases and then creates new codes to represent them. The purpose of coding words and phrases is to help simplify the management of data such that one code can be used to signify different responses that have similar meaning. For example, responses like 'pink', 'light pink' and 'not white' can all be classified under the code, 'color'. Once the codes have been created, the researcher must then determine whether the codes represent an A, C or V and create connections between the different levels of abstraction. In other words, the researcher must form the series of ladders that resulted from each

individual interview. Finally, a master code list is created that represents the coding text of the entire data set for A, C and V.

1.4.2. Description of attribute, consequences and values

The process of categorizing content codes into appropriate ACV categories is a subjective task and remains one of the most important analytical steps in laddering (Costa et al., 2004). This is also a very complex task. In order to simplify this procedure, definitions for ACV have been established to help differentiate between the different categories (Howard and Woodside, 1984; Bech-Larsen et al., 1996; Costa et al., 2004).

Attributes can be concrete or abstract. Concrete attributes are defined as those attributes that are tangible; represented by the visible features of the food product. Concrete attributes may include features such as label information, price and overall appearance of the product (Costa et al., 2004). Conversely, abstract attributes refer to those characteristics that are intangible. These attributes are more subjective and must be experienced through consumption such as being "easy to prepare" (Costa et al., 2004).

Consequences are defined as any result that directly or indirectly affects the consumer after they execute behavior (Gutman, 1982). Consequences can be functional, psychological or sociological. Functional or physiological consequences are those results that serve a functional purpose; such as a food that is easy to digest or helps satisfy hunger (Gutman, 1982; Costa et al., 2004). Psychological consequences refer to results like improved self-esteem and well-being whereas sociological consequences may include the feeling of being part of group (Gutman, 1982).

Finally, values are the desired end-states of existence (Gutman, 1982). Values are classified as either terminal or instrumental. Terminal values may include values such as overall happiness, security or accomplishment (Gutman, 1982). On the other hand, instrumental values are associated with the modes of behavior that aid in achieving these end states (Gutman, 1982). For example,

achieving optimal performance or results that comply with one's expectations may be considered instrumental (Costa et al., 2004).

1.4.3. Creating an implication matrix

An implication matrix is a summary table that determines the number of connections made between any two levels of abstraction across all respondents (Reynolds and Gutman, 1988). In order to form the matrix, the master codes are numbered in order. The numbered codes are then constructed into a square matrix, which displays the number of times one element is linked to each other element (Reynolds and Gutman, 1988). It is important to note that both direct and indirect linkages are considered; direct being A→B, B→C and indirect being A→C, because often times two elements may be indirectly linked but the paths that represent their connection are not found frequently enough for it to be considered significant (Reynolds and Gutman, 1988). By examining both direct and indirect connections, it allows us to reveal important associations between two elements that might otherwise be unnoticed (Reynolds and Gutman, 1988). Ultimately, the purpose of forming this matrix is to identify the dominant linkages in the data set as determined by the frequency of responses for a given association; this is important for forming the final HVM (Reynolds and Gutman, 1988).

1.4.4. Constructing a hierarchical value map

Creating a HVM requires an appropriate cut-off level which is the minimal number of times a linkage between two codes has to be made before it is deemed 'important' enough to be included in the final HVM (Gengler and Reynolds, 1995). Any linkages occurring at a frequency less than the specified cut-off level are considered to be less important and not included in the final HVM (Russell et al., 2004). Typically, a cut-off between 3 and 5 is appropriate for a sample size of 50 to 60 individuals (Reynolds and Gutman, 1988). Unfortunately, there has been limited research on how to choose the most appropriate cut-off level. Ultimately, the best cut-off level is chosen that will create a HVM that is simple and

meaningful; representing the most important ladders associated to the product under investigation (Gengler et al., 1995).

1.5. Limitations to previous consumer research of chicken meat

One of the main drawbacks of the previous research on the topic of chicken meat is that there have been few studies that focused on consumers' acceptance of chicken dark meat in North America. While some research has provided insight on consumers of other countries, the results may not be transferable as consumer attitudes and behavior differ among countries. Therefore, it is important to understand the attitudes of North American consumers.

Furthermore, most of the previous consumer research has compared consumer preference for poultry meat relative to red meats but did not consider differences in consumer preference for white and dark meat chicken. The literature review indicates that North American consumers prefer white meat chicken to dark but does not explain why (Haley, 2001), and there is limited research that focuses specifically on dark-meat chicken consumption.

Black bone discoloration is another area that has been understudied in the literature. Despite being a concern for the industry, the definitive cause of the problem has yet to be determined. While previous research has attempted to understand the root cause of the problem and its prevention, there have been only a few consumer related studies regarding the issue (Stewart et al., 1945, Ellis and Woodroof, 1959, Li et al., 1969). Although these studies have made some progress, they date back 40 to 65 years and modern broilers have changed substantially since then; there is still much more to learn about the problem. Most importantly, consumer attitudes, expectations and preferences have changed as well. Previous studies on black bone discoloration only assume that the discoloration is off-putting for consumers but do not directly address consumers' perception of the discoloration. Therefore, it is essential to first understand the attitudes that consumers have regarding this discoloration before poultry industries can take action on the proposed problem.

1.6. Research proposal

There is currently limited research regarding consumer perception of dark meat and bone-in chicken and very few studies have been able to gauge consumer attitudes toward black bone discoloration.

The aim of this research project was to provide insight to the poultry industry on consumer perceptions of bone-in chicken dark-meat as well as to clarify consumer perceptions of the black bone discoloration problem in order for the industry to make an informed decision on this issue.

The objectives of this research study were to:

1) Understand the motivational drivers that influence consumers' choice of bone-in chicken using the laddering technique as described in chapter 2.
2) Determine consumers' perception of black bone discoloration in bone-in chicken thighs compared to the industry's standpoint by conducting structured interviews with poultry processors (chapter 2).
3) Determine the effects of altering broiler bone growth through diet on the incidence of perceived black bone discoloration and the influence that discoloration has on consumer acceptance of the sensory quality of bone-in chicken thighs as described in chapter 3.

The unique approach to this research is that it compares the perceptions of bone-in chicken consumers and members of the poultry industry to provide a greater scope of the overall attitude toward this meat type and the issue of black bone discoloration.

This research also used both instrumental color and sensory science measurements of the incidence of discoloration in bone-in chicken thighs. Thus, it provides a greater understanding of the severity of the discoloration that is perceived by consumers and also a measurement of how sensory acceptance is affected when consumers perceive the discoloration to be present.

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Chapter 2: Consumer motives for choosing bone-in chicken and perceptions of black bone discoloration

2.1. Introduction

In the past few decades there have been dramatic changes in the consumption trends of meat products. Between 1970 and 2005, the per capita consumption of chicken products has increased by 136% in Canada whereas beef consumption has decreased by 35% (Agriculture and Agri-Food Canada, 2009). Similarly, in the United States, poultry consumption increased by 125% between 1970 and 2007 (American Meat Institute, 2009). Several sources suggest that this trend toward increasing chicken consumption is influenced by the perceived health benefits of poultry compared to red meats (Verbeke and Viaene, 1999; McCarthy et al., 2004; da Conceição et al., 2008; Agriculture and Agri-Food Canada. 2009). The fast-paced lifestyle of consumers today has also been associated with the increase in chicken consumption, as the poultry industry has excelled in developing ready-made convenient chicken products (Resurreccion, 2004).

Much of the research regarding consumer preference and perception of chicken has been conducted in countries other than Canada and there is limited data available on Canadian consumers' preferences. Product development and innovation are key components required to maintain growth in the demand of food products (Resurreccion, 2004). Therefore, despite the observed increase in chicken consumption, it would be valuable for poultry industries to understand the attitudes and motivational drivers that influence consumers to choose chicken in order to maintain or continue the growth in its demand in Canada.

It is thought that in general, North American consumers tend to have a bias against dark meat chicken. In the United States, breast meat is typically preferred over dark meat (Fanatico et al., 2005). Since the appearance of meat is known to be a significant factor influencing consumer preferences for meat (Fortomaris et al., 2006), one of the proposed explanations for this bias is associated with the color defect known as 'black bone discoloration'. Black bone

discoloration is characterized as a dark burgundy or black stain that occurs primarily in cooked chicken thighs on the flesh that is adjacent to the femur (Smith and Northcutt, 2004). This defect is of major concern for the poultry industry as it appears in chickens worldwide and there is limited knowledge of its cause or the impact it has on consumer attitudes toward bone-in chicken. Although the precise cause of this discoloration has not been confirmed, studies indicate that the discoloration may be caused by the leaching of blood from the bone marrow onto the surrounding tissue of the femur, consequently creating a burgundy or black discoloration on the surrounding meat when it is cooked (Smith and Northcutt, 2004). However, factors such as the rate of chilling, freezing, thawing and cooking have also been associated with the development of black bone discoloration (Smith and Northcutt, 2004).

Although the problem exists, it is unknown whether consumers acknowledge the discoloration. The use of sauces or marinades in home cooking may sometimes mask the discoloration and therefore, this defect may be more noticeable in ready-made chicken products such as rotisserie chicken. More importantly, it is also unknown whether or not consumers perceive the discoloration as a problem. In order to get a broader perspective of the problem, it is important to consider consumers who prepare bone-in chicken at home as well as those consumers who choose ready-made chicken available at supermarkets. It is also beneficial to determine whether or not the general perception of chicken differs between the two groups of consumers.

Lastly, with limited knowledge regarding the issue of black bone discoloration, it would be valuable to also understand the perception of the issue from an industry point of view. Examining both consumer and industry views would provide a greater understanding of the depth of the problem.

To understand consumer perspectives, laddering was chosen as the underpinning method for this research. The consumer science technique of laddering has been used widely in consumer research and is considered a valuable tool for understanding consumers' product knowledge and behavioral implications (Costa et al., 2004). It is based on the Means-End Chain theory that

assumes that buying behavior is based only on the perceived benefits that consumers associate with the product (Lind, 2007). The theory suggests that consumers associate product attributes to subsequent consequences that are personally relevant to them and that these consequences will eventually lead them to fulfill a certain personal value (Lind, 2007). The method of laddering uses a one-on-one semi-structured interview approach to derive the underlying linkages between attributes, consequences and values through a series of direct probing questions. Previous research studies have found this approach to produce unconscious associations related to consumer preferences and choices, and the idea of using personally relevant concepts is thought to provide a greater representation of consumer behavior (Roininen et al., 2006; Ares et al., 2008). In meat-related studies, laddering has been used successfully to determine consumers' perceptions of beef (Barrena and Sánchez, 2009) and pork products (Lind, 2007).

This study consisted of a two-part research experiment with two objectives. The first objective was to understand the underlying motives that drive consumers to choose raw, fresh bone-in chicken to prepare in the home compared to ready-made rotisserie chickens, as well as to gain insight on consumers' perception of the incidence of black bone discoloration. The second objective was to compare industry views of bone-in chicken and black bone discoloration to those of consumers, and gauge the relative importance of this defect to each group.

2.2 Materials and methods

2.2.1. Consumer laddering interviews

2.2.1.1. Consumer recruitment

Ethical approval for this study obtained from a University of Alberta Research Ethics Board. Consumer participants were recruited from a local supermarket as well as at the University of Alberta in Edmonton, Alberta, Canada. A recruitment stand was set up at the entrance of the supermarket to attract shoppers as they entered; only those who showed an interest in the study were

approached (Appendix 1). Recruitments from the University were achieved through e-mail advertisements that were circulated through staff and student mailing lists (Appendix 2).

Inclusion criteria required that potential participants had consumed chicken more than once in the past year and were over the age of 18 years. Both consumers and non-consumers of bone-in chicken were included in this study to provide a broader outlook of the attitudinal differences among those consumers who ate chicken but preferred not to eat bone-in products.

All potential participants were given an information sheet about the study and were asked to sign a consent form (Appendix 3). Prior to the interview, all participants were asked to complete a demographic questionnaire (Appendix 4).

2.2.1.2. Laddering technique

The laddering technique was used to interview consumers of bone-in chicken. Two pilot interviews were conducted to ensure the questions asked during the interviews were appropriate and effective. Both short (5-10 minute) and long (20-25 minute) interviews were conducted, however, the initial analysis showed little variation in results when comparing the two methods, therefore, shorter interviews were the preferred method as they were more efficient and as effective as the longer interviews for eliciting underlying motives for bone-in chicken. The shorter interviews were also the preferred method in a study that used laddering to determine consumer perception of different kinds of pork (Lind 2007). The choice to use short interviews was explained by the concept that meal- and food-related decision-making are generally low involvement tasks for unbranded products (Costa et al., 2004). Low involvement products typically generate simpler and less interconnected hierarchical value maps (Gengler and Reynolds, 1995; Gengler et al., 1995). Forty-eight laddering interviews were conducted between July and September 2009; 26 interviews focused on both fresh and ready-made products and the remaining 22 were focused only on ready-made products. The direction of the interview depended largely on the participant and

their purchasing habits; whether they chose fresh chickens or rotisserie style more often.

The interviews began with general questions regarding the eating habits of consumers to generate information that might be useful later in the interview (Appendix 5). Questions that were asked included: How often do you consume bone-in chicken? Where do you purchase bone-in chicken? What is your favorite cut and what do you use it for? Once the participant developed a sense of their own eating habits and purchase behavior, they were then asked to identify the important product attributes when buying chicken. Beginning with their first response, the participants were asked the question "Why is that important to you"? Based on their response, the participants were then asked another probing question starting with the word, "Why?" to help elicit some of the underlying reasons behind their motives. Once the participant could no longer provide new responses, the interviewer moved on to the next important factor listed. The interview continued in this manner until all factors listed were probed.

The interviews ended with questions pertaining to the black bone discoloration. In order to probe for previous incidences of black bone discoloration, the participants were asked if "there were any negative aspects to choosing or consuming bone-in chicken". Based on their response, the interview continued in a similar manner using the laddering technique. It was assumed that consumers would identify the discoloration as a possible negative aspect associated with bone-in chicken. However, in the case where a participant did not have a response or did not comment on the discoloration, the interviewer used a more direct probing question, asking the participant whether or not they noticed any dark discoloration on bone-in chicken meat. Participants were asked to express their overall opinion about the possibility of seeing discoloration on bone-in chicken meat and whether or not it would affect their desire to consume the meat.

2.2.1.3. Data analysis

Laddering interviews were recorded, transcribed and analyzed via content analysis where similar themes and patterns were recorded and coded for each participant. Coding data involved summarizing clusters of similar themes and patterns into a single representative word or phrase in order to simplify data management. To maintain the validity of the content analysis, two analyzers were used in the initial transcripts. Once consensus was achieved in the interpretation of codes, only one analyzer was used to complete the remaining transcripts.

The codes developed from the content analysis of each individual interview were grouped as clusters of codes in which the participant formed an association. The codes within each cluster were then separated into three levels of abstraction; attributes (A), consequences (C) and values (V) and formed into ladders (A→C→V) that displayed the hierarchical links among A, C and V as a series of single chain relationships, for each participant. Deciding whether each code represented an A, C or V was decided by the researchers' interpretation of the participants' response. It is important to note that the ability to create the ladders depended on the participants' responses, the associations that they made as well as the amount of information provided. Thus, ladders may not always begin at the lowest level, A. In cases where the participant commented on both fresh and ready-made bone-in chicken, the ladders created for these interviews were carefully separated between ladders that referred specifically to fresh chicken and those that referred to ready-prepared chicken.

Hierarchical value maps were created with the assistance of Laddermap software (version 5.4, Peffers and Grengler, 2003). This software enables researchers to enter interview responses in the form of ladders. The series of ladders that were formed per interview were entered individually into the software. Based on each entry, the codes were entered followed by the letters, A, C, or V to indicate the level of abstraction in order to allow the software to create the ladders. The interactive data entry features provided by Laddermap also allows researchers to keep track of multiple ladder entries per interview where all coding texts are stored in a code library separated by A, C and V codes to

facilitate data management. Codes with similar meanings were combined and stored under one single synonym that represents the codes as a group. For example, responses such as "pink" and "not too white" were combined into the single synonym, *color*. Next, an implication matrix was created to derive the HVM. An implication matrix quantifies the number of times an association between two levels of abstraction is made, either directly or indirectly, across the total number of subjects. HVM represent only the most important associations; therefore, an appropriate cut-off level is required to determine the level of importance of each association. A cut-off level designates the number of times an association must be made before it is considered important. Typically, cut-off levels between 3 and 5 are deemed appropriate for sample sizes of 50 to 60 subjects (Costa et al., 2004). Overall, the goal was to create a HVM that represents a clear and accurate expression of consumers' underlying motives while retaining all important ladders. A cut-off level of 4 was used to create the HVMs in this study. Quotations from the interviews have been used in the discussion of the HVMs, with participant numbers (*e.g.* P9) used for all participants. False starts, repeated phrases, and irrelevant information have been omitted, as indicated by an ellipsis (…).

2.2.2. Poultry processor interviews

2.2.2.1. Questionnaire development

A structured questionnaire was developed based on the results obtained from Part 1 of the present study (Appendix 8). The questionnaire began with general questions pertaining to the perception of good quality bone-in chicken and then common complaints and concerns that the company has received from consumers, particularly relating to discoloration. In accordance to the perceptual orientations revealed from Part 1 of this study, participants were also asked to evaluate on a 5-point scale how important they perceived each perceptual orientation would be for the consumer and also for the industry. The 5-point scale ranged from "not important at all" (1) to "very important" (5). Participants were also asked to evaluate how important discoloration was to the consumer and

the industry. In the interview, the participants were instructed to provide their answers from the industry's point of view.

2.2.2.2. Poultry processor recruitment

Representatives (n=8) of poultry processing companies across Canada (British Columbia (1), Alberta (3), Saskatchewan (1), Ontario (1), Quebec (2) and Manitoba (1)) were recruited to participate in a telephone interview via an e-mail advertisement (Appendix 6) or verbally through telephone (Appendix 7). Inclusion criteria required that participants were members of the industry involved with quality control at poultry processing facilities. Also, some of the participants represented more than one poultry processing plant in Canada.

2.2.2.3. Telephone interviews

Poultry processors were interviewed via telephone using a structured questionnaire. Telephone interviews have become a more common method of data collection compared to face-to-face methods used in the past (Opdenakker, 2006). One of the main advantages of telephone interviews is that it provides access to a wide geographical area, which is beneficial for this research as it reduces cost and time of data collection (Opdenakker, 2006).

2.2.2.4. Data analysis

Content analysis was performed on open-ended questions and frequency values were represented in percent values. No statistical analysis was performed on the data collected.

2.3. Results and Discussion

2.3.1 Consumer Characteristics

A total of 48 consumers of bone-in chicken participated in the laddering interviews. Forty percent of participants were male and 60% female across the ages of 18 to 70+ years (Table 2-1). All participants had completed at least high school education, however, the overall distribution of participants were dispersed

relatively evenly among all education and income levels. Many participants lived either alone (29%), with one other individual (33%) or with three members of the household (22%) and 81% of all participants reported that no one under the age of 18 years lived in their household.

The frequency of consumption of bone-in chicken varied among the participants. However, cooking and consuming bone-in chicken "at least once a week" or "every 2-3 weeks" was commonly reported by consumers (Table 2-1). Furthermore, 70% of consumers also indicated that the last time they consumed bone-in chicken it was "home-cooked". Ready-made bone-in chickens were purchased less frequently; "every 2-3 weeks" to "once a year".

The breast was the most favored part of the chicken to consume (52%) followed by the thighs (17%) and the whole chicken (17%). Chicken wings and drumsticks were the least favored part at 8% and 6%, respectively.

Supermarkets were the primary source for purchasing bone-in chicken; 84% of consumers indicated they *always* bought bone-in chicken at these locations. However, a small percentage of participants also bought their chickens from meat shops (6%), farmers (3%) or wholesalers (3%).

2.3.2. Hierarchical value maps

The HVM for 'fresh' chicken consumers (n=26) consisted of 8 attributes, 12 consequences and 7 values. The HVM for "ready-made" chicken (n=28) was less complex consisting of 5 attributes, 6 consequences and 4 values. However, there were several similarities between the two. In both HVMs, the common values elicited can be explained through five perceptual orientations: food safety, eating quality, price, health and convenience as described in the following sections.

2.3.2.1. Food safety

Food safety was the most important value for consumers of both fresh and ready-made bone-in chicken which confirms the idea that perceived safety may be more crucial for consumers than objective safety aspects when evaluating meat, as

suggested in previous research (Cardello, 1995). Overall, the physical appearance was the primary focus for consumers when evaluating food safety aspects. For fresh and ready-made chicken, the *color* of the meat was the most important attribute associated with this value, indicating *properly cooked* meat (Figures 2-1 and 2-2). This confirms the importance of color to consumer perception of meat, which has been observed in previous studies regarding meat perception (Kennedy et al., 2005; Fortomaris et al., 2006). Ultimately, the HVMs demonstrated that having properly cooked meat was important to consumers because it suggests that the meat would likely be *safe to eat* and the consumers believed that they *won't get sick* from a food-borne illness such as Listeriosis or Salmonella poisoning.

The degree of pinkness in the cooked meat color was the most important attribute associated with *properly cooked* chicken for both fresh and ready-made chicken consumers. It was important to see that the cooked meat was '*not too pink'* (P9). One participant stated, "*I prefer to have it cooked throughout and not pink at all, it's just something that's always associated with chicken*" (P6). However, in the case of ready-made chickens, consumers also looked at the skin color to evaluate the cooked quality of the meat to determine the degree of doneness. One consumer looked for skin that was '*brown and even colored*' to ensure it was cooked sufficiently (P40).

In addition, the *color* influenced the perceived freshness of the meat. In contrast to the negative associations made with the color pink in the cooked quality, pinkness was a desired characteristic for the raw, fresh meat. Among the fresh chicken consumers, one panelist stated, "*I just always try and make sure it's like a good colored pink, like [it's not] brown or old...I assume if it's different colors it's probably not the best*" (P8). On the other hand, for ready-made rotisserie chicken consumers, the skin color was again an important attribute for perceived freshness of the meat. One panelist looked for the "*general color...like what you'd expect to be what rotisserie chicken looks like, like golden brown*" (P49).

The HVM for fresh chicken also revealed other associations regarding food safety that were not elicited for the ready-made chicken. These included the

perception of *proper meat handling* and *bacteria-free* meat. Although *bacteria-free* was more strongly associated with food safety compared to *proper meat handling*, no attribute was revealed for this consequence. On the other hand, consumers looked at the overall appearance of the meat cut as an indicator of *proper meat handling.* A *clean cut of meat* referred to meat that had less fat tissues and showed no visible damage such as tears to the skin, bruises to the meat or bone fractures. This was important for consumers because they perceived a *clean cut of meat* to be reflective of the practices performed by retailers and producers. For example, one panelist stated, "*if it's punctured, you wonder...who was butchering this chicken...if you have sloppy butchering, you would think that maybe some of their other practices are sloppy as well...if they're not clean you run the risk of cross-contamination, all sorts of different infestations...it's for my own safety*" (P11).

2.3.2.2. Eating quality

The overall eating quality was another important value for consumers of the fresh and ready-made chicken. *Good taste* was the most important consequence that was associated with consuming bone-in chicken, illustrated in both HVMs. The importance of good taste when consuming bone-in chicken correlates with previous research that identifies taste as one of the most important characteristics that influences consumer preference for poultry (Verbeke and Viaene 1999; Vukasovic, 2009). Only the HVM representing fresh chicken revealed an attribute associated with *good taste*. For these consumers, *moist* chicken meat was revealed to be the most important attribute contributing *good taste*. The moistness of chicken can vary depending on how it is cooked, however, bone-in chicken was often considered to be less dry compared to boneless. In one interview, a participant explained, "*I don't like dried chicken so I...eat the darker meat...like the chicken with the bone, it's not nearly as dry so there's another reason why we like the bone*" (P8). Although no attribute was revealed in the HVM representing ready-made chicken, the underlying value of *good taste* was

for overall palatability as one participant exclaimed, "*it's got to be tasty, otherwise there's no point in eating it*" (P16).

In the HVM for fresh chicken, the moistness of the meat was also associated with perceived *good texture*. Meat that was *moist* was perceived to be easier to chew and to swallow; important elements to achieve palatability and overall eating enjoyment (*Enjoy what I eat*).

2.3.2.3. Price

In previous studies, researchers have found that one of the influencing factors motivating consumers to choose poultry over other meats such as beef and pork was the perception that poultry meat was generally a better value for the money (McCarthy et al., 2004). Therefore, it was not surprising that *good value for the money* was revealed as another important value for consumers in this study. The HVMs for both fresh and ready-made chickens revealed that consumers chose bone-in chicken because it was an *inexpensive* product. It was perceived that choosing a low price item allows one to *save money*. For the fresh chicken consumers, the underlying value for saving money was to *spend money on other things*.

2.3.2.4. Personal health

Health is the most commonly acknowledged reason for the preference for poultry over red meats as consumers often perceive poultry as a healthy meat, most notably because of its relatively low fat content (Richardson, 1994; Issanchou, 1996; Verbeke and Viaene, 1999; McCarthy et al., 2004; da Conceição et al., 2008). Similarly, in our study, *health* was the most important value that was elicited for consumers of fresh chicken and the attribute *low in fat* was shown to be an important element for health in both HVMs for fresh and ready-made chicken. As shown on the HVM representing ready-made chickens, consumers perceived this type of chicken to be *low in fat* which was important because low in fat products are *better for you*. For example, one consumer stated, "*I really enjoy [chicken], it's one of the meats that are better for you*" (P39). However,

low in fat in this case also referred to the preparation method. Since roasting is perceived to be a healthier method of preparation compared to frying, one consumer explained, "*they do it on a rotisserie so it doesn't have high fat content...we live a very healthy lifestyle and we believe that too much fat is not good for you*" (P7). Similarly, for the fresh chicken consumers, the *low in fat* quality was also an important attribute as chicken is perceived to be a leaner meat compared to beef and pork. Consumers often stated that they try to avoid fat as much as possible as well as reduce the amount of saturated fat in their diet. One consumer stated, "*I go for a lean cut, if there's the white stuff around it I try to avoid that. I don't want the chicken fat, it's just for health*" (P8).

Overall, the fat content seemed to be the only concern for consumers with regard to health since no other attributes were elicited for either the fresh or ready-made chicken consumers. Although chicken was perceived to be a lower fat, healthier meat, many consumers also indicated that they preferred to purchase skinless chicken or to remove the skin themselves in order to reduce their fat consumption, which was common for both fresh and ready-made chicken consumers.

2.3.2.5. Convenience

The only difference associated with product convenience in the HVM for ready-made chicken compared to fresh was the benefit of having a *faster meal.* Consumers chose rotisserie birds as they were *ready-made* and for the *anticipated ease of preparation*. However, no value was elicited for this association for either group of chicken consumers. For the fresh chicken consumers, convenience referred to the ability to buy bulk packages and the convenience of having pre-cut, pre-portioned cuts readily available. The *convenient portion size* was strongly associated with *ease of preparation* such that bulk packaging provides on-hand ingredients which saves time by avoiding extra trips to the supermarket. Meanwhile, portion size allows for portion control and cooking management that ensure equal cooking time as well as saving preparation time. Although the attribute *clean cut of meat* was associated with food safety, it was

also associated with being *more appealing* and *easy* to prepare and cook. One consumer stated, "*because food, besides being a basic necessity, has to have some eye, has to have some appeal to it: color, smell. It has to affect all your senses*" (P12). Similarly, another consumer stated, "*if it doesn't look good, we don't eat it*" (P7).

Consumers also believed that having a *clean cut of meat* indicated that there would be less work to do during the preparation of a meal, thus making food preparation *easy.* One consumer indicated that having a *clean cut of meat* was "*more pleasant to look at and to handle*" and stated that, "*there's less preparation to do to get it ready to eat*" (P13).

2.3.3. Black bone discoloration

The majority of consumers interviewed in this study acknowledged the discoloration occurring in their bone-in chicken meat. Consumers who disliked the discoloration often described it as 'gross' (P6, P7) and were thrown off by its resemblance to blood (P5, P6, P7). Some consumers (17%) indicated that the discoloration was one of the reasons why they chose not to buy bone-in meat (P11, P35). Furthermore, although consumers were repulsed by the discoloration, some consumers indicated that they would still buy and consume bone-in chicken and just 'eat around it" (P5, P11, P2)

The remainder of the participants, (60% of those interviewed), indicated that they did notice the discoloration but were not bothered by it. For these consumers, the discoloration was most often perceived as being blood, a vein or muscle structure, or an otherwise natural part of the animal; "*I imagine it's because there's some larger veins that is closer to the bone and so it's natural*" (P13). Similarly, another consumer stated, "*it's a normal part of the process, part of the genetic development of the bird; I've never questioned it*" (P44). Consumers who were not bothered by discoloration often expressed their familiarity with eating bone-in chicken and their overall understanding of chicken as a living entity. Some comments included: "*I grew up eating it*" (P2); "*I'm used to it, I've*

seen it ever since I was a kid" (P12) and "*I'm eating an animal, I know it has blood*" (P4).

When asked why someone might be thrown off by discoloration, responses were often related to lack of knowledge with food and where it comes from. Some of the responses made by consumers included: "*I think people are so far away from [chicken]…so far away from what the animal is... if it's not perfect color, perfect package, they're scared of it*" (P3) and "*I think there's a general disconnect from where our food comes from and the familiarity with living animals*" (P13). Furthermore, one consumer even stated, "*the distance from me to chicken is a lot larger than from me to a cow, I feel like they're so much more similar to a human*" (P11).

Although the majority of consumers were not bothered by the discoloration of bone-in chicken, their main concern with the discoloration was whether or not the meat was cooked thoroughly. Several respondents stated: "*the only thing I'm concerned about is that it's cooked through*"(P16); "*as long as it's cooked, it's alright*" (P33); "*discoloration doesn't bother me at all, I just make sure it's well done*" (P39).

A surprising outcome of the laddering interviews was that a small percentage (10%) of consumers indicated that they actually liked the discoloration. Responses made about the discolored meat of the bird included: "*more tasty*" (P18), "*more tender*" (P42) and "*the most flavorful meat*" (P20).

Overall, the impact of black bone discoloration on consumer preference appears to be dependent on the individual and their familiarity with meat. Although the discoloration affected the attitude of some consumers, the greater concern revolved around the food safety aspects of bone-in chicken and understanding whether or not the chicken is fully cooked. Furthermore, although discoloration does have a negative impact on the appearance appeal of bone-in chicken, some consumers still chose to eat the meat. This may indicate that the positive aspects of eating bone-in chicken might compensate for the negative impacts of discoloration for some consumers.

2.3.4. Poultry processor interviews

The results from the poultry processor interviews were similar to those from the consumer laddering interviews. Appearance (88% of respondents) and freshness (50%) were the most commonly mentioned attributes considered important for a good quality bone-in chicken. According to processors, a good quality bone-in chicken should be free of feathers (63%), bruises (63%) and have a good color (38%). Appearance was also the most commonly reported concern by consumers (88%), followed by issues related to food safety (63%).

Of the five perceptual orientations, processors ranked food safety as the most important followed by eating quality, price, health and lastly, convenience. These results were similar to consumers for whom food safety and eating quality were both considered important values present in both HVMs (Figures 2-1 and 2-2). In the industry's perspective, food safety and eating quality were also considered to be very important to both consumers and the industry; each was scored as a 5, 'very important' on a 5-point scale. Price was another attribute that was considered very important for the industry, which was given a score of 5. From the consumer interviews, the value that was associated with price was "*good value for money*", however, processors perceived this feature to be less important for consumers than for the industry. Processors gave price a score of 3.5 on the 5-point scale when considering consumers. Similarly, health was considered to be important for consumers but less important for the industry. Finally, as was expected, discoloration was considered to be important to both the consumers and the industry by processors who scored the level of importance as 4.5 and 4.0, respectively.

A commonality across all processors was that the numbers of consumer complaints received about chicken products in general were minimal. Specifically for black bone, only 5 of 8 processing plants had previously received complaints about black bone and indicated the occurrence had been very rare, only once or twice a year, with no complaints reported within the past two years.

Only one processor had received frequent complaints about black bone, once or twice a month, but stated that the complaints have not been reported in the

past four years. Overall, it appears that black bone discoloration is not a major problem for the Canadian poultry industry due to its presumed rare occurrence based on the limited number of consumer complaints. However, its cause and prevention are still unclear. Although the issue may not have a strong impact on the industry currently, the sporadic nature of its occurrence is a nuisance to the industry. Therefore, further research regarding the cause and prevention would be beneficial.

2.4. Conclusion

Consumers of the fresh, raw chicken and consumers of ready-made chicken provided similar HVMs revealing five main perceptual orientations of food safety, eating quality, health, price and convenience. The underlying motives for choosing bone-in chicken were similar to those found in previous studies, but here they are linked to specific product attributes and consequences which provide a more in-depth understanding of what consumers look for when choosing bone-in chicken products and why it is perceived to be important. As there is limited data available regarding Canadian chicken consumers, this information is useful for the Canadian poultry industry to gain insight on consumer perception and attitudes toward bone-in chicken. In order to maintain or increase the demand of chicken meat, the Canadian poultry industry should focus their advertisements on the values revealed in the HVMs that describe consumer- perceived benefits of choosing bone-in chicken.

Consumer perception of black bone discoloration varied among participants and seemed to be dependent on the individual and their familiarity with the meat. The main concerns with discoloration were associated with food safety, where consumers questioned the safeness of consuming discolored meat. Thus, it may be beneficial to inform consumers that this type of discoloration is related to meat quality rather than food safety, as well as to advertise the safeness of their products to ensure consumers that their product is safe to eat. Lastly, poultry processors across Canada prove to have a good knowledge of consumer needs with regard to chicken meat. Although the issue of black bone does not

appear to have a major effect on the poultry industry, it is still considered an important feature in the industry's perspective as the cause and prevention is still unknown. Therefore, further research on black bone discoloration would be useful.

2.5. Tables

Table 2-1. Distribution of sample demographic characteristics as a percentage of the consumer population segmented by consumption of fresh and ready-made rotisserie bone-in chicken (n=48)

		Number (%)				(Total %)
Characteristics		**Fresh**		**Rotisserie**		
Gender	Males	16	(33)	3	(7)	(40)
	Females	21	(43)	8	(17)	(60)
Age (years)	18 – 29	14	(30)	2	(4)	(34)
	30 – 39	4	(9)	3	(6)	(15)
	40 – 49	6	(13)	3	(6)	(19)
	50 – 59	8	(17)	1	(2)	(19)
	60 – 69	4	(9)	1	(2)	(10)
	70+	1	(2)	0	(0)	(2)
Members in household	1 person	10	(22)	3	(7)	(29)
	2 people	13	(29)	2	(4)	(33)
	3 people	7	(16)	3	(7)	(23)
	4 people	5	(11)	0	(0)	(11)
	More than 5 people	2	(4)	0	(0)	(4)
Members in household under 18 years	0 persons	31	(65)	8	(17)	(82)
	1 person	4	(8)	2	(4)	(12)
	2 people	2	(4)	1	(2)	(6)
*Frequency of shopping location **	Supermarket	20	(65)	6	(19)	(84)
	Meat shops	2	(6)	0	(0)	(6)
	Farmers Market	1	(3)	0	(0)	(3)
	Whole Sale	1	(3)	0	(0)	(3)
	Other	1	(3)	0	(0)	(3)
Frequency of consuming bone-in chicken	More than 3 times per week	1	(2)	1	(2)	(4)
	2-3 times per week	2	(4)	2	(4)	(8)
	At least once a week	6	(13)	4	(8)	(21)
	Every 2-3 weeks	12	(25)	3	(6)	(31)
	Once a month	7	(15)	1	(2)	(17)
	Once a year	5	(10)	0	(0)	(10)
	Never	4	(8)	0	(0)	(8)
Type of bone-in chicken last eaten	Fresh	26	(55)	7	(15)	(70)
	Ready-made	10	(21)	4	(9)	(30)
Frequency of preparing fresh chicken	More than 3 times per week	2	(4)	0	(0)	(4)
	2-3 times per week	3	(7)	0	(0)	(7)
	At least once a week	9	(20)	4	(9)	(29)
	Every 2-3 weeks	11	(24)	2	(4)	(28)
	Once a month	4	(9)	2	(4)	(13)
	Once a year	6	(13)	0	(0)	(13)
	Never	2	(4)	0	(0)	(4)
Frequency of purchasing ready-made chicken	More than 3 times per week	1	(2)	0	(0)	(2)
	2-3 times per week	0	(0)	0	(0)	(0)
	At least once a week	4	(8)	1	(2)	(10)
	Every 2-3 weeks	8	(17)	3	(6)	(23)
	Once a month	7	(15)	4	(8)	(23)
	Once a year	11	(23)	2	(4)	(27)
	Never	6	(13)	1	(2)	(15)
Favorite chicken cut	Breast	20	(42)	5	(10)	(52)
	Wing	3	(6)	1	(2)	(8)
	Leg	3	(6)	0	(0)	(6)
	Thigh	6	(13)	2	(4)	(17)
	Whole chicken	5	(10)	3	(6)	(16)
Education	High School Graduate	2	(4)	3	(6)	(10)
	Some University or College	5	(10)	2	(4)	(14)
	College diploma/degree	8	(17)	1	(2)	(19)
	University Undergraduate	7	(15)	4	(8)	(23)
	Some Post Graduate	6	(13)	0	(0)	(13)
	Post Graduate University	9	(19)	1	(2)	(21)
Income (annual)	Less than $20 000	6	(13)	3	(6)	(19)
	$20 000 - $40 000	5	(11)	2	(4)	(15)
	$40 000 - $60 000	8	(17)	1	(2)	(19)
	$60 000 - $80 000	5	(11)	0	(0)	(11)
	$80 000 - $100 000	4	(9)	0	(0)	(8)
	More than $100 000	9	(19)	4	(9)	(28)

*Values are based on results from consumers who indicated they "always" shopped at the location

2.6. Figures

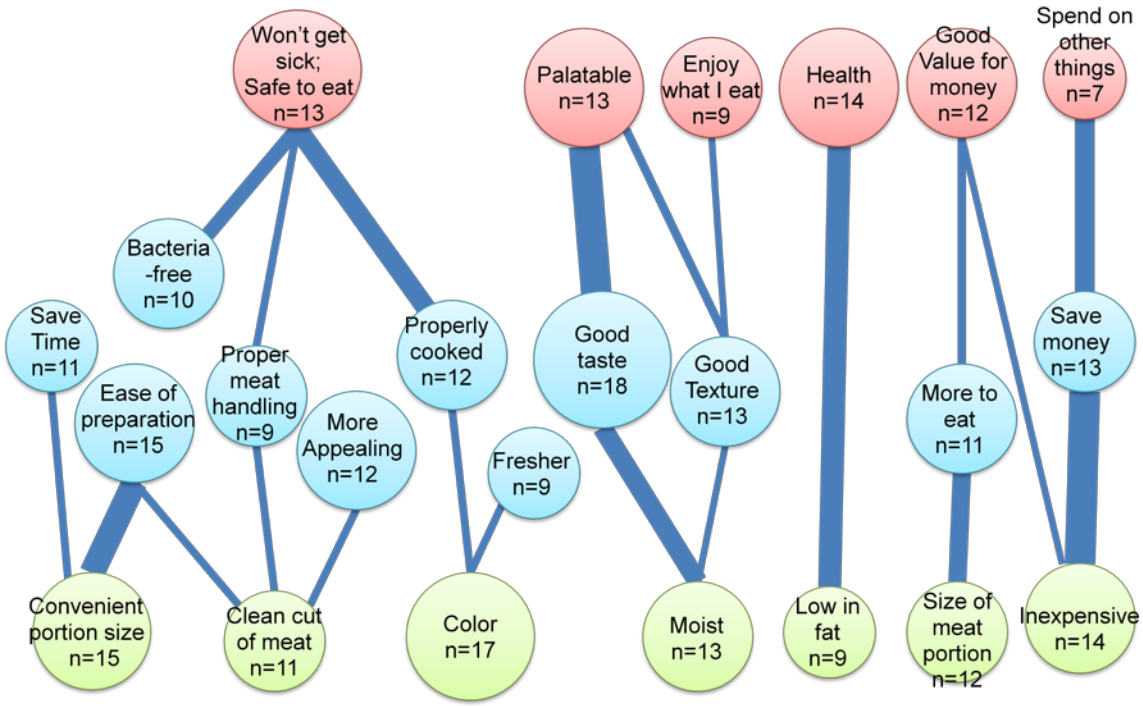

Figure 2-1. HVM illustrating consumer motivational drivers for choosing fresh, raw, bone-in chicken to prepare at home (n=26) including attributes (bottom), consequences (middle) and values (top). Bubble sizes represent the frequency of the response and line widths represent the strength of the association.

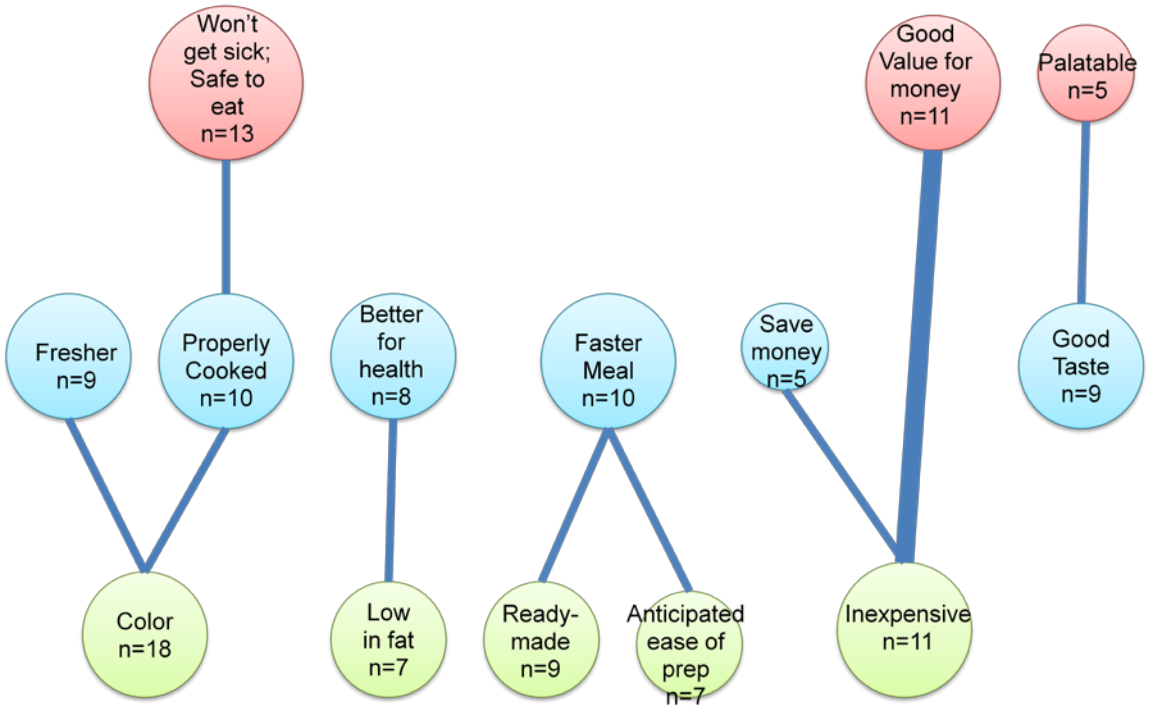

Figure 2-2. HVM illustrating consumer motivational drivers for choosing ready-made rotisserie-style chicken (n=22) including attributes (bottom), consequences (middle) and values (top). Bubble sizes represent the frequency of the response and line widths represent the strength of the association.

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Chapter 3: The effects of altering broiler bone growth through diet modification on consumer sensory acceptance and instrumental bone color measurements

3.1. Introduction

Appearance has been recognized as a significant factor influencing consumer preference for meat (Fletcher, 2002), thus, the presence of discoloration in chicken meat could negatively affect consumer acceptance. A specific type of discoloration is 'black bone' or 'bone darkening'. Black bone discoloration is characterized as a dark black or burgundy color stain appearing on the flesh that is adjacent to the femur (Smith and Northcutt, 2004b). There have been very few recent research studies on this type of discoloration, which creates a research gap in understanding the severity of the problem in terms of its prevalence and consumer acceptance. One of the problems noted by Smith and Northcutt (2004a) is that reports of black bone discoloration have been mainly sporadic making it difficult to quantify. With no valid statistical data, it is unknown whether or not it is a regular feature of bone-in chicken that is only recognized occasionally by consumers or if it is truly a sporadic, acute problem (Smith and Northcutt, 2003).

Although black bone discoloration has not been researched extensively, young age and incomplete bone mineralization of broiler chickens have been suggested as some of the factors that contribute to the incidence of the discoloration due to their influence on bone porosity (Ellis and Woodroof, 1959). Rapidly-growing modern broilers have more porous cortical bone structure than slower-growing chickens (Leterrier and Constantin, 1999). Earlier published research (Koonz and Ramsbottom, 1947) and more recent research (Smith and Northcutt, 2004a/b) suggest that porous bones allow blood to leach out from the bone marrow of the femur onto the surrounding tissue which consequently creates a dark stain after cooking. Also, freezing bone-in chicken meat prior to cooking is known to greatly influence the incidence of bone darkening as well (Spencer et al., 1961, Li et al., 1969; Lyon et al., 1975). Earlier studies have found frozen bone-in chicken thighs were consistently darker in color than thighs that had not

been frozen (Brant and Stewart, 1950; Lyon et al., 1975). Freezing and thawing chicken meat disrupts the cells containing hemoglobin which is responsible for the red color of blood and muscle tissue (Koonz and Ramsbottom, 1947). As a result, hemoglobin is oxidized to form methemoglobin and the red color is converted to a brown grey color (Koonz and Ramsbottom, 1947).

Modern broilers are genetically selected to reach maximum muscle growth in a short period (Williams et al., 2000; Schmidt et al., 2009). However, the rapid increases in muscle growth may compromise skeletal development (Rath et al., 1999; Williams et al., 2000). In fast growing bird strains, the muscle tends to grow faster than the bones can develop causing the bones to be more susceptible to deformity and fragility due to the excess stress and physical load (Julian, 1998; Rath et al., 2000). However, broiler chickens have the ability to adapt to the rapid growth by increasing intramembranous ossification; the growth of the bone width ways to increase the circumference of bones. A wider bone diameter can be beneficial as it helps resist deformation from bending. On the other hand, wider bones are more porous. Williams et al. (2000) observed that fast growing broiler strains had more porous cortical bone tissue and thicker and wider bones compared to slow-growing strains.

Vitamin D is a crucial component of calcium metabolism during bone development and maintenance. However, in order for vitamin D to exert its effects on calcium metabolism, it must be in its active form, 1, 25 – dihydroxycholcalciferol ($1,25(OH)_2D_3$). To reach this state, vitamin D undergoes two hydroxylations in the body. It is first hydroxylated to 25-hydroxycholcalciferol ($25\text{-}OHD_3$) in the liver and then again in the kidney to form $1,25(OH)_2D_3$, the final metabolite that enables the vitamin to exert its actions (Norman and Hurwitz, 1993; Soares et al., 1995). Although vitamin D is already a component in the feed, genetic, environmental and nutritional factors have been acknowledged as components that may alter vitamin D requirements in broilers (Whitehead et al., 2004). Therefore, supplementation of $25\text{-}OHD_3$ may be beneficial for decreasing bone porosity.

Previous studies have also shown that a slower growth rate reduces the incidence of skeletal abnormalities such as high bone porosity, compared to faster growing broilers (Leterrier and Nys, 1992; Williams et al., 2000; Scott, 2002). The amount of strain put on the bones caused by rapid muscle growth of fast growing broilers would be reduced with a slower growth rate and it has been proposed that a slow growth rate may improve bone mineralization in birds (Julian, 1998). Diet modification has been one method to decrease the growth rate of modern day broilers (Brickett et al., 2007). Bone porosity, in particular, has been shown to improve in birds fed a slow-growth diet based on diet restriction compared to birds fed *ad lib*; the cortical bones were less porous (Williams et al., 2004). This may suggest that a slow growth rate could reduce bone porosity and in turn the incidence of black bone.

The growing conditions of birds have also been shown to impact the sensory properties of the meat. Fanatico et al., (2007) compared fast- to slow-growing birds raised indoors or with outdoor access and found fast-growing birds with outdoor access to be more cohesive than those grown indoors. According to the descriptive analysis panel, the fast-growing birds also tasted saltier then the slow-growing birds but had less dark meat fat flavor (Fanatico et al., 2007). Similarly, previous research has found that modifying broiler diets altered the sensory characteristics of the meat as well (Le Bihan-Duval, 2003; Milosevic et al., 2005). Therefore, it is necessary to determine the effects of diet on the sensory quality and consumer acceptance of the meat when broiler diets are manipulated.

The sensory properties of chicken meat also differ among various cuts. Previous research by Smith and Northcutt (2003) compared the degree of discoloration among bone-in chicken breast, thigh and drum cuts using both objective instrumental measurements as well as subjective measurements using one experienced observer to evaluate the degree of discoloration in the meat on a 4-point intensity scale. They found that the thighs had a darker discoloration than breast and drum cuts, which was true for both the objective and subjective measurements. Therefore, it is also necessary to investigate consumer acceptance

of the sensory qualities of this portion of chicken when diet is modified to alter growth rate.

It was hypothesized that reducing growth rate of broilers may decrease the incidence of black bone discoloration, and in turn increase consumer acceptance of broiler chicken dark meat. The objectives of this study were to determine the effects of diets designed to reduce growth rate on the sensory quality of bone-in chicken thighs, as well as to determine the impact of diet on the incidence of black bone discoloration using both consumer and instrumental color evaluations.

3.2. Materials and methods

The animal care protocol was approved by the Animal Care and Use Committee for Livestock of the University of Alberta. The sensory evaluation protocol for this experiment was approved by a University of Alberta Research Ethics Board.

3.2.1.Chicken production

Male Ross 308 broiler chickens were obtained from a commercial hatchery at day of age and were raised at the Poultry Research Centre at the University of Alberta. The birds were fed one of three diets: Control (standard, nutritionally-complete broiler feeds), 25-OHD_3 supplemented (Control + 25-OHD_3 at the manufacturer's recommended level of 69 µg/kg feed) and a reduced nutrient density diet (Control diet diluted with 25% wheat bran), during the feeding period. A total of 320 birds were slaughtered on days 39 and 40 of age at the Canadian Food Inspection Agency-certified processing plant at the Poultry Research Centre, University of Alberta. Following chilling (forced air), the eviscerated carcasses were cut into parts. The right thigh of each bird was identified and individually packaged into a clear plastic bag that had been labeled with diet treatment and bird code number. All thighs were stored at -20°C overnight. The packaged thighs were then transported and stored in a food-grade freezer (-18°C) at the University of Alberta for approximately 10 days.

3.2.2. Chicken thigh preparation and presentation

Chicken thighs were defrosted in a food-grade refrigerator (4°C) two days prior to the consumer panel to ensure sufficient time for defrosting. On the afternoon prior to the consumer panel, each thigh was trimmed of skin and any excess fat.

On the day of the consumer panel, the thighs were arranged on foil-lined trays sprayed with cooking spray. Another sheet of aluminum foil lightly sprayed with cooking spray was placed over the thighs to prevent drying during cooking. Thighs were arranged eight thighs per treatment per tray. Three trays were cooked at one time (24 thighs total). Tray positions in the oven were alternated from top, middle and bottom positions for each of the treatment trays. The thigh placement and corresponding code numbers were recorded to track thigh presentation to panelists.

Thighs were cooked for 30 minutes in a conventional oven preheated to 350 ºC to an internal temperature of 75 ºC as measured by a standard digital meat thermometer. Each thigh was placed in a white Styrofoam hinged lid container coded with a 3-digit code number to blind the sample identity. Each panelist was presented with three chicken thighs, one thigh from each treatment, on a serving tray that contained 3 sets of cutlery, napkins, a wet-serviette, a glass of filtered water and three unsalted soda crackers. Samples were presented to panelists in a randomized block design.

3.2.3. Participant recruitment

Participants were recruited from the University of Alberta via email (Appendix 9) and poster advertisements (Appendix 10) as well as on-the-spot recruitment through common areas (Appendix 11). Inclusion criteria required that the potential participant was a consumer of bone-in chicken thighs, had consumed bone-in chicken thighs within the past year and was over the age of 18 years.

3.2.4. Consumer evaluation

The consumer panel was held in the Food Sensory Laboratory at the University of Alberta. Written informed consent was obtained from each panelist before participation (Appendix 12). Panelists were informed that the chickens were fed three different diets, however the treatments were not revealed to them until after the evaluation was completed.

Consumers evaluated each of the three thighs on 5 sensory attributes (external appearance, internal appearance, flavor, texture and overall liking) using a 9-point hedonic scale where 1= 'dislike extremely' and 9= 'like extremely'. Panelists were instructed to cut open the thigh with the knife and fork and assess the internal appearance, and to indicate whether or not the meat adjacent to the bone was discolored; responding "yes" or "no" on the questionnaire (Appendix 13). Panelists were given the opportunity to write any additional comments about the chicken thigh samples. Finally, demographic information and chicken consumption habits were collected for all (Appendix 14). Participants each received a $5 coffee shop gift card for their participation.

3.2.5. Colorimeter measurements

Colorimeter measurements were made using a Konica Minolta Colorimeter (Konica Minolta Sensing, Inc) that measures color on the CIE (1978) system color profile of lightness (L*), redness (a*) and yellowness (b*). Throughout the study the colorimeter was calibrated using a standard white ceramic tile. Hue angle ($\tan^{1}(b^*/a^*)$) and saturation ($\sqrt{(a^{*2} + b^{*2})}$) were calculated using the average values for the color coordinates a* and b* (Brown et al., 2008).

Colorimeter measurements were taken in duplicate at two femur sites: the proximal interior and the mid-section. A study by Woodroof and Shelor (1948) indicated that bone discoloration was worse at the knee joints, legs and thighs, and was typically darker in adjacent tissues closest to the bone. Similar results were found in a more recent study by Smith and Northcutt (2003) who found that discoloration in bone-in thigh cuts were more intense compared to that of bone-in

breast and drum cuts when measured by instrument. They concluded that processing errors such as cutting off the ends of the femur was the likely cause of the discoloration, as it would increase the chance of marrow leaking on to the femur (Smith and Northcutt, 2003). Therefore, color measurement at the proximal interior femur site would be important as increased marrow leakage may induce a greater discoloration at the site after cooking. As panelists would only be exposed to the mid-section of the femur when conducting the evaluations, two sites were chosen to provide a more accurate analysis when matching evaluation scores to the incidence of discoloration.

3.2.6. Data analysis

SAS statistical software (version 9.1) was used for all data analysis. Analysis of Variance (using non-parametric Wilcoxon Median test at ($P<0.05$)) was performed on consumer evaluation scores as well as bone color measurements for L*a*b* (Steel et al., 1977). Normal data (Mid-femur site b* values and proximal site L* values) were analyzed using General Linear Model ANOVA and t-tests at $P<0.05$ (Steel et al., 1977). Chi-square analysis using a categorical response model was performed on observed discoloration frequencies across diets (control, 25-OHD_3 and reduced nutrient density) at $P<0.05$ (Steel et al., 1977). Observed ratios of discoloration responses (yes/no) were also analyzed using the frequency procedure across diets at $P<0.05$ (Steel et al., 1977). Demographic data were analyzed by frequency distribution.

3.3. Results and discussion

3.3.1. Demographic and chicken consumption habits

A total of 107 consumers of bone-in chicken thighs participated in the consumer evaluation panel. The panelist distribution was 53% male and 47% female across the ages of 18 to 69 years and was composed of mostly North American (53%) or Asian (36%) consumers (Table 3-1). Participants indicated they consumed bone-in chicken thighs (30%) and other bone-in chicken cuts (35%) on average ‘every 2-3 weeks’. Home-cooked bone-in chicken thighs were

consumed more often (‘every 2-3 weeks’ or ‘at least once a year’) than ready-to-eat bone-in chicken (‘once a month’ or ‘at least once a year’) (Table 3-1). Overall, oven-roasted (33%) and barbequed (33%) were the most preferred methods of preparation for bone-in chicken thighs; often served as a side dish to complete a meal (30%).

3.3.2. Consumer evaluation scores

There were no statistically significant differences among the three diets for any sensory trait ($P>0.05$). Scores across all sensory traits averaged approximately 6 on a 9-point hedonic scale, ‘like slightly’. Similarly, the chi-square analysis revealed no significant differences in the frequency of observed discoloration on the internal appearance of the meat among diet for any treatment ($P>0.05$).

Appearance. There were no significant differences in the liking of the external appearance among thighs of the diet treatments, which was expected as consistent external appearance was maintained by using foil-lined baking trays and coverings. Similar results were shown in the overall liking scores for the internal appearance. Mean scores for the liking of the internal appearance was significantly influenced by the presence of discoloration; for all treatments, the presence of discoloration significantly lowered the liking score for internal appearance ($P<0.05$) (Table 3-2).

The percentage of consumers who indicated they perceived discoloration in the bone-in thighs was greater than the percentage of consumers who did not perceive discoloration for each treatment ($P<0.05$) (Table 3-2). Although the incidence of black bone in industry has not been reported, Smith and Northcutt (2003) reported that another condition similar to black bone, called red discoloration, occurred in 11% of cooked bone-in chicken products in an experiment. This discoloration was identified as a more intense red, almost bloody color on the meat adjacent to the bone and was suggested to be closely related to black bone (Smith and Northcutt, 2003). It is known that when meat is cooked, hemoglobin is broken down and the red pigments are converted to shades

of brown and grey (Koonz and Ramsbottom, 1947). Although it has not been proven, red discoloration is likely the color defect that occurs prior to the dark brown color that defines black bone. In other words, we assume that the red discoloration will eventually form into the dark brown color as the meat cooks. Since the occurrence of red discoloration was found to be low according to Smith and Northcutt (2003), black bone discoloration was expected to have a low occurrence rate in the present study. Our results suggest that the occurrence of discoloration averaged about 50%; significantly higher than expected ($P<0.05$).

The higher percentage of 'yes' responses was likely due to the generalizability of the evaluation question which asked consumers to identify whether or not they perceived the internal thigh meat to be discolored. To eliminate biases, the questionnaire only asked the panelists to identify if they perceived the internal thigh meat to be discolored, but were not informed of the condition of black bone prior to the evaluation. Therefore, the percentage of discolored thighs could represent any form of discoloration including minor variation in meat color, red discoloration or the pinking of meat; all different from black bone.

Another unexpected result was that the greatest percentage of perceived discoloration was found in the thighs from chickens fed the reduced nutrient diet (66%) compared to the control (57%) and 25-OHD_3 supplemented (55%)(Table 3-2). Previous studies suggest that the reduced nutrient birds would have a lower incidence of discoloration since slower growing birds have less porous bones (Williams et al., 2004) and that bone porosity has an influence on discoloration (Smith and Northcutt, 2004b).

Overall, although these results do not indicate the degree of discoloration or whether or not the observed discoloration was 'black bone', any form of discoloration in bone-in chicken appeared to have only a minor impact on consumers' overall liking of bone-in chicken thighs.

Flavor. No significant differences were found in consumer liking scores of flavor among the three thigh treatments in the present study. Our results were similar to an earlier study done by Fanatico et al. (2007) who compared slow- and

fast-growing birds and found no significant differences in consumer acceptance scores for flavor. However, when using a trained panel, Fanatico et al. (2007) found a trend in which a greater percentage of trained panelists considered slow-growing birds to provide a stronger flavor than the fast-growing birds. On the contrary, another study comparing slow-, medium-, and fast-growing birds did not find any difference in flavor while using a trained panel (Latter-Dubois, 2000). In the present study a single fast-growing strain was used and altered growth rate was achieved by diet modification, whereas in previous research, different genotypes were used to compare the effects of growth rate on flavor quality (Fanatico et al., 2007; Latter-Dubois, 2000). These results suggest that regardless of genotype, the growth rate of birds does not have a strong effect on the flavor quality of chicken meat that is recognized by the average consumer and therefore, does not significantly impact the flavor acceptance of bone-in chicken thighs.

Bird age is known to contribute to the flavor of meat (Farmer, 1999). During growth, it is only after growth inflection that flavors begin to increase and flavor precursors deposit into the muscles (Gordon and Charles, 2002). In present production methods, fast-growing broilers grow to market weight at an early age; their inflection point is reached at approximately 38.4 d and 35.2 d for male and female broilers, respectively (Scheuermann et al., 2003). In the present study, only male birds were used and were harvested at 39d and 41d; just after the broilers had reached their inflection point. Therefore, there may not have been sufficient time to allow further flavor development and differentiation among the diets during the growth of the birds.

Overall, the consumer flavor acceptance scores for the bone-in thighs in the present study were similar and relatively low (6 on the 9-point scale), which was also seen in the study by Fanatico et al. (2007). Although dark meat is considered to have more flavor compared to white meat (Fanatico et al., 2007), the lack of salt and seasoning during cooking may not be an ideal method of preparation for the average consumer. This may have influenced the overall acceptance of the flavor quality in the present study.

Texture. There were no significant differences in the present study for the acceptance of thigh meat texture among the three diets. However, consumer comments were notably more positive towards the texture of bone-in thighs from birds on the reduced nutrient density diet, indicating that the meat was "more tender" than meat from the other diets (Table 3-3).

Meat toughness has been associated with muscle fibre characteristics in broilers (Dransfield and Sosnicki, 1999; Fanatico et al., 2006). Research has shown that a lower nutrient diet (in quantity or quality) decreases muscle fibre diameter in broilers (Rehfeldt et al., 2004). According to Farmer (1999), birds with smaller muscle fibres produce more tender meat so it was expected that birds fed the nutrient dilute diet would produce more tender meat. Although bird age has also been known to affect meat tenderness, Schmidt et al. (2009) indicated that modern-day practices allow birds to be harvested at a younger age as they reach market weight faster. Therefore, age-related toughness is unlikely to be associated with meat tenderness in the present study.

The presence of discoloration significantly lowered the liking score for texture of the 25-OHD_3 treated thighs ($P<0.05$); an effect not observed in the control or the nutrient dilute diet (Table 3-2). This was surprising because the 25-OHD_3 thighs were the only treatment that received a significantly lower liking score overall ($P<0.05$) (Table 3-2); the overall liking scores for the control and nutrient dilute treatments were not affected regardless of discoloration. Therefore, these results indicate that perhaps the texture quality has a stronger influence on consumers' overall acceptability of bone-in chicken thighs.

Consumer comments were generally diverse which supports the lack of differences in consumer acceptance scores overall (Table 3-3). Both positive and negative comments were received for each sensory attribute for thighs from all diets, indicating that the evaluation of bone-in chicken thighs was relatively subjective. It is because of this variation in personal preference that sample sizes of 60 to 100 participants are used in the evaluation of consumer acceptance (Meilgaard et al., 1999). Overall, the use of modified diets to alter bone growth

did not appear to affect the sensory quality and acceptability of bone-in chicken thighs by consumers.

3.3.3. Colorimeter measurements

Mid-femur color measurements (L*, a* and b* values) of broilers fed the nutrient dilute diet were significantly different from both the control and 25-OHD_3 treatments overall ($P<0.05$). The reduced nutrient density diet treatment resulted in bone color that was significantly lighter in color, less red and less yellow than the other diets (Table 3-2). As expected, the bone color at the mid-femur was significantly darker when discoloration was perceived, but only for the 25-OHD_3 and nutrient dilute diet treatments (Table 3-2). The hue values were also significantly different when discoloration was present ($P<0.05$), which was observed across all treatments at the mid-femur, while no difference was found in saturation values for any treatment (Table 3-2).

At the proximal femur site, the reduced nutrient density diet bones were significantly lighter in color compared to the other diets ($P<0.05$) while no significant differences were found in the redness or yellowness ($P>0.05$). Similar to the mid-femur site, no significant differences were found between the bone color of the control and 25-OHD_3 diet treatment groups overall, but the presence of discoloration produced bones that were more red and more yellow in the 25-OHD_3 treatment than when discoloration was not perceived (Table 3-2). Furthermore, hue angle and saturation values did not differ significantly with the presence of discoloration with the exception of the hue value in the control treatment (Table 3-2).

Despite the darker bone color with the presence of consumer perceived discoloration, it was surprising that the overall bone color for the reduced nutrient diet was lighter compared to the other treatments since the percentage of perceived discoloration was the greatest in this treatment compared to the others (66%)(Table 3-2). These results indicate that bone color may not be a direct indicator of the presence of discoloration in bone-in meat. Although previous research has shown an association between bone porosity and the incidence of

discoloration (Koonz and Ramsbottom, 1947), it appears that there are other factors that may have a greater contribution to the cause of black bone such as freezing the meat prior to cooking as well as errors in processing such as mis-cuts.

3.4. Conclusion

Dietary modifications using a 25-OHD_3 supplemented or a reduced nutrient density diet produced subtle differences to the texture and flavor qualities of bone-in chicken meat but did not have a strong impact on consumer acceptance of the sensory qualities of bone-in chicken thighs overall. Despite the negative impact on consumer liking for internal appearance when discoloration was perceived, dietary effects on the texture of 25-OHD_3-supplemented thighs had a stronger negative impact on overall acceptance of the meat. Instrumental color measurements showed the reduced nutrient density diet produced significantly lighter bone color, but these results did not correspond with the incidence of meat discoloration reported by consumers. Although the degree of discoloration and the type of discoloration was not measured, the results indicate that the appearance of discoloration in bone-in chicken meat did not influence consumers' liking of the appearance and acceptability of the meat. This information is vital for poultry industries to make informed decisions regarding the severity of the black bone problem as perceived by the consumer.

3.5 Tables

Table 3-1. Summary of participant demographics and chicken consumption habits (n=100)

Characteristics	Number [1]	(%)
Gender		
Male	53	(53%)
Female	47	(47%)
Age		
18-29 years	83	(83%)
30-39 years	8	(8%)
40-49 years	3	(3%)
50-59 years	5	(5%)
60-69 years	1	(1%)
Ethnicity		
North American	50	(53%)
Asian	34	(36%)
Central American	2	(2%)
European	8	(8%)
Middle Eastern	1	(1%)
On average, how often do you eat bone-in chicken thighs?		
More than 3 times a week	2	(2%)
2-3 times a week	10	(10%)
Once a week	17	(17%)
Every 2-3 weeks	30	(30%)
Once a month	23	(23%)
At least once a year	18	(18%)
How often do you consume other bone-in chicken parts?		
More than 3 times a week	3	(3%)
2-3 times a week	15	(15%)
Once a week	20	(20%)
Every 2-3 weeks	35	(35%)
Once a month	19	(19%)
At least once a year	8	(8%)
On average, how often do you eat home-prepared bone-in chicken thighs?		
More than 3 times a week	1	(1%)
2-3 times a week	5	(5%)
Once a week	21	(21%)
Every 2-3 weeks	26	(26%)
Once a month	19	(19%)
At least once a year	27	(27%)
Never	1	(1%)
On average, how often do you eat 'ready-to-eat' bone-in chicken thighs?		
More than 3 times a week	1	(1%)
2-3 times a week	3	(3%)
Once a week	7	(7%)
Every 2-3 weeks	15	(15%)
Once a month	31	(31%)
At least once a year	32	(32%)
Never	10	(10%)
What method of preparation do you prefer the most when consuming bone-in chicken thighs? [2]		
Oven-roasted/baked	41	(33%)
Deep-fried	16	(13%)
Grilled/Pan-fried	14	(11%)
Barbequed	37	(30%)
Slow-cooked	16	(13%)

[1] Values are based on the number of participants who responded to the question
[2] Consumers were allowed to choose all options that applied

Table 3-2. Summary of mean score values and color measurements of bone-in chicken thighs overall and when internal discoloration was or was not perceived by consumers.

Treatment	**Control**			**25-OHD$_3$ supplemented**			**Reduced nutrient density**		
Discoloration[1]	**Yes**	**No**	**Overall**	**Yes**	**No**	**Overall**	**Yes**	**No**	**Overall**
% consumers[2]	57%	43%		55%	45%		66%	38%	
External Appearance[3]	5.8 ± 1.6^{a}	6.4 ± 1.5^{a}	6.2 ± 0.16^{x}	6.0 ± 1.6^{a}	6.2 ± 1.7^{a}	6.0 ± 0.16^{x}	5.7 ± 1.8^{a}	6.0 ± 1.9^{a}	5.9 ± 0.16^{x}
Internal Appearance[3]	5.2 ± 1.8^{a}	6.5 ± 1.7^{b}	5.8 ± 0.17^{x}	5.3 ± 1.8^{a}	6.4 ±1.6^{b}	5.8 ± 0.17^{x}	5.3 ± 1.7^{a}	6.7 ± 1.5^{b}	5.9 ± 0.17^{x}
Flavor[3]	6.3 ± 1.7^{a}	6.7 ± 1.5^{a}	6.5 ± 0.16^{x}	5.9 ± 1.8^{a}	6.4 ± 1.6^{a}	6.5 ± 0.16^{x}	6.3 ± 1.7^{a}	6.7 ± 1.4^{a}	6.2 ± 0.16^{x}
Texture[3]	6.3 ± 1.6^{a}	6.6 ± 1.5^{a}	6.4 ± 0.15^{x}	6.2 ± 1.8^{a}	6.9 ± 1.4^{b}	6.5 ± 0.15^{x}	6.5 ± 1.7^{a}	6.8 ± 1.5^{a}	6.6 ± 0.15^{x}
Overall[3]	6.2 ± 1.8^{a}	6.7 ± 1.5^{a}	6.4 ± 0.16^{x}	5.8 ± 1.9^{a}	6.7 ± 1.7^{b}	6.2 ± 0.16^{x}	6.2 ± 1.7^{a}	6.6 ± 1.5^{a}	6.4 ± 0.16^{x}
Mid-femur									
L*	56.71 ± 2.0^{a}	55.88 ± 2.7^{a}	56.32 ± 2.3^{x}	55.50 ± 2.3^{a}	57.49 ± 2.5^{b}	56.17 ± 2.4^{x}	57.31 ± 3.6^{a}	58.36 ± 2.6^{a}	57.65 ± 3.1^{y}
a*	3.51 ± 0.78^{a}	3.45 ± 0.89^{a}	3.61 ± 0.83^{x}	3.71 ± 0.78^{a}	3.48 ± 0.60^{a}	3.69 ± 0.74^{x}	3.43 ± 0.79^{a}	3.03 ± 0.60^{b}	3.40 ± 0.71^{y}
b*	3.81 ± 0.59^{a}	3.91 ± 0.75^{a}	3.81 ± 0.66^{x}	3.78 ± 0.80^{a}	3.71 ± 0.79^{a}	3.72 ± 0.79^{x}	3.26 ± 0.75^{a}	3.21 ± 0.60^{a}	3.23 ± 0.68^{y}
Hue°	47.35 ± 37^{a}	48.58 ± 40.0^{b}	46.54 ± 38.5**	45.54 ± 45.7^{a}	46.83 ± 52.8^{b}	45.00 ± 46.9**	43.54 ± 43.5^{a}	46.65 ± 45.0^{b}	44.06 ± 44.0**
Saturation	5.18 ± 0.98^{a}	5.21 ± 1.2^{a}	5.30 ± 1.1**	5.30 ± 1.1^{a}	5.09 ± 0.99^{a}	5.24 ± 1.1**	4.73 ± 1.1^{a}	4.41 ± 0.85^{a}	4.72 ± 0.98**
Proximal femur									
L*	60.59 ± 3.0^{a}	59.89 ± 3.4^{a}	61.33 ± 3.2^{x}	59.84 ± 3.0^{a}	61.00 ± 2.9^{a}	60.40 ± 3.1^{x}	61.35 ± 3.4^{a}	61.11 ± 2.8^{a}	60.01 ± 3.2^{y}
a*	3.52 ± 0.84^{a}	3.50 ± 0.58^{a}	3.37 ± 0.44^{x}	3.72 ± 0.85^{a}	3.35 ± 0.63^{b}	3.57 ± 0.75^{x}	3.39 ± 0.48^{a}	3.33 ± 0.38^{a}	3.55 ± 0.73^{x}
b*	2.89 ± 1.2^{a}	2.64 ± 1.0^{a}	2.56 ± 1.0^{x}	2.94 ± 1.1^{a}	2.34 ±1.0^{b}	2.59 ± 1.1^{x}	2.59 ± 0.96^{a}	2.53 ± 0.90^{a}	2.71 ± 1.1^{x}
Hue°	39.37 ± 55.5^{a}	37.03 ± 60.4^{b}	37.22 ± 66.5**	38.32 ± 52.3^{a}	34.93 ± 58.3^{a}	35.96 ± 55.5**	37.38 ± 63.4^{a}	37.23 ± 67.1^{a}	37.36 ± 57.1**
Saturation	4.55 ± 1.5^{a}	4.38 ± 1.2^{a}	4.23 ± 1.1**	4.74 ± 1.4^{a}	4.09 ± 1.2^{a}	4.41 ± 1.3**	4.27 ± 1.1^{a}	4.18 ± 0.98^{a}	4.47 ± 1.4**

[1]Indicates whether or not consumers perceived the presence of discoloration on the internal meat appearance of bone-in chicken thigh samples
[2] Percentage of consumers who indicated there was or was not discoloration in the bone-in chicken thigh sample
[3] Mean score values and standard deviations for overall scores based on a 9-point hedonic scare representing the percentage of consumers within each category
[a-b] Different letters indicate significant difference between mean scores within a row, with or without the presence of discoloration (P<0.05)
[x-y] Different letters indicate significant difference between mean scores for overall values among the diets (P<0.05).
[**] Values were calculated using the average color values for a* and b*; no statistical analysis was conducted.

Table 3-3. Summary of descriptive comments by consumer participants on the sensory quality of bone-in chicken thigh treatments

	Control		**25-OHD$_3$ supplemented**		**Reduced nutrient density diet**	
APPEARANCE	Less black (1) Looked appetizing (1) Good outer appearance (1) Okay (1) Some bloody vessels was alarming (1) Taste better than it looked (1)	A lot of vein material (1) Quite red (1) Least good looking (2) darker; less appealing (1) Discoloration more noticeable (2) Very pink (1)	Nice, more appealing (3) Less redness, more consistent color than (2) Very minor discoloration (1) Discoloration higher (3) Old; not fresh (1) Darker meat near bone (1)	Too brown at parts (1) Interior - unappealing greyish brown; darker (2) Blood inside meat, blood clots, red blood vessels (4)	Less pale – more appealing (1) Darker brown; dark patches; inconsistent; marbly (4) More discolored (1) Red color inside (2) Veiny (1) Greyer (1) Less appealing (1)	Slight discoloration (1) Dark red spots on outside- unappealing (1) Initial appearance unappealing (2) Wrinkled exterior (1) Clear, not blackened like others (1)
FLAVOR	Less tasty than reduced nutrient thigh (1) Better taste than 25-OHD$_3$ (1) Delicious (1) Best taste (1) Tasty (1) Nice taste/flavor, good (3)	Darker taste – like duck or goose (1) Very flavorful (1) Not a very strong chicken taste (1) Tastes like blood (2) Tastes like dirt (1) Watery (2) Plain, bland, boring (5)	Good taste (3) Very tasty (2) More flavor (2) Delicious (1) Deep flavor – Nice (1) Boiled taste (1) mild flavor, tasteless, no taste (5)	Strong; not good (2) Slightly less flavor Sour; mealy taste (1) Off flavors (1) Iron flavor (1) Unpleasant aftertaste (1) Old (1) Watery (1)	Very tasty; pretty tasty, good (3) Strong chicken flavor (1) More flavor (1) Nice flavor (1) Great; delicious (2)	Least tasty (1) Tastes a bit off (1) Too light Bland, milder, not a lot of flavor (3) Grainy (1) Average, alright (2)
TEXTURE	More Juicy (1) Tender; easy to bite (1) Nice texture (1) Good texture; smooth and even inside (1) Better texture; smooth and bouncy (1) Chewy (4)	Not the best (1) Dry (1) Hard to chew (1) Too greasy (1) Bit sticky (2) Tough, not tender (3) Rubbery, gummy (2) Stringy (4)	Good texture (3) Good; Smooth (2) Decent (1) Very tender (2) Soft and fresh (1) Less appealing (1)	Firm, yet tender (1) Little chewy (1) Bit rubbery; hard to chew (1) Hard to cut – firm (1) Slippery (1)	Good texture (2) More tender (2) Firmer (2) Nice texture (2) Really good (1) Moist (1) A bit elastic (1) Alright (1)	Too tough (1) A bit chewy (1) Dry (1) Rubbery (3) Less firm; harder to cut (1) Soft – not good (1)

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Chapter 4: Summaries, Conclusions and Future Recommendations

4.1. Summaries

The consumption of chicken meat has been growing as a commodity worldwide. The increase in demand has lead to changes in production methods of broiler chickens, moving towards genetic selection for increased feed efficiency and muscle growth (Williams et al., 2000; Schmidt et al., 2009). However, rapid growth of modern broilers has been linked to skeletal development problems. Bone porosity, in particular, has been associated with a color defect known as black bone discoloration, characterized as a dark black or burgundy stain appearing on bone-in chicken meat.

As appearance is known to influence consumer attitudes, the incidence of black bone may be a concern for poultry industries. With limited knowledge about consumer perception of chicken meat, it is important for poultry industries to understand consumer perceptions of this discoloration as well as their perception of bone-in chicken in general in order to maintain its growth as a commodity.

The objectives of this research were to:

1) Determine consumers' underlying motivations for choosing bone-in chicken and gain insight on their perception of black bone discoloration.
2) Determine the industry's perception of these issues in comparison to consumers' response.
3) Examine the effects of modifying broiler diet to alter bone growth rate on the sensory properties of the meat, the incidence of discoloration and consumer acceptance.

The unique approach to this research was the use of sensory and consumer science techniques. The laddering technique incorporated consumer values and beliefs into consumer research, which allowed us to understand the consumers at a deeper level than quantitative techniques such as surveys. A comparison of both the industry and consumer perspective of bone-in chicken products and black bone discoloration put into context the extent of the problem for the poultry industry. Furthermore, the precise methodology of the sensory component of this research allowed us to provide concrete

and valid data on the sensory properties of bone-in chicken meat that set the present research apart from previous studies on poultry.

This chapter summarizes the research project as a whole and includes recommendations for future opportunities in sensory and consumer research in poultry science.

4.1.1. Chapter 2

A two-part research study was conducted to determine the overall perception of bone-in chicken and black bone discoloration of consumers and poultry processors. In the first component of the study, the qualitative method of laddering was used to reveal the underlying motives that drive current consumers to choose bone-in chicken (fresh and ready-made rotisserie) as well as to gain insight on the impact of black bone discoloration on consumer preference. Based on the interviews with 48 consumers, two hierarchical value maps (HVM) were developed, revealing five perceptual orientations of the underlying motivations for choosing bone-in chicken: food safety, health, eating quality, price and convenience.

In the second component, representatives (n=8) from poultry processors across Canada were interviewed using a structured questionnaire that was developed from the results obtained from the consumer interviews in part 1 of the experiment. The aim of this component was to determine how poultry processors perceived the level of importance of each of the five perceptual orientations and also how their perceptions compared to those of consumers.

Similarly, for both consumers and processors, black bone discoloration was acknowledged but was not considered a major concern. The results revealed that food safety was perceived to be the most important feature of bone-in chicken from both the consumer and poultry processing industry perspective.

4.1.2. Chapter 3

A consumer sensory evaluation panel was conducted to determine the effects of altering broiler chicken diet with a HyD supplement or reduced nutrient density diet on consumer acceptance of the sensory properties of bone-in chicken thighs as well as the

incidence of black bone discoloration. In addition, instrumental color measurements were conducted to provide objective measures of bone color. Birds (n=320) were fed a control diet or one of two dietary treatments that may potentially improve bone porosity: control diet plus 25-hydroxy cholecalciferol or control diet diluted 25% with wheat bran diet.

No significant differences were found among the three dietary treatments for any sensory trait based on consumer acceptance evaluations, although consumer comments revealed minor effects on acceptance of the texture and flavor of the meat. Also, contrasting results were found among consumer perceptions of discoloration and instrumental color measurements of the femur. Consumers perceived discoloration to be more prevalent in the meat of chicken thighs from birds fed the diluted diet as confirmed by consumer comments which included: “darker brown”, “dark patches”, “inconsistent”, and “marbly”. Meanwhile, instrumental color measurements showed the femur of these birds to be significantly lighter in bone color compared to the other dietary treatments. Thus, these results suggest that bone color may not be directly related to discoloration in the meat of bone-in chicken thighs.

Overall, the incidence of black bone discoloration was low (57%), even for the control treated thighs. The addition of 25-hydroxycholecalciferol or the diluted diet did not significantly affect the sensory quality of bone-in chicken thighs and the appearance of discoloration did not significantly influence consumer acceptance for the meat.

4.2. Conclusions and future recommendations

The use of laddering to elicit consumer motivations for choosing bone-in chicken proved to have a substantial impact on the present research as it allowed us to truly engage with consumers and understand their values and attitudes toward bone-in chicken. The practicality of this method can be applied to a diverse range of products making it a very useful technique in consumer science (Gutman, 1982; Costa et al., 2004; Veludo-de-Oliveira et al., 2006). This novel approach to consumer research on poultry provided valuable and transferable information for the poultry industry and should be considered when conducting research on other issues related to poultry.

In future research toward consumer acceptance of black bone discoloration, it would be beneficial to include an intensity scale to measure the perceived level of

discoloration by consumers. In the present research, it appears that the bone color measurements did not correspond with consumer perception of discoloration in the bone-in thigh meats. Therefore, it would be also beneficial to conduct instrumental color measurements on the internal meat surface as well.

Previous studies by Fanatico et al. (2005, 2006, 2007a, 2007b) found that genetic strain can affect the sensory properties of broilers. However, these studies were focused mainly on eating quality; color evaluations were only performed on breast meat. The present research included only a fast-growing broiler strain, which was a more practical approach as they are typically used for commercial production. Perhaps the use of different genetic strains in place of modified growth rate diets may provide more substantial results in terms of discoloration in the present study.

In conclusion, black bone discoloration is merely a color defect associated with meat quality (Fletcher, 2002) and its low incidence appears to have minimal effects on the poultry industry. Although consumers do not appear to be negatively influenced by the discoloration, it is often perceived to be a food safety issue. Therefore, in order to maintain the growth of chicken consumption, it would be valuable for the poultry industry to provide consumers with more information regarding food safety when consuming chicken meat as well as to advertise the other positive aspects of choosing bone-in chicken products.

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Appendix 1: Verbal recruitment text for laddering interviews

Interviewer will approach an individual and invite them to participate in an interview to discuss bone-in chicken.

Script:

"Excuse me, I'm a grad student at the University of Alberta and I'm doing a project involving bone-in chicken. Do you eat bone-in chicken on a regular or occasional basis?"

When the participant responds, continue: "Would you be willing to participate in an interview about your thoughts on bone-in chicken? It will take approximately 5-10 minutes.

If respondent responds negatively, thank them and terminate the conversation.

If respondent responds positively, continue: "Thank you very much; here is an information sheet for you to read more about the study. The respondent will then be given a consent form to sign and then a demographics questionnaire to fill out before the interview begins.

If respondent wants to "think about it", interviewer will give them an information sheet and circle her contact information.

NOTE: The interviews will be conducted at the recruitment location, (provided that the location has a room available and are permitting its use).

Appendix 2: E-mail recruitment for laddering interviews

E-mail subject line: Chicken consumer needed!

Do you eat chicken?? I want to hear from you!
Come participate in a 20-25 min interview at AFNS (Rm 2-35) and tell me why YOU eat chicken!

For more information, please contact **Debrah Yu** at debrah@ualberta.ca or 780-492-3833.

Appendix 3: Laddering interview information sheet and consent form

Purpose: The purpose of this project is to determine consumer perception of bone-in chicken.

Interview Methods: You are being asked to participate in an interview to discuss your thoughts and opinions about bone-in chicken as well as your reasons for choosing it. The interview is expected to last about 5 - 10 minutes. The session will be recorded using a digital recorder and will be transcribed to allow the researchers an opportunity to review and interpret the comments that were generated. At the end of the interview, you will be asked to complete a one-page questionnaire about yourself. (*Note: Laddering is a type of interview technique that the researchers will use that employs a series of questions*.)

Confidentiality: Your name will not be associated with the comments that you provide and will not appear in the final report. Only the investigators will have access to the tape recordings and transcripts of the interviews. You are not obligated to provide information that you are uncomfortable sharing. If you are asked a question that you are not comfortable answering, do not answer it.

Benefits: The results of this study may not have any direct benefits for you but you may enjoy the research experience and the opportunity to contribute your thoughts and opinions. You will receive a $10 gift certificate from Save-On-Foods at the end of the session. The results from this study will be valuable to the Canadian poultry industry to gain insight on current consumer perception of bone-in chicken to better meet consumers' needs.

Risks: There are no anticipated risks in participating in this study.

Withdrawal from the Study: Even after you have agreed to participate in the interview, you can change your mind at any time before or during the session and withdraw from the study. You will still receive a $10 gift certificate from Save-On-Foods.

Use of Your Information: This study is being conducted by researchers in the Department of Agricultural, Food and Nutritional Science at the University of Alberta. Your comments from the interview will be summarized along with those of other participants and will be incorporated into research reports for the funding agency and for publishing in scientific journals. A summary of the research results may be e-mailed to you if you have requested this information.

For further information about this project you may contact:

Wendy Wismer
492-2923; wendy.wismer@ualberta.ca

Debrah Yu
492-3833; debrah@ualberta.ca

Additional Contacts: If you have concerns about this study, you may contact Dr. Wendy Rodgers, Chair of the PER-ALES Research Ethics Board, at 780-492-8126. Dr. Rodgers has no direct involvement with this project.

Consent Form: Laddering Interviews for Consumer Perception of Bone-in Chicken

Consent: Please circle your answers:

As a potential participant...

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you can quit taking part in this study at any time?	Yes	No
Has confidentiality been explained to you?	Yes	No
Do you understand the interview will be recorded?	Yes	No
Do you know what the information you say will be used for?	Yes	No
Do you agree to be contacted by the researcher if needed for a follow-up interview to clarify certain topics discussed during your interview?	Yes	No
Do you give us permission to use your data for the purposes specified?	Yes	No

This study was explained to me by: Debrah Yu

I agree to take part in this study.

_____ _____ _____/_____/ 2009

Signature of Research Participant Printed Name Date (dd/mm/yyyy)

If you would like to receive a summary of the research results:
Please fill in your e-mail address or postal address below. Your contact information will not be used for any other reason than to provide you with a summary of the results.

E-mail or Postal Address: _____

Appendix 4: Demographic questionnaire for laddering interview participants

Information about Yourself Participant: _____

1. Please indicate your gender:

❒ Male ❒ Female

2. Please indicate the age group that you belong to:

❒ 18-29 years ❒ 50-59 years
❒ 30-39 years ❒ 60-69 years
❒ 40-49 years ❒ 70 years plus

3. Please indicate how many people live in your household:

❒ 1 person ❒ 4 persons
❒ 2 persons ❒ more than 5 persons
❒ 3 persons

4. Please indicate how many people in your household are under 18 years of age:

❒ 0 person ❒ 3 persons
❒ 1 person ❒ 4 persons
❒ 2 persons ❒ more than 5 persons

5. Where do you normally purchase your bone-in chicken? (Please circle the number that best represents your purchasing habits)

	Always	Most Often	Sometimes	Rarely	Never
Supermarkets (e.g., Save-On, Safeway)	1	2	3	4	5
Meat Shops (e.g., M&M Meat Shops)	1	2	3	4	5
Farmer's Markets	1	2	3	4	5
Wholesalers (e.g., Costco)	1	2	3	4	5
Other: (please specify)	1	2	3	4	5

6. On average, how often do you eat bone-in chicken?

❒ More than 3 times a week
❒ 2 – 3 times a week
❒ Once a week
❒ Every 2 – 3 weeks
❒ Once a month
❒ At least once a year
❒ Never

7. Thinking of the last time you ate bone-in chicken at home, was the chicken cooked in your home or bought in "ready to eat"?

❒ Cooked at home
❒ Ready to eat

8. On average, how often do you personally cook or prepare any meals or snacks at home with fresh bone-in chicken?

- ❒ More than 3 times a week
- ❒ 2 – 3 times a week
- ❒ Once a week
- ❒ Every 2 – 3 weeks
- ❒ Once a month
- ❒ At least once a year
- ❒ Never

9. On average, how often do you purchase "ready to eat" bone-in chicken?

- ❒ More than 3 times a week
- ❒ 2 – 3 times a week
- ❒ Once a week
- ❒ Every 2 – 3 weeks
- ❒ Once a month
- ❒ At least once a year
- ❒ Never

10. Which would you say is the favorite chicken part to eat in your household?

- ❒ Breasts
- ❒ Wings
- ❒ Legs
- ❒ Thighs/ Drumsticks
- ❒ Skin
- ❒ Whole chicken
- ❒ Other_____

11. Please indicate the level of education that corresponds to what you have completed:

- ❒ Some high school
- ❒ High school graduate
- ❒ Some university or college
- ❒ College diploma/ degree
- ❒ University undergraduate degree
- ❒ Some post graduate university study
- ❒ Post graduate university degree (e.g. Master's or Ph.D.)

12. Please indicate the range that represents your household income level in the year 2008, before taxes:

- ❒ Less than $20,000
- ❒ $20,001 - $40,000
- ❒ $40,001 - $60,000
- ❒ $60,001 - $80,000
- ❒ $80,001 - $100,000
- ❒ More than $100,000

Appendix 5: Guiding questions for consumer laddering interviews

How often do you consume bone-in chicken?

Where do you buy your chicken?

What type of cut do you normally buy?

What do you use it for?

If a recipe did not specify a certain type of chicken cut, what type of chicken cut would you likely use?

How do you prepare it?

Where do you normally eat bone-in chicken?

What's your favorite cut eat? What is your favorite cut to prepare? Why?

Why do you prefer bone-in chicken over other types of chicken?

Do you ever buy pre-made chicken?
What cuts?

When buying bone-in chicken, what attributes/characteristics are you looking for?
Do you look for certain features in the appearance of the meat?

Are there any negatives aspects about bone-in chicken that would make you not want to buy/eat it?

Appendix 6: E-mail recruitment for poultry processor telephone interviews

E-mail subject line: Black bone survey

Hello,

My name is Debrah Yu. I am a graduate student from the University of Alberta and I am working on a research study on the perception of bone-in chicken. After completing preliminary research with consumers, I am now interested in understanding the industry's perspective of chicken as a food commodity and also the type of feedback that the industry receives from consumers.

I am looking for members of the industry who would be willing to complete a short telephone interview (approx 15min). The interview will consist of a few general questions about your thoughts on chicken and the chicken that is supplied at your establishment. You will also be asked to evaluate the level of importance and how much you agree/disagree with some of the statements that consumers made about chicken in our preliminary consumer study.

Please let me know if you would be interested in participating or have further questions.

Thanks

Debrah Yu

Debrah Yu
MSc. Student
University of Alberta
Department of Agricultural, Food and Nutritional Science
Phone: 1+ (780) 492-3833

Appendix 7: Verbal recruitment for poultry processor telephone interviews

Script:

"Hello, My Name is Debrah, I'm a graduate student from the University of Alberta. I'm conducting a research project on chicken I am looking for industry members who are willing to answer a few questions about their thoughts on chicken. Would you be interested?"

If respondent responds negatively, thank them and terminate the conversation.

If respondent responds positively, continue: "Thank you, I'm interested in understanding the industry's perception of chicken as a food commodity and also what type of feedback you receive from consumers. Are you still interested?"

If respondent responds negatively, thank them and terminate the conversation.

If respondent responds positively, continue: "I would like to do a short interview what will take about 15 to 30 minutes of your time. I will be asking you a few general questions about your thoughts on chicken and also chicken that you supply in your establishment. I will then ask you to evaluate how important and how much you agree with some of the statements that consumers made about chicken in our preliminary consumer study. Are you still interested? "

If respondent responds negatively, thank them and terminate the conversation.

If respondent responds positively, the researcher will ask the participant to provide a time that would be convenient for them to complete the interview.

If respondent is indecisive or wants to 'think about it", the researcher will offer her contact information.

NOTE: The interview session will be conducted over the telephone on campus (rm 2-35 Ag/For)

Appendix 8: Black bone survey for poultry processor telephone interviews

The interview will begin with an explanation of the study intent and procedures:

Script:

"The purpose of this study is to understand the perception of bone-in chicken from an industry's point of view. I'll be asking you some general questions about what you think about chicken as a food commodity and I'll ask you to evaluate how important you think certain aspects are for chicken and then finish off with some general questions about the chicken that you supply from your establishment. There are no perceived risks to participating in this study, you will remain anonymous, your name and company will not be attached to any information that you provide. If you do not feel comfortable answering a question, you may skip the question. You may withdraw from the study at any time. All information that you provide up to that point will be discarded. I may also contact you in the future for clarification if necessary. Do you have any questions?"

Do you agree to take part in this study? Yes / No

1. In your opinion, what are the most important attributes associated with good quality bone-in chicken?

_____
_____

2. In our preliminary research, we interviewed a group of consumers and asked them what they thought about bone-in chicken and why they chose to eat it and we found there were 5 main perceptual orientations that were associated with chicken. I would like you to evaluate on a scale of 1 to 5; 1 being "not important at all" and 5 being "very important", how important you think each quality is.

a) *On a scale from 1 to 5, how important would you say the ____ aspect of chicken is for consumers?*

	Not Important at all				Very Important
Food safety	1	2	3	4	5
Health	1	2	3	4	5
Eating Quality	1	2	3	4	5
Price	1	2	3	4	5
Convenience	1	2	3	4	5

b) *On a scale from 1 to 5, how important would you say the ____ aspect of chicken is to the industry?*

	Not Important at all				Very Important
Food safety	1	2	3	4	5
Health	1	2	3	4	5
Eating Quality	1	2	3	4	5
Price	1	2	3	4	5
Convenience	1	2	3	4	5

3. Are there any other attributes that you think are important that were not mentioned?

_____
_____

4. In the industry's perspective, how would you rank the 5 qualities in level of importance?

Food Safety	Health	Eating Quality	Price	Convenience
____	____	____	____	____

5.

a) How would you summarize consumer concerns about the chicken you provide?

_____
_____

b) What chicken product receives the most complaints? Why?

_____
_____

6. Are you familiar with black bone discoloration? (If no, black bone discoloration will be explained)

a) If yes, do you ever receive consumer complaints about black bone discoloration? Yes / No

i) How often? _____

ii) What do consumers say about the discoloration?

_____
_____

7. Do you ever receive complaints about discoloration other than black bone? Yes / No

a) What is the most common?

_____
_____

8. On a scale from 1 to 5, how important would you say discoloration is for the industry? Influencing consumer choice?

	Not Important at all				Very Important
Industry	1	2	3	4	5
Consumers	1	2	3	4	5

Appendix 9: E-mail recruitment for bone-in chicken thigh consumer panel

Chicken thigh consumer tasters needed!

Do you like bone-in chicken thighs and have eaten bone-in chicken thighs within the past year? You are invited to participate in a consumer panel for cooked bone-in chicken thighs! You are only required to attend one session that will take approx. 30 min of your time.

When: March 24, 25, 30 and 31st
Location: Ag/For Rm 2-35
Time: 10am to 2pm.

If you are interested, please schedule a time slot to come by contacting **Debrah Yu** at **debrah@ualberta.ca** or **ext. 23833**.

Appendix 10: Poster advertisement for bone-in chicken thigh consumer panel

Chicken Consumers Needed!!

Do you like bone-in chicken thighs and have eaten bone-in chicken thighs within the past year?

You are invited to participate in a consumer panel for cooked bone-in chicken thighs! Only 1 sessions in needed!

When: March 24, 25, 30 & 31st
Location: Ag/For Rm 2-35
Tasting sessions hourly: 10:30 – 1:30pm
(approx 30 min each session)

If you are interested, please schedule a time slot to come by contacting **Debrah Yu** at debrah@ualberta.ca or **ext. 23833**.

Appendix 11: Verbal recruitment text for bone-in chicken thigh consumer panel

Interviewer will approach an individual and invite them to participate in an interview to discuss chicken.

Script:

"Excuse me, I am a graduate student from the University of Alberta. My project is on chicken. Would you be interested in participating in a consumer taste panel to evaluate cooked bone-in chicken thighs?"

If respondent responds negatively, thank them and terminate the conversation.

If respondent responds positively, continue: "We are interested in participants who have eaten bone-in chicken thighs in the past year. Are you still interested?

If respondent responds negatively, thank them and terminate the conversation.

If respondent responds positively, continue: "Thank you; we will be conducting the consumer taste panels next week (dates and times TBA) and will take approximately 30 minutes of your time. Your participation will benefit the Canadian poultry industry, and we will give you a $5 Tim Horton gift card to thank you for your participation. Are you still interested?"

If respondent responds negatively, thank them and terminate the conversation

If the respondent responds positively, the researcher will ask the participant to sign up for one of the available time slots for the consumer taste panel. The participants name and contact information will be obtained in order to send out reminders about their consumer panel.

If respondent is indecisive or wants to "think about it", the researcher will offer them an information sheet and circle her contact information.

NOTE: The consumer panel will be conducted on campus (rm 2-35 Ag/For)

Appendix 12: Consumer panel information sheet and consent form

Purpose: The purpose of this project is to complete a consumer evaluation of the sensory qualities of bone-in chicken thighs to determine if the addition of wheat bran to the chickens' diet influences the sensory qualities

Consumer Panel Methods: You are being asked to participate in a consumer sensory panel to taste and evaluate four different cooked bone-in chicken thighs. The session will take place in Room 2-35 at the Ag/For Building at the University of Alberta. The tasting session is expected to last approximately 30 minutes and you will also be asked to complete a short demographic questionnaire.

Confidentiality: You will not be asked to provide your name; the sensory evaluation and demographics are anonymous. The contact information you will provide on the consent form will be used to inform you of the study outcome if you have requested this information. All documents will be stored in a locked cabinet at the University of Alberta for a minimum of 5 years.

Benefits: The results of this study may not have any direct benefits for you but you may enjoy the research experience and the opportunity to eat chicken. You will also receive a $5 Tim Horton gift card at the end of your session if you desire. The results from this study will be valuable to the Canadian poultry industry to gain insight on the effects of wheat bran on the sensory quality of bone-in chicken thighs

Risks: There is minimal risk to participating in this study. Potential risks include allergies, sensitivities or intolerance to chicken, unsalted soda crackers (enriched wheat flour, sour dough culture, sodium bicarbonate, malt flour, yeast, amylase, protease, soybean oil and hydrogenated cottonseed oil with TBHQ and citric acid) or distilled water. If you have any of these conditions, do not participate in this study.

Withdrawal from the Study: Even after you have agreed to participate in the consumer panel, you can change your mind at any time before or during the session and withdraw from the study. The researchers will not use any evaluations you have completed to that point.

Use of Your Information: This study is being conducted by researchers in the Department of Agricultural, Food and Nutritional Science at the University of Alberta. Your consumer panel data will be averaged with those of other participants and these mean values will be used to generate overall preferences of the appearance, flavour, texture characteristics and overall liking of the chicken thighs and determine whether or not a diet containing wheat bran is the more preferred meat quality. A summary of the research results may be e-mailed to you if you have requested this information.

For further information about this project you may contact:

Wendy Wismer	Debrah Yu
492-2923	492-3833
wendy.wismer@ualberta.ca	debrah@ualberta.ca

Additional Contacts: If you have concerns about this study, you may contact Dr. Kelvin Jones, Chair of the PER-ALES-NS Research Ethics Board, at 780-492-0650. Dr. Jones has no direct involvement with this project.

Consent Form: Consumer evaluation of the sensory qualities of bone-in chicken thighs

Consent: Please circle your answers:

As a potential participant...

Do you have any allergies, sensitivities or intolerances to any of the following ingredients?	Yes	No

- Bone-in chicken thighs

Unsalted soda crackers

- enriched wheat flour
- sour dough culture
- sodium bicarbonate
- malt flour
- yeast
- amylase
- protease
- soybean oil and hydrogenated cottonseed oil with TBHQ and citric acid

If you have answered" yes", please stop and tell one of our staff immediately.

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you can quit taking part in this study at any time?	Yes	No
Has confidentiality been explained to you?	Yes	No
Do you know what the information you say will be used for?	Yes	No
Do you give us permission to use your data for the purposes specified?	Yes	No

This study was explained to me by: Debrah Yu

I agree to take part in this study.

_____ _____ _____/_____/_2010

Signature of Research Participant Printed Name Date (dd/mm/yyyy)

If you would like to receive a summary of the research results:

Please fill in your e-mail address or postal address below. Your contact information will not be used for any other reason than to provide you with a summary of the results.

E-mail or Postal Address: _____

Appendix 13: Sensory evaluation questionnaire for bone-in chicken thigh consumer panel

Panelist #_____

You have 3 samples in front of you that are coded with a 3-digit number. Evaluate the samples in the order they are presented.

Please cleanse your palate *between each sample* by taking a bite of cracker and a sip of water
For each evaluation, please evaluate by marking an 'X' in one of the boxes

---

Sample _____

1. Observe the exterior of the thigh. Overall, how much do you like the **exterior appearance**?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

2. Use the knife and fork to cut through the meat exposing the bone. Remove the bone to observe the interior of the thigh.

Do you notice any inconsistency in the color of the meat? (circle) Yes / No

Overall, how much do you like the **interior appearance**?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

3. Eat a small portion of the thigh. Overall, how much do you like the **flavor** of the thigh?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

4. Take a bite of the chicken thigh. Overall, how much do you like the **texture** of the thigh?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

5. Overall, how much do you like this chicken thigh?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

If you have any comments on this chicken, please record them below:

_____
_____
_____

Thank You!

Please return to the discussion room to receive your treat.

Appendix 14: Demographic questionnaire for bone-in chicken thigh consumer panel

Information about Yourself Participant: _____

1. Please indicate your gender:

❒ Male ❒ Female

2. Please indicate the age group that you belong to:

❒ 18-29 years ❒ 50-59 years
❒ 30-39 years ❒ 60-69 years
❒ 40-49 years ❒ 70 years plus

3. Please indicate you ethnicity:

❒ North American ❒ European
❒ Asian ❒ Middle Eastern
❒ Central American ❒ Other: _____
(Please specify)

4.

(Please check the option that applies to you)

	More than 3 times a week	2-3 times a week	Once a week	Every 2-3 weeks	Once a month	At least once a year	Never
On average, how often do you eat bone-in chicken thighs?							
How often do you consume *other* bone-in chicken parts (ie. Whole, legs, drumsticks)?							
On average, how often do you eat *home-prepared* bone-in chicken thighs?							
On average, how often do you eat *'ready-to-eat'* bone-in chicken thighs? (e.g. grocery stores Rotisserie chicken)							

5. What method of preparation do you prefer the most when consuming bone-in chicken thighs?

❒ Oven-roasted/baked ❒ Barbequed
❒ Deep-fried ❒ Slow-cooked
❒ Grilled/Pan-fried ❒ Other: _____
(Please specify)

6. What kind of dish do you typically prepare when using bone-in chicken thighs?

_____
_____
_____

7. Based on question 6, why do you choose bone-in chicken thighs to prepare this dish?