Consumer Purchase Preferences for Carnosine Enhanced Pork in Canada –A Functional Food

by

Arenna

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Department of Resource Economics and Environmental Sociology
University of Alberta

Abstract

In this study, we examine Canadian consumers' purchase preferences for a particular kind of functional pork – enhanced carnosine pork. Carnosine is a naturally occurring dipeptide that exhibits anti-aging properties (McFarland and Holliday, 1994). Carnosine is a relatively unknown nutrient and so we are interested in understanding the relative merits of informing consumers of enhanced carnosine levels through a carnosine health claim, a carnosine nutrient content claim or including carnosine in the nutrition facts table. As a basis of comparison we include two other possible labels, a protein nutrient content claim, and a Verified Canadian Pork (a label created by industry identifying food safety, animal care, traceability and farm to table quality assurance attributes of the production system) label.

A survey including a choice experiment was used to collect data, from which conditional logit, random parameters mixed logit, and latent class models were estimated for the probability of consuming pork with different label (and actual) attributes. Results suggested that heterogeneity exists among consumers, mostly related to different attitudes more than socio demographic characteristics. Potentially, due to the unfamiliar nutrient (carnosine), consumers discounted the value of pork labeled with the carnosine health claim or the carnosine nutrient content claim. As compared to carnosine (as a functional attribute), consumers preferred the identification of protein content. In terms of labeling carnosine, consumers had higher willingness to pay for carnosine content included in a nutrition facts table than for nutrient or health claims for carnosine. This is potentially due to lack of understanding of who verifies the health or nutrient content claims. Higher level of nutrition knowledge was associated with higher willingness to pay for different pork attributes.

Preface

This thesis is an original work by Arenna. No part of this thesis has been previously published. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Boards, Project Name “Public Attitudes towards the Use of Genomic Selection in the Canadian Hog Industry”, No. Pro00031056 (Renew No. Pro00060060), April 24, 2012.

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Chapter 1: Introduction

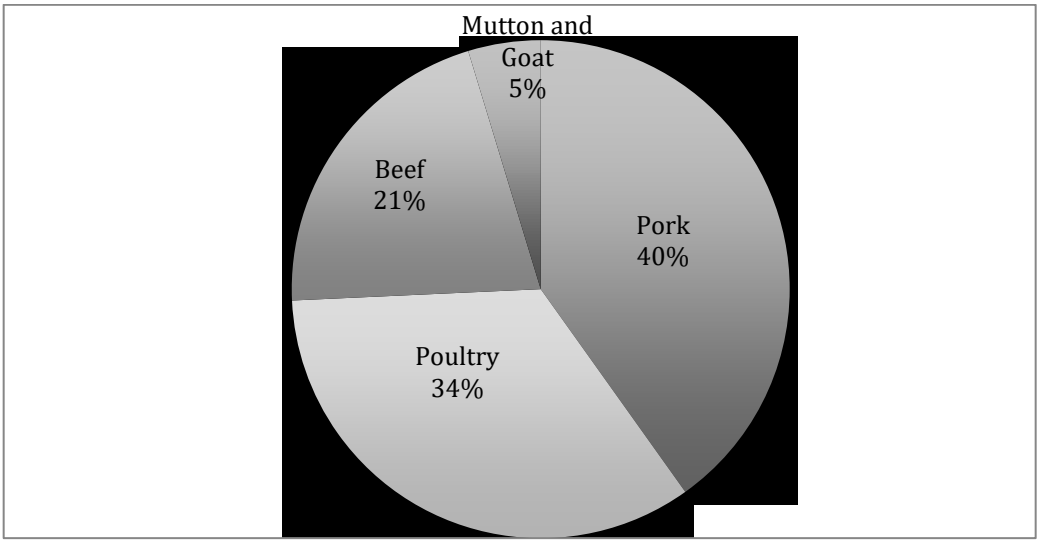
1.1 Introduction

Pork is the most widely eaten meat in the world, accounting for over 40% of world meat consumption in 2015 (OECD, 2015, Figure 1.1). Red meat is an important component of the human diet due to its rich content of protein and micronutrients (McNeill and Van Elswyk, 2012). The advances in understanding the linkage between nutrition and health led to the concept of functional food (Mollet and Rowland, 2002). It may be possible to increase the health attributes of food or specifically pork, in this care, through animal feed or genomic selection. The pork industry could make pork into a more functional food by increasing the level of carnosine in pigs and ultimately in the pork. Carnosine is a naturally occurring dipeptide that exhibits anti-aging properties (McFarland and Holliday, 1994) and other health benefits (Lee et al., 2005. Fonteh et al., 2007). There are no functional foods using pork as a carrier and there are not many anti-aging food products in the market. We know little about consumer preferences for anti-aging functional food products. It will be interesting to know whether or not consumers have any significant interest in anti-aging foods and specifically is it possible for a meat product to be seen as a reasonable vehicle for a functional attribute, in this case an anti-aging characteristic. This is particularly interesting given some negative press about meat consumption and health (IARC, 2015) and other recommendations to reduce meat consumption for environmental reasons (Carlsson-kanyama, 1998). If accepted though, functional foods could decrease public health costs through providing health benefits but only if consumers actually consume sufficient amounts of the functional food to have a health impact.

A big question is whether or not the public understands the benefits of functional foods. Their

preference towards particular functional foods may relate to the way information about the functional nature of the food is disseminated (through labels (health or nutrient content claims or nutrition facts tables) or scientific articles and advertising). It also relates to the vehicle chosen for the functional food. Tobin et al. (2014) found that consumers were very pro-bioactive compounds in yoghurt style products but unsure of their feelings when it comes to functional meat products. Preferences also relate to the characteristics of the people making the food choices – would everyone respond to the availability of particular functional foods in the same way – despite cost or is a higher level of nutrition knowledge or concern about health essential to functional food uptake?

Figure 1.1 World Meat Consumption Share - 2015



Source: USDA Foreign Agricultural Service, UN Food & Agricultural Organization

1.2 Functional Food

The Canadian market for functional foods is robust and growing at a fast pace, which is greater than that of the agriculture and agri-food sector overall. According to Agriculture and Agri-Food Canada (2015), functional foods, such as eggs, milk and meat with omega-3, probiotic yogurt, and pea fiber-fortified breads and pasta, are foods enhanced with bioactive ingredients which have demonstrated health benefits. The concept of functional food was initiated in Japan in the late 1980s and is becoming increasingly popular across the globe nowadays (Stanton et al., 2001). Functional foods are similar in appearance to conventional foods and are usually consumed as part of a usual diet. Functional foods are developed mainly through three following means: fortification with vitamins and/or minerals; an addition of bioactive ingredients; and enhancement with bioactive components through livestock feeding, genomic selection, genetic modification, and/or plant breeding techniques.

1.3 Technologies related to this study

In this study, pork is used as a vehicle for a functional attribute through genomic selection and/or feed. Genomics selection refers to the process of using genome-wide genetic markers to predict the breeding value of selection candidates (Meuwissen et al., 2001). The advantage of genomic selection over traditional selection is that animals can be selected accurately based on their genomic predictions in their early life, and for traits that are expensive or difficult to measure (Meuwissen et al., 2001). For example, traditionally, dairy bulls were selected using progeny testing, because the genetic merit for milk production of a bull can only be accurately assessed through the milk production of his daughters (Hayes et al., 2013), but they can now be used much earlier based on genomic information.

Another modification technique, to increase functionality of a meat, is to control the dietary

supplements in the livestock feed. For example, laying hens could be fed a diet enriched with dietary omega-6 and omega-3 fatty acids for the production of nutritionally enhanced shell eggs with high levels of essential fatty acids (omega-3 and omega-6) (Pilgrim et al., 2000). Feeding grass or concentrates containing linseed (rich in omega-3 fatty acid) in the diet increases the content of omega-3 in beef (Scollan et al., 2006).

1.4 Red Meat and Health

The topic of red meat and its health effects often makes the headlines. Red meat refers to all types of mammalian muscle meat, such as pork, beef, and lamb. (IARC, 2015). Red meat is considered to be a highly nutritious food. It plays an essential role in building a healthy and balanced diet due to its rich content of protein and micronutrients (McNeill and Van Elswyk, 2012). One of the common byproducts of red meat is processed meat, which refers to meat that is not sold fresh but has been transformed through salting, curing, fermentation, smoking or other processes to improve preservation or enhance flavour. Examples of processed meat are bacon, sausages, and ham (IARC, 2015; Cancer Research UK, 2015). However, red meat and its processed products are also considered to be both a health and an environmental risk (IARC, 2015). The public may be confused about whether or not to eat meat as the conflicting information becomes more prevalent and they (the public) have an increasing interest in nutrition and the relationships between diet and health.

1.4.1 Potential health risk of consuming red meat

The International Agency for Research on Cancer (IARC) is the cancer agency of the World Health Organization and has gathered a working group of 22 experts from 10 countries to evaluate the carcinogenicity of red meat by a review of more than 800 related studies. According

to the limited existing evidence, both red meat and processed meat have been classified as probably carcinogenic to humans by IARC. According to the Global Burden of Disease Project, diets high in red meat are responsible for 50,000 cancer deaths per year worldwide (IARC, 2015).

More specifically, the risk of colorectal cancer (also known as bowel cancer) has been found to have the strongest association with consuming red meat. The risk of colorectal cancer is increased by 18% for an individual who eats a 50-gram portion of processed meat daily (IARC, 2015). Associations were also observed for pancreatic cancer, prostate cancer and cardiovascular disease (Harvard School of Public Health, 2017). Consumption of processed meat can lead to colorectal cancer (IARC, 2015).

Possible reasons why consuming red meat increases cancer risk include dietary heme iron and cancer-causing chemicals that are created while the red meat is cooked at high temperatures, digested or processed (Cancer Research UK, 2015).

However, a growing body of research has concluded there may be no association between consuming red meat and any cause of death, include cardiovascular disease and cancer (Kappeler, Eichholzer, & Rohrmann, 2013). The large meta-analysis has also reached consistent results that, intake of processed meat, but not red meat, is associated with higher risk of coronary heart disease (CHD) (Micha et al., 2010). It has been drawn to the researchers' attention that it is important to distinguish between processed meat and red meat when evaluating the health risks (Binnie et al., 2014).

1.4.2 Health benefits of consuming red meat

In Canada, according to Canada's Food Guide, 2 (female) to 3 (male) servings[1] per day of meat and alternatives are recommended (Health Canada, 2011).

Red meat is a rich source of many vitamins and minerals in the human diet that is essential for good health (McAfee et al., 2010). It is a primary source of protein, providing about 25-31g of protein/100g of lean pork consumed (Canadian Pork Council, 2013), 23.2 g/100g of beef consumed (Williams, 2007), and 21.9g/100g of lamb consumed (Williams, 2007). Protein intakes have been found to be highest in meat-eaters and lowest in vegans (Davey et al., 2003). Red meat is recognised as a significant source of heme iron (Statistics Canada, 2015). Iron plays many roles in human health; it helps produce red blood cells and transports oxygen throughout the body (Government of Canada, 2012). 100 grams of lean pork contains 10% of the Canadian recommended daily iron intake (Health Canada, 2006; Canadian Pork Council, 2013). Davey et al. (2003) found that vegans had the lowest intake of vitamins B12 and zinc, which are both high in red meat. Vitamin B12 is essential for red blood cell production and useful nervous system function (Higgins et al., 2010). 100 grams of lean pork provides 23% to 54% (depends on the type of pork cut) of the Canadian recommended daily zinc intake (Health Canada, 2005; Canadian Pork Council, 2013).

1.5 Factors influencing consumer preferences

According to Sims (1998), the individual factors that affect food choices are attitudes, values, and knowledge. In this study, nutrition knowledge and health consciousness are focused on as individual factors to assess consumer preferences for carnosine enhanced pork. The fact that these two indicators may be important is derived from literature such as Xue et al. (2010) and

[1] Per serving meat is 75g or 2.5 oz (Health Canada, 2011).

Herath et al. (2008).

1.5.1 Nutrition knowledge

Studies have shown that consumers with higher nutrition knowledge are more likely to adopt healthy dietary habits and meet dietary recommendations on fat, fibre, fruit and vegetable intakes (Wardle et al., 1993; Harnack et al., 1997). Studies aimed at investigating the relationship between nutrition knowledge and food consumption behaviour found a statistically significant influence of nutrition knowledge on explaining variations in dietary behaviour and suggested using nutrition knowledge as a target for health education and healthy eating promotion (Wardle et al., 2000).

When considering how healthy a food product is, the nutrition information shown on labels may play an essential role in providing nutrition knowledge. However, does "knowledge-is-power (Francis Bacon)" hold in the situation of making food purchase decisions?

1.5.2 Health consciousness

"Health consciousness refers to an individual's comprehensive mental orientation toward his or her health, being comprised of self-health awareness, personal responsibility, and health motivation, as opposed to being related to a specific issue (Hong, 2009. p.8)". In other words, health conscious individuals are more likely to have a higher awareness of their health condition, take responsibility for managing their health, and are motivated to engage in healthier behaviours.

Moreover, studies have shown that health consciousness has high power in indicating health-related behaviour. Health consciousness was found to have a positive influence on one's

food consumption behaviour and lifestyle characteristics, which include higher fruit, vegetable and vitamin intake, calorie reduction, and regular exercise (Gould, 1990; Iversen and Kraft, 2006).

1.6 Problem statement

It is possible to make red meat such as pork a more functional food through genomic selection or animal feed. In this study, carnosine enhanced pork is the product that will be the focus. Functional foods could decrease public health costs through reducing certain chronic diseases but only if consumers consume sufficient amounts of the functional food to have a health impact and the people that need it the most are the ones who consume the product. There is a question as to whether or not consumers would be interested in buying carnosine enhanced pork (or pork identified as an excellent source of protein as a comparator), given the possibility of negative press about meat consumption, potential unfamiliarity with this nutrient and with the processes used to enhance pork.

Functional foods, on the one hand, challenge the consumers' nutrition knowledge and their familiarity with specific nutrients and health attitudes; and on the other hand, provide challenges for the regulatory systems as to what health benefits can be claimed and the way information about the functional nature of the food is disseminated (i.e. food labels).

Understanding how consumers make a decision about a new product is of importance to the process of developing a functional product and to the potential social impact of the product. Understanding consumer preferences allows producers to make better decisions on whether to alter the way of breeding or feeding, allows food companies and government to more efficiently allocate research investments and public funding, and allows the government to design and implement better regulations on functional foods regarding labelling and advertising. Given the

significant costs associated with approval processes for including another nutrient in the nutrition facts table versus a nutrient claim versus a health claim, it would be useful to know what the potential response toe ach sort of information might be.

In this study, three different food labels (requiring permission of Health Canada) are assessed for impact: health claim, nutrient content claim, and nutrition facts table.

Health claims and nutrient content claims are two types of nutrition claims allowed by regulation. In Canada, the development of policies, regulation, and standards that are associated with the use of nutrition claims on a food product is governed by the Food Directorate of Health Canada. The use of nutrition claims on a food product is regulated by the Food and Drugs Regulations (FDR), that aims to help consumers to make informed decisions on food (Canadian Food Inspection Agency, 2014, 2016). A nutrition facts table is aimed to help consumers make informed food choices when grocery shopping and preparing food at home (Government of Canada, 2015). In addition to nutrition-focused labels, the industry can also try to influence food purchases through the use of labels they create, verify and try and persuade retailers to use for fresh meat products.

1.7 Objective

The ultimate aim of this study is to understand the potential purchase behaviour of Canadian consumers for carnosine enhanced pork. The objectives of this study are:

1) to examine the socio-demographic characteristics of Canadian consumers and the impact on their purchase preferences for carnosine enhanced pork with carnosine identified in different food labels.
2) to investigate the role of nutrition knowledge and health consciousness as they affect the consumers' willingness to pay for carnosine enhanced pork with carnosine identified in

different food labels.

When investigating whether higher levels of nutrition knowledge could affect consumers' WTP for pork attributes, potential endogeneity should be considered.

A survey containing a stated preference experiment was conducted in 2015 with 992 Canadian respondents to reveal consumer preferences for pork chops with various food label attributes. The label attributes included are a carnosine health claim, a carnosine nutrient content claim, carnosine included in the nutrition facts table (NFT), a protein nutrient content claim, and the Verified Canadian Pork label. The inclusion of carnosine and the other labels will allow the identification of how important the carnosine attribute is in the presence of other pork characteristics such as protein.

To address the first objective, econometric models will be estimated to analyze the economic experiment data, and the willingness to pay (WTP) will be calculated for different label attributes based on regression results obtained from the econometric models. Individual WTPs will be clustered into groups based on the individual levels of nutrition knowledge (sum of the nutrition knowledge scale) and health consciousness (obtained from factor analysis) to address the second objective.

1.8 Outline of thesis

In Chapter 2, a literature review on many topics including anti-aging properties, carnosine, functional foods, consumer label use behaviour, consumer food consumption behaviour and methods of collecting data is provided. In Chapter 3, a conceptual framework, dataset and the econometric models that will be used to address the objectives, and descriptive statistics, are described. In Chapter 4, the results and discussions are presented. Chapter 5 summarises the conclusions and limitations of the whole research and provides recommendations for future

studies.

Chapter 2: Literature Review

2.1 Introduction

This study is an attempt to understand consumer purchase preferences for carnosine enhanced pork in Canada. The particular focus is on the influence of socio-demographic factors, nutrition knowledge and health consciousness on consumer preferences for carnosine enhanced pork with different types of labels.

To better understand the related theories, this chapter reviews the literature on anti-aging properties and products, carnosine, consumer label use behaviour, food consumption behaviour and methods of collecting data ex-ante. The literature review provides the basis for specifying empirical approaches in this study to identify the potential consumer response to carnosine enhanced pork labelled in a number of different ways.

2.2 Anti-aging property and anti-aging product

Aging is a natural biological process that retards the function of organ systems, such as oral, dental, vision, hearing, olfactory and cardiovascular systems, and reduces the life span (Cefalu, 2011). Various possible environmental and endogenous factors which impact the survival ability of an organism have been used to explain the causes of aging, and they are: genetic changes (e.g. DNA damage), altered gene expression, increased oxidative stress, compromised energy provision, and accumulation of altered proteins (Hipkiss, 2009).

In 2010, 14% of the Canadian population was 65 or older. This number grew to 16% in 2015 – nearly one in six Canadian (Statistics Canada, 2015). With the aging of the baby boomer, the proportion is estimated to reach 25% approximately in 2036 (Statistics Canada, 2015). The aging Canadian population will impose significant impacts on the Canadian health care system,

economy and society over the next 25 to 30 years (CMA, 2013). Although age does not necessarily mean ill health or disability, it is expected that an older population will have greater needs for health services. According to a report from CMA (2013), almost 44% of provincial and territorial health care budgets were consumed by Canadians who are currently over 65. The aging demographic will be a challenge for Canada's health care system capacity.

2.2.1 Growing anti-aging market

The growing aging population also drives the growth of the anti-aging product market. A report conducted by Transparency Market Research (2014) forecast that the global anti-aging market value is expected to surge from US$122.3 billion in 2013 to US$191.7 billion in 2019 with a 7.8 percent annual growth rate.

Our interest lies in the anti-aging food products. Nonetheless, there is very limited information on the commercial potential for anti-aging food products in the market; as of 2016 there were no previous studies about hypothetical or actual purchase behaviour for anti-aging food products available. This is one aspect that we will investigate in the current study.

However, just as for many other things, anti-aging products are not perfect solutions to prolonging youthful appearance or health. A report from the United States General Accounting Office (GAO, 2001) warned the unwary consumers that, with little or no supporting scientific evidence for safety or efficacy, some anti-aging products might pose potential health risks and economic harm to senior citizens, especially the seniors who have underlying diseases or health conditions. Furthermore, free market regulation does not help to weed out the risk, harm, ineffectiveness, and fraudulence of some anti-aging products (Mehlman et al., 2004).

One possible approach to better protect consumers and promote the well-being of older

people is to have government interventions on product safety and efficacy, labelling, and advertisement (Mehlman et al., 2004).

2.2.2 Consumer characteristics and anti-aging properties

To better serve the objective of understanding the consumers' purchase behaviour for an anti-aging food product, it is important to know what type of consumers are more interested in anti-aging products. Anti-aging properties are usually associated with appearance and the use of cosmetics. Under the Food and Drugs Act, a cosmetic includes "any substance or mixture of substances, manufactured, sold or represented for use in cleansing, improving or altering the complexion, skin, hair or teeth and includes deodorants and perfumes" (Government of Canada, 2017). All cosmetics sold in Canada must meet the requirement of the Food and Drugs Act and the Cosmetic Regulations (Government of Canada, 2017). In developing new food products with health benefits that are age-related (such as reduced chronic disease), the regulations that apply will depend on the specific ingredients and methods used (Agriculture and Agri-Food Canada, 2015). Health Canada may require pre-market submissions justifying the health benefits or safety of an ingredient or technology before a product can be approved for sale in the market (Agriculture and Agri-Food Canada, 2015). Canadian Food Inspection Agency (CFIA) maintains a list of permitted nutrient function claims to facilitate the communication of health benefits of foods (Agriculture and Agri-Food Canada, 2015). One thing we need to know is that carnosine, as a nutrient, hasn't been approved to appear on food labels yet.

Previous research has shown the characteristics of consumers who are more interested in anti-aging facial treatments and the factors that determine women's purchase of anti-aging products. Muise and Dermarais (2010) explored the factors that determine Canadian women's

likelihood of purchasing anti-aging (skin or hair care) products using on-line surveys. Muise and Dermarais (2010) surveyed 304 Canadian women, who were recruited both from on-line and the Anti-Aging Show in Toronto. They found that age, income, aging anxiety, and the importance of appearance all had positive correlations with the probability of purchasing anti-aging products.

A report from Transparency Market Research (2014) segmented the anti-aging market by age demographics and geographies. They concluded that baby boomers, individuals who were born between 1946 and 1965 (Statistic Canada, 2015), are the major target consumers of anti-aging products as they are getting older and have high disposable incomes. Geographically, North America is the leading market for anti-aging products as a result of high awareness about aging and lifestyle (Transparency Market Research, 2014).

If the level of anxiety due to aging and the level of valuing the importance of appearance and health have such a deterministic effect on the likelihood of purchasing anti-aging products, there is the potential that the level of valuing the importance of health and the care of own health conditions, which can be revealed by one's nutrition knowledge and one's health consciousness, may be related to the purchase of anti-aging food products. This is one hypothesis that we will examine in the current research.

2.2.3 Summary

The anti-aging market is growing, and government interventions in the anti-aging market are in great need to better protect consumers and promote the well-being of the senior population. Anti-aging is often used exclusively for attributes related to appearance, rather than for attributes related to enhanced health (reduced chronic disease, for example). This may be an additional hurdle to be overcome for a functional food which could reduce age related disease. Previous

literature summarised the factors that contribute to the likelihood of purchasing anti-aging products are age (baby boomer), income, the level of aging anxiety, and the importance of the level of appearance and health. There is no literature to date on the perspective of reduced disease as an anti-aging attribute.

2.3 Carnosine

Carnosine, first discovered in 1900 by the Russian chemist V.S. Gulewitch (1900), is a naturally occurring dipeptide and is composed of two amino acids b-alanine and L-histidine (Budzen and Pymaszewska, 2013). Carnosine is found in skeletal muscle tissue, stomach, kidney, olfactory bulb, cardiac muscle and brain in human and some other vertebrates (Budzen and Pymaszewska, 2013; Hipkiss et al., 1998).

Carnosine concentration varies among individuals, depends on fibre type, sex, age and other factors. Carnosine content declines with age (Derave et al., 2008). Other factors, such as physical exercise and diet, also have an impact on carnosine concentration (Boldyrev et al., 2013).

2.3.1 Source of carnosine

Due to the significant variation in carnosine concentration between animal species, the dietary ingredient derived from different animals plays an essential role in determining daily carnosine intake (Harris et al., 2012). As can be seen from Table 2.1, pork contains the highest carnosine concentration followed by beef.

Table 2.1: Concentration of Carnosine in Different Anatomical Localizations of Animal Species (mg/100g wet weight tissue)

Animal species	Tissue origin	Mean	SD
Pork	Loin	313	35.7
	Ham	449.5	59.2
	Neck	186.4	15.1
	Blend	230.1	3.5
Beef	Top Loin	372.5	32.2
	Neck	253.4	28
	Blend	201.9	30.8
Lamb	Shoulder	39.3	5.2
	Neck	94.2	10
	Blend	95.3	15.6
Chicken	Pectoral	180	10.9
	Leg	63	5.8
	Blend	109.8	10.2
Turkey	Wing	66.2	4
Salmon		0.53	0.06
Trout		1.6	0.15
Sardine		0.1	0.02
Blue whiting		0.42	0.04
Common sole		0.09	0

Source: Aristoy and Toldra, 2004.

2.3.2 Properties of carnosine

A constant stream of studies now indicates that carnosine has shown an anti-aging effect (disease reduction and appearance) and other health benefits on both humans and animals.

A study done by McFarland and Holliday (1999), one of the earliest observations, thoroughly investigated the anti-aging properties of carnosine. They found that the carnosine-treated senescent cells looked far younger than untreated senescent cells (McFarland and Holliday, 1999). They also concluded that, under a sufficient dosage of carnosine, the cells had an extended lifespan, both in population doublings and chronological time (McFarland and

Holliday, 1999).

Carnosine was observed to have pronounced anti-aging effects on senescence accelerated mice (SAM). Boldyrev et al. (1999) found that there was a 20% increase in mean life span for carnosine-treated mice as compared to control mice. They also concluded that carnosine improved the quality of life by diminishing senescence-accelerated activities (Boldyrev et al. 1999).

Carnosine has also been found to reveal beneficial outcomes in preventing and treating a number of diseases, such as diabetes and its complications (Lee et al, 2005), cancer, and neurological disorders (such as Alzheimer's disease (Fonteh et al., 2007) and Parkinson's disease (Boldyrev et al., 2008)). Carnosine also helps wound healing (Fitzpatrick, 1982) and improves physical performance (Derave et al., 2010).

2.3.3 Carnosine pork and conventional pork

What is the difference between carnosine enhanced pork and conventional pork? Ma et al. (2010) examined the effect of dietary carnosine supplements on 96 finishing pigs. Their results indicated that dietary carnosine supplements do not impact the growth performance and carcass traits of pigs, but improve antioxidant capacity in tissues and (the key features of) meat quality. Specifically, a sufficient amount of a carnosine (100 mg per kg of feed) diet supplement increases pH value (an important modulator of cardiac function (Vaughan-Jones et al., 2006)) of pig muscle and redness of meat, and decreases drip loss. They suggested that since carnosine is safe and efficient in enhancing meat quality, it could potentially be used as a feed additive for finishing pigs.

As mentioned previously, there are three major methods for the development of functional

foods. To enhance the level of carnosine in pork, which is already high (Aristoy and Toldra, 2004), enhancement with bioactive components through special livestock feeding techniques or genomic selection can be applied (Agriculture and Agri-Food Canada, 2015).

Carnosine is high in pork, and it exhibits anti-aging properties and other various health benefits to human beings and animals. Carnosine enhanced pork, as a functional food, may also have improved antioxidant capacity and meat quality.

2.4 Functional foods

Recall from chapter 1 that functional foods are defined as foods enhanced with bioactive ingredients and are demonstrated to have physiological benefits and/or to reduce the risk of chronic disease beyond basic nutritional functions (Agriculture and Agri-Food Canada, 2015).

As we are interested in knowing the consumer purchase preferences for carnosine enhanced pork, it is important to understand consumer acceptance of functional foods in general and the characteristics of consumers who are more interested in purchasing functional foods.

Verbeke (2005) used consumer data collected through a survey with a consumer sample of 215 Belgian respondents in 2001 and explored the determinants of functional food acceptance. Functional food acceptance is defined as giving a score of a minimum of 3 on a 5-point scale, simultaneously for acceptance if "Functional foods are all right for me as long as they taste good (Verbeke, 2005. P49)", and if "Functional foods are all right for me even if they taste worse than their conventional counterpart foods (Verbeke, 2005. p49)". 46.5% of the respondents claimed to accept functional foods (Verbeke, 2005). Results also showed that females, elderly and respondents who had an ill family member had a higher probability of accepting functional foods. Knowledge and belief in the health benefits of functional foods outweighed the impact of socio-demographic characteristics as determinants of functional food acceptance. The likelihood

of functional food acceptance increased with a belief in the health benefits but decreased with a higher level of knowledge on food and health.

Herath et al. (2008) identified Canadian consumer segments related to functional food consumption behaviour. Consumers who were more interested in functional foods tended to be older, have attained less education and reside in lower income households in rural areas. In contrast, consumers who were less receptive to functional foods were younger, had received a higher level of education and reside in higher income households in urban areas.

Ares and Gámbaro (2007) used data collected through a survey of 200 randomly recruited consumers in Uruguay. Conjoint analysis was conducted in their survey. 20 different functional foods were defined consisting of different carriers (honey, yoghurt, vegetable cream and delce de leche (a type of sweeten condensed milk)) and different enrichments (fibre, calcium, antioxidant extracts, and iron) in a full factorial experimental design. Ares and Gámbaro (2007) concluded that differences in consumer preferences for functional food concepts were found with gender and age. However, attitudes towards functional food concepts largely depended on the carrier and type of enrichment. Women had a more positive attitude towards functional foods with yoghurt and marmalade as carriers than men. Besides, men showed a more positive attitude towards functional foods with honey and cream soup as carrier products than women. Women showed a more positive attitude towards products enriched with fibre and iron, which might be attributed to a higher perceived need for these nutrients. Sugary functional foods might be targeted to young people. Older people (people with more than 45 years) showed less interest in concepts enriched with iron. Their results suggested the importance of segmentation of the particular groups of potential consumers when designing functional foods.

Bech-Larsen and Scholderer (2007) summarised that consumers prefer functional

ingredients that are enriched with compounds that are well-known for their health benefits (such as calcium, vitamin C) than functional ingredients which are unfamiliar to the general public or which appeal only to consumers with advanced nutrition knowledge. This finding will be tested in this study since consumer preference for pork chops that enriched with both carnosine - a nutrient that consumers are not familiar with, and protein, which consumers are familiar with, were assessed.

Bech-Larsen et al. (2001) also concluded that consumers were more positive towards enrichments with well-known nutritional effects and that used health claims. Regarding using a meat product as a carrier for functional attribute, there is literature examining consumer preferences for the concept of functional processed meat. By conducting seven focus groups, Shan et al. (2016) investigated consumer attitudes towards functional processed meat, and found that participants were uncomfortable with the idea of using processed meat as a carrier for functional foods; however, many of participants expressed an openness to purchase this food product if taste and price remained uncompromised. Whether pork can be a successful functional food carrier has not been assessed yet. This study is an attempt to fill this gap.

Barreiro-Hurlé et al. (2008) suggested there is a market potential for functional wines and that consumers are willing to pay 5.89 € per bottle for this functional attribute. They also concluded that consumers who trust the technological development in agribusiness and those who showed more concerns for the relationship between diet and health tend to choose functional wines more often (Barreiro-Hurlé et al., 2008).

Xue et al. (2010) examined how consumers' nutrition knowledge influenced their willingness to pay (WTP) for grass-fed beef (market good). Grass-fed beef is tenderer, has a lower fat thickness, and more vitamin E and Omega-3 fatty acids, as compared to conventional

beef (Xue et al., 2010). Non-hypothetical in-store experiments were conducted in supermarkets in three cities. Xue et al. (2010) found that consumers' WTP for grass-fed was positively affected by their knowledge of nutrient functions. However, consumers with more knowledge about the main food sources of the nutrients had lower WTP because they are more aware of substitutes in the market and will not value the nutritional attributes of grass-fed beef as much.

Nutrition knowledge increases the efficiency of information processing from nutrition labels and decreases the cost of using labels, therefore may facilitate label use (Drichoutis et al. 2005). Drichoutis et al. (2005) used data collected from personal interviews with consumers shopping at supermarkets in Athens in 2003, and concluded that nutrition knowledge had a strong positive influence on general nutrition label use.

Herath et al. (2008) summarised that consumers who had a higher interest in functional food tend to be more concerned about their health and indicate greater motivation to learn about foods with potential health benefits and make more use of a credible source of information (i.e. health professional). In contrast, consumers who were less receptive to functional foods tend to be less concerned about health issues. This may because (as mentioned earlier younger consumers tend to fall into this group) they face fewer health problems and have the confidence and knowledge to choose a healthy diet through consuming conventional foods.

Cavaliere et al. (2016) explored the role of health-orientation (this is, healthy attitudes, beliefs, behaviours, willingness to take responsibility for their health) on consumers' use of food labels. They found that highly health-orientated consumers are more likely to use more complex and detailed labelled information, that is NFT, whereas low orientation to health is associated with high interest in using nutrition and health claims. Highly orientated consumers are more health-motivated and more likely to undertake actions to improve their health, whereas low

health orientated are less information seeker (Cavaliere et al., 2016).

To sum up, differences in consumer preferences for functional food concepts have been found with gender, age, education, income, the area of residence, and attitudes towards technology. Consumers' attitudes towards functional food concepts largely depended on the carrier and type of enrichment. They were more positive towards enrichments with well-known nutritional effects and the use of health claims. Nutrition knowledge and health consciousness have been shown to have an impact on consumers' decision making.

2.5 Food labels and consumer label use behaviour

In this study, four commonly seen food labels are being assessed for impact: health claim, nutrient content claim, nutrition facts table, and industrial labels.

2.5.1 Health claim

A statement, such as "a healthy diet low in saturated and trans fat may reduce the risk of heart disease", given by Health Canada (2016), is an example of a health claim. A health claim includes information for a certain food product that is beneficial to human health and is aimed at providing truthful information to help people make informed dietary decisions (Health Canada, 2016).

As Health Canada (2016) states, "a health claim is any representation in labelling or advertising that states, suggests, or implies that a relationship exists between consumption of food or an ingredient in the food and a person's health." Before any health claims are allowed to appear on food, mandatory and voluntary pre-market health claim submissions are reviewed by the Food Directorate to assess whether the health claim being proposed is truthful and not misleading. Hence, scientific evidence is needed to guarantee the truthfulness of the proposed

food health claim. Examples of acceptable disease risk reduction health claims are vegetables and fruit and heart disease and sodium and potassium (Canadian Food Inspection Agency, 2016). Unacceptable disease risk reduction health claims are the ones, which lack sufficient scientific support, such as whole grains and coronary heart disease (Health Canada, 2012). Based on the Guidance Document for Preparing a Submission for Food Health Claims (2009), the acceptability of a health claim depends upon an evaluation of the following factors:

1) Causality - Consumption of the food has a direct health impact on the individual.

2) Generalizability - The claimed health effect is still valid when the sample size is extended to the general population while maintaining its physiological meaning.

3) Quality assurance - The quality of food is assured under quality standards and predefined specifications.

2.5.2 Nutrient content claim

Nutrient content claims characterise the amount of a nutrient in the food, such as “low-fat,” “high in iron” (Government of Canada, 2012).

Consumers can choose foods that contain a nutrient they may want either more or less of based on a nutrient content claim. Products that have nutrient content claims, such as “source of fibre” and “high in vitamin A”, allow consumers to obtain more of a nutrient; while claims, such as “sodium free” and “fat-free”, help consumers avoid a certain nutrient intake (Government of Canada, 2012).

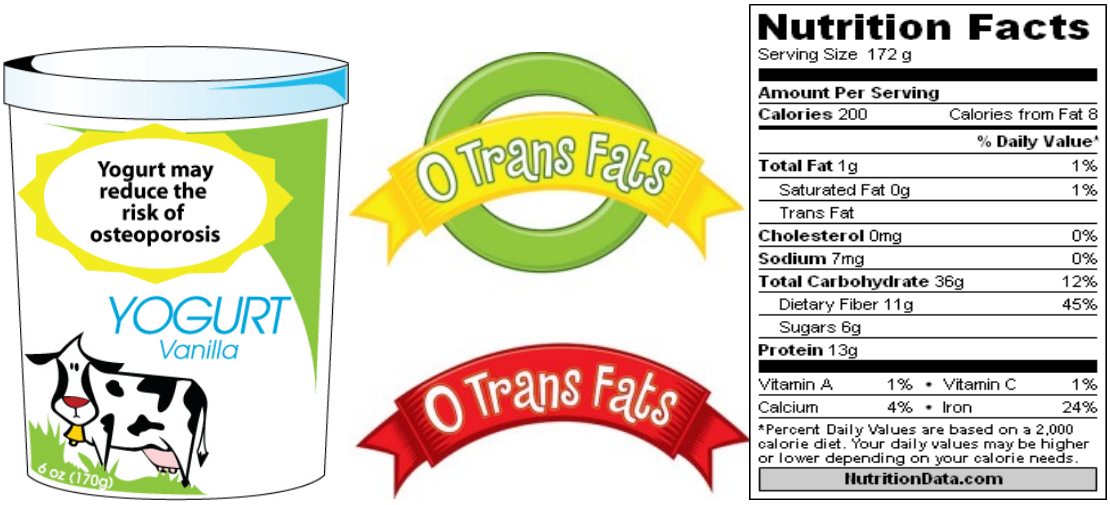
Similar to the process of health claim authorization, there are a few steps involved in getting a nutrient content claim approved. Nutrient content claims must adhere to the General Principles for Labelling and Advertising, and the specific nutrient content claim requirement for the desired

claim category. Other conditions, such as language, wording, size, prominence and location also need to be met to make a nutrient content claim (Canadian Food Inspection Agency, 2015).

One thing necessary to mention is that nutrition claims are voluntary and only highlight one nutrient. Garretson and Burton (2000) found that nutrition claims sometimes might have little impact on consumers' food decision making. Consumers need to refer to the nutrition facts table if they are looking for more detailed and complete nutrition information on food (Government of Canada, 2015).

According to the Canadian Food Inspection Agency (2016), food has a protein rating of 40 (the details about how the protein rating are defined are available in Appendix A) or more can be labelled as an "Excellent source of protein". Pork tenderloin roasted, for example, has a protein rating of 75.6. The high protein rating qualifies pork to be labelled as an excellent source of protein.

Figure 2.1: Health Claim, Nutrient Content Claim, and Nutrition Facts Table



Source: FDA, 2017. Dreamstime, 2017. Nutrition Data, 2014.

2.5.3 Nutrition Facts Table

The nutrition facts table (NFT) is a rich resource of nutrition information for consumers when choosing and comparing among food products. An NFT provides information on serving size, calories, the percent daily value (% DV)[2], and 13 core nutrition[3] (Government of Canada, 2015).

As a part of nutrition labelling, it became mandatory for all prepackaged foods to have a nutrition facts table in 2007 (Health Canada, 2015). It can be used to make informed food choices, track the calories and nutrient of a certain amount of food by comparing to the serving size, and to learn about the nutritional value of food (Government of Canada, 2015). One study suggested that approximately two-third of respondents used NFPs when purchasing food (Ollberding, Wolf, and Contento, 2011).

Almost all pre-packaged foods have an NFT in Canada, but not all foods need to have one. Foods that do not need to have an NFT are fresh vegetables and fruit, raw single ingredient meat and poultry, raw seafood, food prepared in-store. NFT may also be unavailable for foods that do not contain rich nutrients, such as coffee, tea, spices, and vinegar, and foods that are made in restaurants and food service businesses (Government of Canada, 2015). However, meats, in some cases, are required to display an NFT if the product is ground meat, ground poultry, ground meat by-product, or ground poultry meat by-product (Canadian Food Inspection Agency, 2016). In the choice experiment that the data of this research is based on, carnosine (a naturally occurring dipeptide that has anti-aging properties) is included in the nutrition facts table for some pork chops. Government approval would be needed to include a nutrient that has not previously

[2] It shows you whether the serving size has a lot or a little of a nutrient: 15% DV or more is a lot; 5% DV or less is a little (Government of Canada, 2015).

[3] 13 core nutrition includes fat, saturated and trans fats, cholesterol, sodium, carbohydrate, fiber, sugars, protein, vitamin A, vitamin C, calcium, and iron (Government of Canada, 2015).

been addressed by Health Canada.

2.5.4 Industrial Labels

In addition to nutrient or nutrition focused labels, the industry can also try to influence food purchases through the use of labels they create, verify and try and persuade retailers to use for fresh meat products. One example of that is the Verified Canadian Pork (VCP) label which has been developed as a partnership between Canadian farmers, processors and retail operators who are dedicated to offering premium quality Canadian pork under the highest food safety standards in the world. VCP branded programs are managed and implemented by the national pork organisation, Canada Pork. Participation in the VCP program requires a no-charge licensing agreement between Canada Pork[4], the retailer, supplier, and processors (Verified Canadian Pork, 2015). It identifies food safety, animal care, traceability and farm to table quality assurance attributes of the product system (Verified Canadian Pork, 2015).

2.5.5 Consumer use of different food labels

The linkages between health and diet are well documented in that individual dietary choices are important determinants of health (Ippolito and Mathios, 1991). Nutrition labels are used as an important source of providing dietary information and informing consumers as to how to make healthier dietary decisions. According to Derby and Levy (2001), one-third of consumers changed their purchasing behaviours due to the information on nutrition labels.

Blitstein and Evans (2006) conducted a cross-sectional survey of 1139 adults and found that fifty-three percent of respondents reported using NFT consistently when making food purchase

[4] Canada Pork is a national alliance of innovative pork producers and meat processors committed to supporting customers in Canada (Canada Pork International, 2016).

decision. They also found that women are more likely to use NFT than men when shopping, married individuals are more apt to use NFP than those who are not currently married.

Burton and Andrews (1996) collected data from a quarterly mail survey, with a choice experiment included. There were three labels formats that they examined. The first format was a full format, which contained information on "absolute nutrient per serving, percent daily values, a table of absolute daily values, and the number of calories contained in one gramme of fat, carbohydrates, and protein (p69-70)". The second format was a "simplified" format, which eliminated the information on the table of recommended daily values and calories per gramme. The third format included only amounts per serving for a limited set of nutrients. They found that the format of the nutrition label matters, especially for younger consumers, and older consumers found it 's hard to understand (Burton and Andrews, 1996).

Kim et al. (2001) extended their study using the same data (Kim et al. 2000) and discovered the linkage between food label use and diet quality. They found that food labels significantly improve diet quality, which was measured by the Healthy Eating Index. Moreover, they found that the use of health claims, among other nutrition labels; provide the highest level of improvement in diet quality.

Using data from choice experiments conducted in a survey, Berning et al. (2008) found that the majority of consumers prefer to have nutrition information provided on the food labels rather than no information, but have different preferences regarding the format of labels. Consumers who perform most of their household's shopping prefer the detailed nutrition labels, such as NFT, and they also have a high nutrition consciousness score; whereas, consumers who have less nutrition conscious prefer summary nutritional labels, such as a heath claim. Summary nutrition labels require less time to process but also provide less nutrition information.

The U.S.' Nutrition Labeling and Education Act (NLEA) moved the labelling regime from voluntary to mandatory for most food products since 1994 (Mathios, 2000). Mathios (2000) investigated the impact of NLEA on consumer purchase behaviour using pre- and post- NLEA market-level data on salad dressings from a supermarket chain located in New York State. The supermarket chain provides two sources of data: demographic information from membership application forms, and purchase data from the scanner. Results indicated that the sales of high-fat level dressings dropped remarkably after they were labelled. He concluded that mandatory labelling could make a difference in consumer behaviour and contribute to their health.

In Canada, the Food and Drug Regulations were amended to make nutrition facts tables mandatory on processed food labels in December 2002 (Health Canada, 2013). The nutrition labelling became mandatory for most prepackaged foods in December 2005, and December 2007 to allow for smaller businesses to comply with the new regulation (Health Canada, 2013).

2.5.6 Personal socio-demographic characteristics and label use

Bender and Derby (1992) found that consumers who use food labels are more likely to be young, female, better educated, and more knowledgeable about nutrition.

According to Wang et al. (1995), high income and education level consumers may be cautious about nutrient contents of food and thus utilise food labels for nutrition information/ are more likely to use food labels for nutrition information. Food shoppers are more aware of nutrient contents of food by using food labels when they are responsible for the food of more family members, especially children in their households. Nonmetro area residents are more likely to obtain nutrition information from food labels compared with suburb area residents.

Nayga (1996) examined how socio-demographic characteristics of a household's main meal

planner affect the use of food labels. Results implied that main meal planners, who have a larger household, reside in the non-metro area, older, and whose households have higher-income are more likely to use food labels. They also found that main meal planners who obtained college and more education are more likely to use food labels than those who are less than college educated. Males are less likely to use nutrition information on food packages than are females. This may because men are less likely to perceive nutrition as important in food shopping than are women.

Kim et al. (2000) summarised that the probability of using nutrition information on food labels increases with income and decreases with age in calories and sodium intake consumptions.

2.5.7 Summary

The literature showed that the format (health claim, nutrient content claim or NFT) of the food labels matters for consumers because of variations in the ability of people to process information and the cost of obtaining information. Food labels as a source of nutrition information can have a positive influence on food acceptance and have been positively linked with healthy dietary behaviour. Socio-demographic characteristics play a major role in determining consumer nutrition label use.

Based on the literature above, frequently used methods for investigating consumer label use behaviour are surveys combined with stated preference experiments, or revealed preference data. Given that this study focuses on purchase intentions for carnosine enhanced pork, which is not currently available on the market, data was collected using a survey combined with stated preference questions that were designed to address the objectives of this study (discussed in greater detail in section 2.7).

2.6 Methods of collecting data

Inside the market research toolkit, there are desk research, surveys, interviews, focus groups and observation (Hague et al., 2016). Market research plays an essential role when we are trying to understand the markets and consumers.

2.6.1 Surveys

For any market products, market research could cover subjects such as its relation to consumer needs, pricing, advertising support, market definition and segmentation, forecast purchase intentions and so on (Hague et al., 2016). Surveys, as an important tool of quantitative market research, have been used since the early 1990s for advertising purposes, obtaining attitudinal data, tracking customer satisfaction (Hague et al., 2016).

Table 2.2 summarises the different ways to carry out a survey, along with the occasion to use, pros and cons.

Table 2.2: Summary of Different Survey Types

Survey type	When to use	Pros	Cons
Mail / Self-Completion paper questionnaires	-check customer satisfaction among hotel guests -airline passengers -attendees at seminars and events	-Respondents can fill in questionnaires in their own time and can take their time to reflect on questions that need extra thought -can contain graphs and images in the survey	-low response rate (need to offer incentive) -not suitable for all respondents, such as the very young, people with literacy problems, or the very old -the questionnaire must be as near perfect on working, formatting, and layout to get fully understood by respondents -cost on paperwork, printing, envelopes, and franking, administration (to keep up with the timeline)
Face-to-face interview	-household interviews -street/mall interviews	-better and longer explanations are possible -less chance of mishearing or misunderstand -products/samples can be shown -easier to maintain the interest of a respondent for longer -able to judge the accuracy of the response through body language, environment observation -the household interview may make respondents feel safe and secure if the questions are personal or sensitive in any way	-difficult to organise: need interviewer spread around the targeted geographic region -hard to supervise -time-consuming and expensive -home environment can influence the responses, for example, teenagers' response may alter when their parents are present -a street interview cannot take too long and questions have to be short and simple -interviewer bias
Telephone interview	-used for uncomplicated and structured	-allow rapid information gathering over a wide geographical area at a lower cost than personal interviews	-require interviewers with good interpreting and typing skills -require interviewers with great confidence,

	interviews	-capture information directly into computers at the time of the interview -easy to monitor	enthusiasm, and knowledge about the subject to hook and maintain the interests of respondents -not suitable for respondents who cannot be reached via telephone -questions have to be short and simple -hard to show visual images or products -it is easy to say "no" on the phone
Online surveys	-e-mail surveys -collect information from a website -website pop-up questions -mobile surveys	-gather information quickly and cheaply -get high response rate by getting access to a panel which is consist of participants who agree to provide information on a continuous basis -responses are generally well considered and of high quality: no time limit and no interviewer bias -quick and easy to carry out -respondents can complete the survey using their tablets, computers or smartphones	-not suitable for respondents who do not have access to the internet, and not suitable if there are a limited number of respondents -will not provide deep insights -script writers need to program the routeing of the questions and format the questions to make them look attractive -the size of the mobile screen poses difficulties on how easy it is to answer questions

Source: summarized from Hague et al. (2016)

Face-to-face interviews have often been used by interviewers in the early days of market research. As households acquired telephones, telephone interviews quickly replaced face-to-face interview with advantages of lower cost and less time-consuming. Over the last decade, hard-wired phones have been quickly replaced by mobiles. Nowadays, telephone interviews account for a tenth of the interviews conducted by the industry. Today, online surveys have been taken over as the predominant source of quantitative research. Respondents can complete the online survey using mobile phones, computers, and tablet. Online surveys have made a significant improvement in lowering the cost and improving the respondent rate and speed of completion (Hague et al., 2016. P107). It is also associated with some problems, such as it is not suitable for respondents who do not have access to the Internet and the size of the mobile screen poses difficulties on how easy it is to answer questions.

2.6.2 Choice experiment (CE)

Revealed preference analyses only apply to existing market products. To determine consumer preferences for hypothetical products, stated preference experiments are useful when there is no revealed preference data available. Based on the previously reviewed literature, surveys combined with choice experiments have been widely used by researchers to assess the impact on food purchases of nutrition label use (Burton and Andews, 1996; Berning et al., 2008)

Choice experiments (CE) are one of several types of stated preference methods. CE are used

when there are needs to estimate demand or value of new products, policies, and services with new attributes or combinations of attributes. In a CE, respondents are asked to pick their most preferred alternative out of all alternatives (Carson and Groves, 2007).

2.6.2.1 Advantages

CEs have been widely employed in the marketing, transportation, health economics and environmental economics literature over time due to the several advantages CE offer (Adamowicz et al. 1998).

CE can be used to value attributes of goods that are not available in the market (Adamowicz, 1995), and attributes can be customised such that they are realistic for respondents (Adamowicz et al. 1998). CE makes subjects think about the trade-offs and allow researchers to assess preferences or tradeoffs in a behavioural setting. The format presentation of CE makes choices relatively easy for respondents and similar to those that consumers face in markets. Statistically, the use of CE also facilitates the use of smaller sample by increasing the statistical efficiency of the parameters estimated, and thus helps to reduce implementation costs (Holmes and Adamowicz, 2003).

According to Lusk and Schroeder (2004), the frequent use of CEs can also be explained by its flexibility because numerous attributes can be simultaneously valued, its consistency with theory that posits that consumers derive utility from consuming attributes embodied in a good, and its property that the CE questions closely mirror actual consumer purchasing situations.

2.6.2.2 Disadvantages

One important issue when using choice experiments is whether individuals actually would do what they state they would do if it were for real purchases with their own money. It is important to distinguish between private goods, such as choice of mode of transport, and public goods, such as environmental goods (Carlsson, 2011).

First of all, the survey needs to meet certain conditions before it can be used to produce useful information about an agent's preferences, that is the survey questions need to be consequential. There are two criteria for survey questions to be consequential: *"First, the agent answering a preference survey question must view their responses as potentially influencing the agency's actions. Second, the agent needs to care about what the outcomes of those actions might be."(*Carson and Groves, 2007. *p183.)* In this case, the responses to the questions are interpretable and standard economics theory applies (Carson and Groves, 2007).

However, according to Carson and Groves (2007), most survey questions are not incentive-compatible. They argued that the only incentive-compatible format is a binary discrete choice questions with three types of good – (1) "new public good with coercive payment", (2) "choice of which of two new public goods to provide", (3) "change in an existing private or quasi-public good" (Carson and Groves, 2007. P192)

The case of introducing a new private good does not improve the incentive compatibility of the questions. As long as there is any positive probability of wanting the new good at the stated

price, the respondent would say they would purchase the product. The respondent's logic is that such a response will encourage the company/industry to produce the food, with them being able to decide later whether or not to purchase this private good (Carson and Groves, 2007).

There is literature testing the validity of choice experiments and proving the existence of hypothetical bias. Lusk and Schroeder (2004) tested for the hypothetical bias in the CE for private goods by comparing hypothetical and non-hypothetical responses to choice experiment questions on beef steaks with different quality attributes. Their estimates suggest that hypothetical responses predicted higher probabilities of purchasing beef steaks than nonhypothetical responses (when payment is actually required). Therefore, hypothetical responses overestimate total willingness-to-pay for beef steaks.

Harrison and Rutstrom (2008) claimed that the evidence strongly favours the conclusion that hypothetical bias exists in a hypothetical context for both private and public goods.

Hypothetical bias is a problem when estimating the total WTP; however, if the main interest is marginal WTP (MWTP), it is less problematic because the scale parameter cancels out when MWTP is calculated (Carson and Groves, 2007). Carlsson and Martinsson (2001) also found no differences between the hypothetical and actual MWTP in choice experiments for environmental projects. A similar conclusion was obtained by Luck and Schroeder (2004) from choice experiments on beef steaks.

Follow-up certainty questions, cheap talk and consequential scripts and time-to-think

protocols are useful strategies to reduce and/or correct hypothetical bias (Carlsson, 2011).

2.6.2.3 Steps in conducting a CE

Characterise the decision problem

The first step in developing a CE is to identify the dimension of the problem. This requires researchers to think the potential changes of the product attributes and other values associated with those changes. It is also essential to identify who will be impacted by the attribute changes (Holmes and Adamowicz, 2003).

Identify and describe the attributes

Once the decision problem is characterised, it is necessary to identify and describe the attributes and determine the levels to be used for each attribute. Focus group can be very helpful to determine how many attributes to include in the experiment, the level each attribute can take, and the appropriate framing of a choice task.

Develop an experimental design

After determining the number and level of attributes, the researcher needs to determine the number of alternatives to include in each choice set, and the number of choice sets to present to each respondent.

Develop the questionnaire

As one of the stated preference methods, CEs involve surveys and various questionnaire formats to collect data, including mail survey, telephone survey, in-person survey, and

internet-based surveys.

The selection of the questionnaire format is often based on the availability of a sample frame and budget limitation. Internet-based surveys are becoming increasingly popular because they are relatively cheap to conduct compare to other survey methods. CEs often include graphics or other visual aids; internet-based survey makes it easier to represent the attributes and levels within the choice matrix.

Collect data

Internet-based surveys also hold the advantage when it comes to data collection. Data can be collected through the design of the survey implementation program of the Internet-based surveys. However, it could be challenging to collect data for mail survey since researchers have to go through the questionnaire manually.

Estimate model

There have been a growing number of econometric models used to analyse choice data, such as random utility model, the multinomial logit model,

Interpret results for decision support

Welfare measures, such as willingness to pay (WTP), are often generated as part of the CEs outcomes; as such CEs provide a richer set of information to researchers than most of other valuation approaches.

2.6.3 Summary

Choice experiments, as one of the several types of stated preference methods, are useful in the absence of revealed preference data. Choice experiments combined with a survey have been widely used in the economic literature in assessing the impact on food purchase of nutrition label use. There are pros and cons for using choice experiments, and including the fact that they require advanced experimental design, development and data analysis techniques. There are other methods of experiments, such as Becker-DeGroot-Marschak methods (Becker et al., 1964) and Vickrey auctions (Vickrey, 1961). In this study, which is part of a sequence of studies on pork, a choice experiment is used because it had not been used previously in related studies.

2.7 Summary

This study is attempting to address objectives around how the levels of nutrition knowledge and health consciousness affect the consumer purchase probabilities for carnosine enhanced pork, with information treatments – a health claim, a nutrient content claim, or including carnosine in the nutrition facts table. Data from a national survey designed for the carnosine enhanced pork, contained a choice experiment and was conducted among Canadian in 2015, used to address both objectives. Survey data was also used to generate other important variables in the econometric model, such as demographic and other attitude characteristics. Econometric model regressions will be used to not only explain the consumer purchase intentions for carnosine enhanced pork

but also to calculate the consumers' WTP for pork attributes.

Chapter 3: Methods, Data Collection, and Descriptive Statistics

3.1 Introduction

In the previous chapter, a literature review on anti-aging, carnosine, label use, consumer food purchase behavior and methods were presented. In this chapter, conceptual framework, data sources, which include descriptive statistics, and stated preference experiment data are described. In order to address the two objectives of this study, which are how do socio-demographic characteristics of Canadian consumers, and how do their levels of nutrition knowledge and health consciousness impact their probability of purchasing carnosine enhanced pork under different information treatments, econometric models are employed.

3.2 Conceptual framework

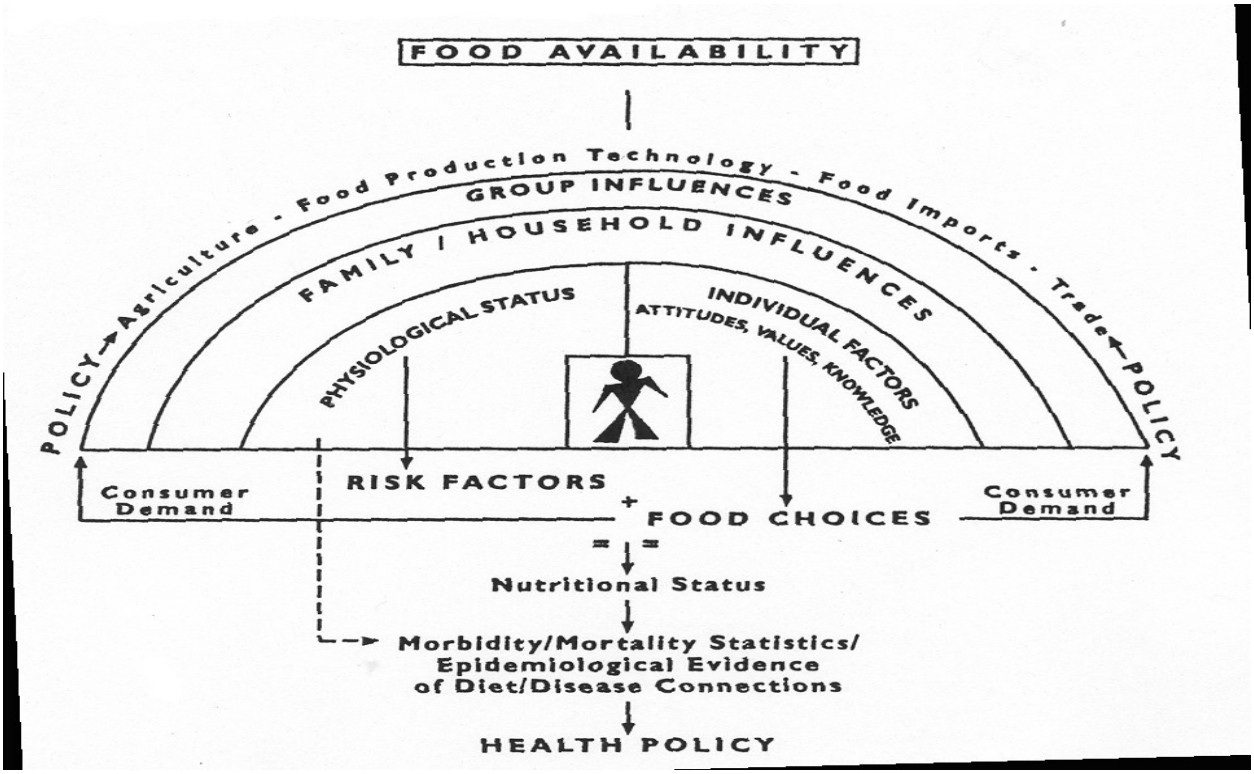
This conceptual framework was adapted from Sims (1998) to demonstrate the factors affecting food choices. The conceptual framework was used to guide the empirical approach and choice of variables to include in the regression models (and in the actual survey from which the data in this thesis are derived). Generally speaking, these factors can be categorized into two sets: factors external to the individuals that apply to groups of people and factors internal (specific) to the individuals.

In Figure 3.1, food, agriculture, and trade policies, which may be influenced by technology, determine food availability. These policies, on the other hand, are also affected by consumer

demand, which is highly affected by food choices of individuals with different internal factors.

Sims (1998) further grouped the factors influencing food choices into group influences, such as a group's cultural identify and family/household influences, and internal/idiosyncratic/individual factors that are both immutable and modifiable. Immutable individual factors are characteristics that are genetically defined, such as age, gender, food allergies, etc. On the other hand, modifiable factors, which are the focus of this study, include one's knowledge of food and nutrition, health concerns, attitudes and beliefs.

Figure 3.1: Conceptual Framework



Reprinted from Sims (1998. p63)

3.3 Data Source

In order to address the two objectives of this study, data was collected in 2015 using an online pork survey (Survey instrument is available in Appendix B), delivered through a national market research company, TNS Canada (http://www.tnscanada.ca/about-us.html now Kantar TNS). The survey was opened to the TNS Canada household consumer panel (22,000) with a provincial distribution relevant for population distribution, with the objective of obtaining 1000 completes. The survey was initiated by 1287 respondents, with 992 completing the survey. The majority of respondents completed the survey on a PC/laptop/netbook. With some extraordinary exceptions, the average time to completion was over half an hour. The survey was designed with several sections to elicit information about consumer food purchase behavior, thus the data set provides rich stated preference data on carnosine enhanced pork along with data on nutrition knowledge, health consciousness measures, food and everyday life, health and taste attitudes (Descriptive statistics are shown in Appendix C), attitudes towards science and technology development (Descriptive statistics are shown in Appendix D), and demographic information.

The data for some variables was recoded for analytical purposes; for example, adjusting gender (male dummy variable), live in city (urban dummy variable), region into provincial dummy variables, rescaling income into thousands and making it into a continuous variable at the mean of the income categories, rescaling education and age into numbers of years and recoding reverse statements in health consciousness scales.

Once the variables were recoded, the data was reordered specifically into formats that are appropriate for TSP and Nlogit 5 respectively (examples of data set-up for TSP and Nlogit 5 can be found in Appendix E and F, respectively). Data from 80 respondents who eat pork and chose the opt-out (none) options for all 8 stated preference questions were excluded from the final modeling (these respondents had, on average, very short completion times – ranging between 9 and 13 minutes and we were concerned that they had not properly examined the stated preference pork chop selections). Economic analyses were thus conducted with the data from 912 respondents. We included respondents who don't eat meat in the regression models just in case the potential for added health could have an impact on their eating consumption behaviour; however, we also ran the models without respondents who don't eat meat to check if regression results would change (Regression results for model without the respondents who don't eat meat and welfare measures are presented in Appendix H –Estimate of conditional logit model with attribute only, I – Estimate of conditional logit model with interactions, and J – Consumers' WTP for pork attributes obtained from conditional logit models).

3.3.1 Descriptive statistics

Table 3.1 presents the descriptive statistics on mean, standard deviation, minimum and maximum for the main variables, and Table 3.2 summarizes and compares demographic statistics with frequencies from survey respondents and related Canadian census information from 2006

and 2011 (general considered unreliable due to lack of representativeness).

The survey sample was 50.4% female and 49.6% male, and was consistent with both 2006 and 2011 census data. The sample consisted of respondents ranging from 18 to 65 plus years old, with an average age of 51. Compared to census data, the respondents of the survey were slightly older. For example, with only 0.7 % of survey respondents aged 18 -20 as compared to 7% and 6% of the census populations in 2006 and 2011, similarly with the age group between21-24 and 25 - 29. However, in the survey, there were more respondents who were in the age group of 30-39 and 50-64 and 65 and older as compared to the census population. There were more respondents who resided in the region of the Maritimes, provinces of Quebec and Manitoba in the survey than that of the census population. In general, respondents had a mean level of education of 14 years, which is equivalent to a college completion. Respondents from the survey represented a higher education level than census populations, 33.2 % of respondents finished high school as compared to 23.9% and 23.2% of census populations in 2006 and 2011; 7.6% of respondents attended post graduate studies as compared to 4% and 5.1% of census populations in 2006 and 2011, respectively. In the survey, respondents had a lower income level than people in the census populations in general. There were more respondents who earned an income ranging from $24,999 or under to $39,999, and fewer respondents whose income was $40,000 and above as compared to the census population from 2006 and 2011.

Table 3.1: Descriptive Statistics

Variable	Definition	Obs	Mean	S.D.	Min	Max
Age	Continuous	992	51	12.6	19	65
Gender	0 - Male	992	0.49	0.5	0	1
	1- Female					
Income	In thousands dollar	992	57.7	28.8	25	120
Children	Number of children in the HH	992	1	0.7	0	5
Education	Years of education	992	14	1.9	8	18
Maritimes	Live in Maritimes	992	0.11	0.31	0	1
QC	Live in Quebec	992	0.28	0.5	0	1
ON	Live in Ontario	992	0.32	0.5	0	1
MB	Live in Manitoba	992	0.04	0.2	0	1
SK	Live in Saskatchewan	992	0.03	1.17	0	1
AB	Live in Albert	992	0.08	0.28	0	1
BC	Live in British Columbia	992	0.11	0.3	0	1
Yukon	Live in Yukon, Northwest Territories, Nunavut	992	0	0	0	0
Lvcity	Live in city dummy	992	0.62	0.5	0	1
Gnfm	Familiarity about genomics	992	1.7	0.8	1	4
Fqby	Frequency of buying meat	992	3.5	0.8	1	5
Nomeat	If the respondent doesn’t eat meat	992	0.05	0.2	0	1

Source: Calculated from survey data of this thesis

Table 3.2: Descriptive Statistics on Frequency and Canadian Census 2006 and 2011 (in %)

		Survey	Census, 2006	Census, 2011
Gender	Male	49.6	48.9	49.1
	Female	50.4	51.1	50.9
Age	18-20	0.7	7	6
	21-24	1.9	7	7
	25-29	3.9	6	7
	30-39	17.9	13	13
	40-49	13.8	16	15
	50-64	39.6	19	21
	65+	22.1	13.7	14.8
Children under 18 living in household	Yes	19		
	No	81		
Province	Maritimes	11.1	8	7.7
	Quebec	28.7	23.9	23.6
	Ontario	32.6	38.5	38.4
	Manitoba	4.4	3.6	3.6
	Saskatchewan	3.0	3.1	3.1
	Alberta	8.9	10.4	10.9
	British Columbia	11.3	13	13.1
	Yukon, Northwest Territories, Nunavut	0	0.3	0.3
Urbanization	Live in city	63	*81*	*81*
	Live in town/countryside	37	*19*	*19*
Education level	Elementary school	0.6	15.4	12.7
	Secondary (high) school	33.2	23.9	23.2
	Technical/ business school/Community college	36.1	37.7	34.1

	University	22.6	22.9	24.9
	Post graduate studies (Masters or PhD)	7.6	4	5.1
Income	$ 24,999 or under	17.8	10	9
	$ 25,000 - $ 39,999	17.8	14	14
	$ 40,000 - $ 64,999	24.2	28	27
	$ 65,000 - $ 79,999	10.7	15	16
	$ 80,000 - $ 99,999	10.3	12	11
	$ 100,000 - $ 119,999	5.3	10	10
	$ 120,000 or more	6.3	12	13

Source: Calculated from survey data of this thesis

3.3.2 Nutrition knowledge

This section is designed to determine the respondents' level of nutrition knowledge about pork. Questions used to measure nutrition knowledge about pork are presented in the Table 3.3. Nutrition knowledge questions were taken from the "Nutrition Value of Canadian Pork" from the Canadian Pork Council website (2013). Five items were included to assess the respondent's nutrition knowledge about pork with a scale ranging from 1 equals strongly disagree to 5 equals strongly agree. Responses were summed to obtain one nutrition knowledge score for each respondent. All statements provided were true and higher nutrition knowledge individuals might then have strongly agreed with each statement.

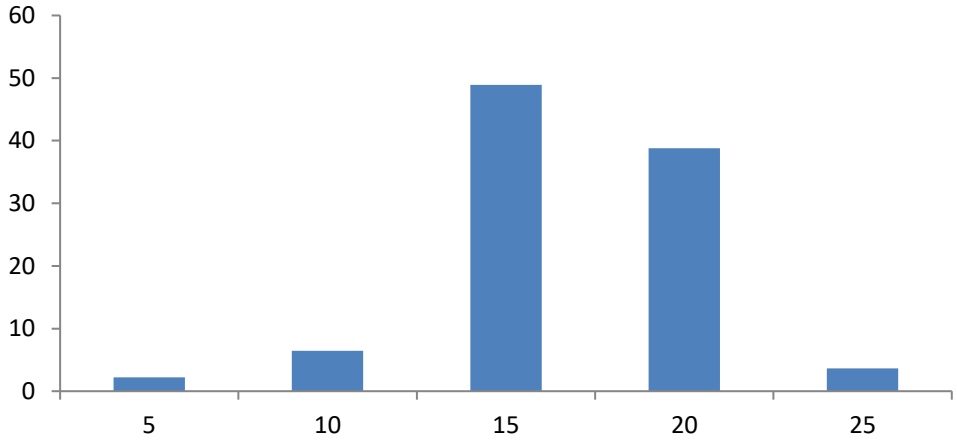
Table 3.3: Description of Questions Used to Assess Nutrition Knowledge

Statements
1. In a 100 gm portion of pork there is only 2 % of your recommended daily value of sodium.
2. In a 100 gm portion of pork, there are 25-29 gm of protein.
3. In a 100 gm portion of pork, there is 6% of your recommended daily intake of iron.
4. In a 100 gm portion of a grilled pork loin centre chop there are approximately 174 calories.
5. In a 100 gm portion of a grilled pork loin centre chop there is only 3.8 gm of fat about 5% of your recommended dairy value of total fat.

Source: Canadian Pork Council (2013)

The nutrition knowledge score was calculated by summing the scales from each of the five individual statements. Figure 3.2 shows the distribution of the nutrition knowledge of the sample population. 49% of the respondents obtained a nutrition knowledge score of 15 (with a maximum possible score of 25). There were more respondents (42.4%) who scored higher than the mean nutrition knowledge, which is 15, as compared to the respondents (8.6%) who scored lower.

Figure 3.2: Distribution of Nutrition Knowledge Score



Source: Obtained from survey data of this thesis

Table 3.4 summarizes the nutrition knowledge of individuals with different demographic characteristics. According to the literature, women, people of higher education, and people of middle age score better (Shepherd and Towler, 1992; Wardle et al, 2000). Contraindicated to most of the above findings, in this survey, males obtained slightly higher nutrition knowledge scores than did females. Individuals who were in the age group of 65 and above had the highest nutrition knowledge scores, followed by the respondents who were in the age group of 30-39. In terms of education, nutrition knowledge score increased with the education level, except for elementary school. Due to the small number of observations, individuals from the elementary school educated group obtained the highest average nutrition knowledge score.

Table 3.4: Nutrition Knowledge Score by Demographic Characteristics

		Obs	Mean	SD	Min	Max
Gender	Male	492	16.01	3.01	5	25
	Female	499	15.53	3.57	5	25
Age	18-20	7	14.43	5.13	5	19
	21-24	19	15.47	2.01	12	20
	25-29	39	15.67	3.06	10	20
	30-39	178	15.84	3.09	5	25
	40-49	137	15.61	3.19	5	23
	50-64	393	15.78	3.55	5	25
	65+	219	15.86	3.23	5	25
Education	Elementary school	6	16.50	2.59	13	20
	Secondary (high) school	329	15.56	3.27	5	25
	Technical/ business school/Community college	358	15.75	3.50	5	25
	University	224	16.07	3.25	5	25
	Post graduate studies (Masters or PhD)	75	15.80	2.87	5	22

Source: Calculated from survey data of this thesis

3.3.3 Health consciousness

Three factors – self-health awareness, personal responsibility and health motivation, with 11 items were used to conceptualize health consciousness (Table 3.5). Health consciousness was measured by applying an 11-item scale developed by Hong (2009). Each item had a scale of 1 (strong disagree) to 5 (strongly agree). Item 8 was reverse coded.

Table 3.5: Description of Questions Used to Assess Health Consciousness

Factor	Item
Self-health awareness	HC1: I'm very self-conscious about my health.
	HC2: I'm generally attentive to my inner feelings about my health.
	HC3: I reflect about my health a lot.
	HC4: I'm concerned about my health all the time.
Personal responsibility	HC5: I notice how I feel physically as I go through the day.
	HC6: I take responsibility for the state of my health.
	HC7: Good health takes active participation on my part.
	HC8: I only worry about my health when I get sick. (R)
Health motivation	HC9: Living life without disease and illness is very important to me.
	HC10: My health depends on how well I take care of myself.
	HC11: Living life in the best possible health is very important to me.

Note: R means the statement is reverse coded.
Source: Hong (2009)

Factor analysis was conducted for health consciousness scale using SPSS to summarize data so that relationship and patterns can be easily interpreted and understood (Yong and Pearce, 2013). Following Hong (2009) who re-conceptualized the health consciousness scale, principal axis factor analysis using Varimax with Kaiser Normalization (Eigenvalues over 1) were conducted for each factor. Table 3.6 presents the factor loadings for the 11 items. Variables with factor loading coefficients below 0.4 were deleted. Factor loadings presented in the brackets in the table 3.6 are the factor loadings obtained by Hong (2009) in their study. Although the factor

loadings are not identical, both factor analyses indicated that statement 1 to 4 heavily loaded to factor 1 – self-health awareness, statement 5 to 8 loaded to factor 2 – personal responsibility, and the remaining statements loaded to factor 3 – health motivation.

The score of Cronbach's Alpha for the three scales was 0.815, 0.595 and 0.772, indicating highly reliable internal consistency of the scales. The results of the Kaiser-Meyer-Olkin measure of sampling adequacy exceeded the recommended acceptance value, which is 0.5 (Kaiser, 1974). The Bartlett Test of Sphericity also indicated that there were patterned relationships amongst the variables. The factor analysis is appropriate for the data considered and factors may be used in further analysis rather than individual item scores.

Table 3.6: Factor Loadings in Analysis of Health Consciousness (n=912)

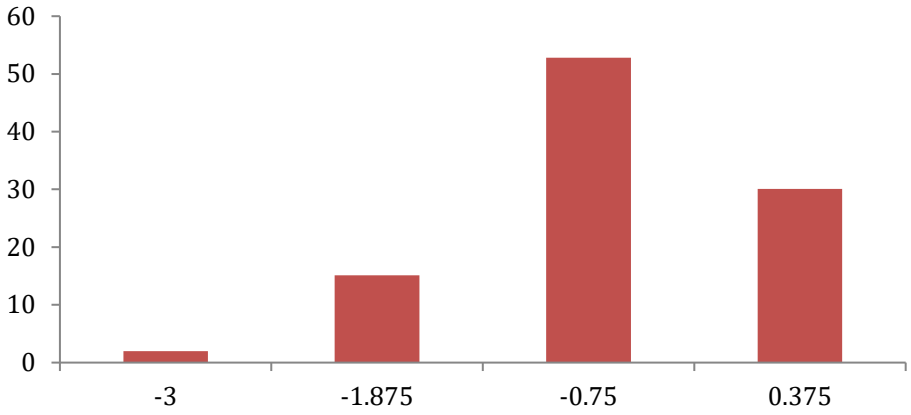
Statement	Factor 1	Factor 2	Factor 3
HC1: I'm very self-conscious about my health.	0.838 (0.816)		
HC2: I'm generally attentive to my inner feelings about my health.	0.539 (0.771)		
HC3: I reflect about my health a lot.	0.793 (0.748)		
HC4: I'm concerned about my health all the time.	0.730 (0.709)		
HC5: I notice how I feel physically as I go through the day.		0.530 (0.888)	
HC6: I take responsibility for the state of my health.		0.750 (0.813)	
HC7: Good health takes active participation on my		0.790	

part.	(0.490)	
HC8: I only worry about my health when I get sick. (R)	0.219 (0.405)	
HC9: Living life without disease and illness is very important to me.		0.742 (0.800)
HC10: My health depends on how well I take care of myself.		0.709 (0.546)
HC11: Living life in the best possible health is very important to me.		0.739 (0.500)

Cronbach's Alpha = 0.815, Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.774;
Bartlett's Test of Sphericity: Chi-squared = 1311.74, df=6, p<0.000
Cronbach's Alpha = 0.595, Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.669;
Bartlett's Test of Sphericity: Chi-squared = 646.629, df=6, p<0.000
Cronbach's Alpha = 0.772, Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.701;
Bartlett's Test of Sphericity: Chi-squared = 725.973, df=3, p<0.000
Source: Obtained from survey data of this thesis; Hong (2009)

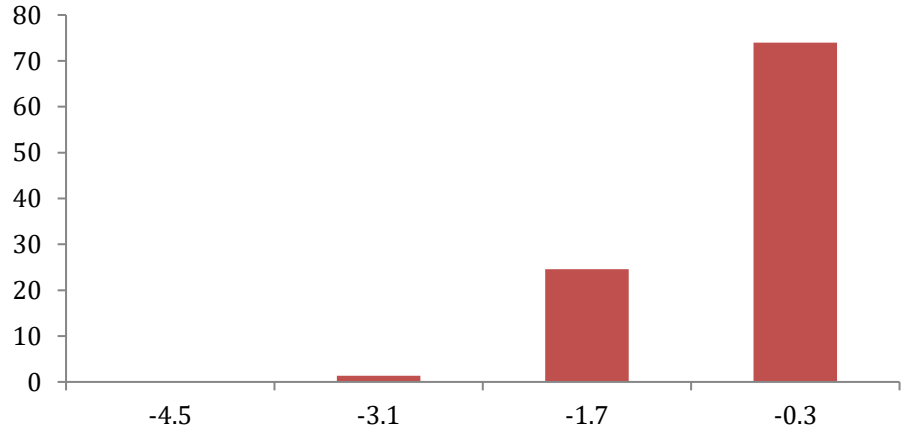
Distributions of self-health awareness, personal responsibility and health motivation scores obtained from factor analysis are presented in Figure 3.3 to 3.5. Based on the factor scores obtained for each individual, 52.8% of respondents had a self-health awareness score within the second-highest score group and 37.5% of respondents had a self-health awareness score within the highest score group. 73.9% and 59.2% of respondents had personal responsibility and health motivation scores within the highest score group.

Figure 3.3: Distributions of Self-Health Awareness Factor Scores Obtained From Factor Analysis



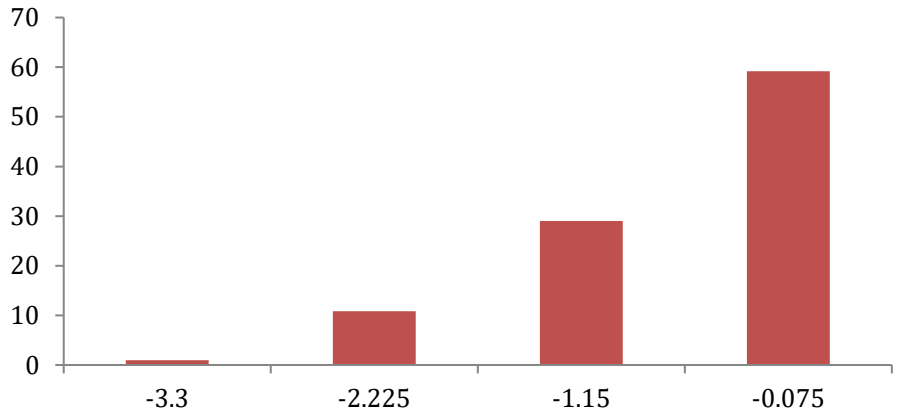
Source: Obtained from survey data of this thesis

Figure 3.4: Distributions of Personal Responsibility Factor Scores Obtained From Factor Analysis



Source: Obtained from survey data of this thesis

Figure 3.5: Distributions of Health Motivation Factor Scores Obtained From Factor Analysis



Source: Obtained from survey data of this thesis

3.4 Stated preference experiment

The data from the stated preference choice experiments was used to determine the consumer preferences for pork with five attributes, which are a carnosine health claim, a carnosine nutrient content claim, carnosine included in the NFT, a protein nutrient content claim, and the Verified Canadian Pork label. Table 3.7 is a table of pork attributes and levels that are used in this study. Three types of carnosine food labels are treated as three attributes in the analysis.

Table 3.7: Table of Pork Attributes and Levels

Attribute	Attribute levels
Carnosine label	Carnosine health claim; carnosine nutrient content claim; carnosine included in the nutrition facts table; no label
Protein label	Protein nutrient content claim, no label
Industry label	Verified Canadian Pork label; no label
Price	$4.01/package (0.405kg); $6.01/package; $8.01/package;

	$10.01/package.

Source: Obtained from the survey design

Figure 3.6 gives an example of one pork chop option that was included in the survey. Before they were given the set of choice experiment questions, the respondents were provided with information about genomics and carnosine.

Information about genomic analysis was provided early in the survey:

"Genomics is the study of the genes and genetic characteristics of organisms like plants, animals, and humans. The study of genomics in hogs can allow for: the identification of specific genes that are linked to disease susceptibility (there are a number of current diseases within the hog industry including PCVAD, PRRS and PED, for example), the identification of specific genes that could be linked to enhanced feed efficiency (also leading to reduced manure) or the identification of genes linked to particular compounds in hogs/pork that could be beneficial for both hog and consumer health (one example is carnosine).

With knowledge of the presence (absence) of any of these genes, selective breeding (selecting particular boars or semen and particular sows that genetics suggest would produce progeny with the desired traits) could produce hogs with significantly lower probabilities of contracting disease, or high probabilities of increasing feed efficiency or higher probabilities of increased levels of human health beneficial components of the meat."

Information about carnosine was also provided (before the second stated preference exercise, which is the main focus of this thesis):

"*Carnosine, a natural molecule (or compound) present in the muscle of animals and humans, has been observed to exert antiaging activity at cellular and whole animal levels (including potentially people who may*

consume sufficient quantities in meat). Carnosine is available in fish and meat products only and has been shown to be in available in high quantities in pork. The therapeutic potential of carnosine has been tested in numerous diseases in which ischemia or oxidative stress are involved. For several pathologies, such as diabetes and its complications, ocular disease, aging, and neurological disorders, promising preclinical and clinical results have been obtained. Carnosine levels in pork can be increased through what hogs are fed or by selectively breeding hogs with higher levels of existing carnosine."

Although the information is not particularly consumer friendly, however, it is provided in this form to ensure scientific accuracy. Respondents were then presented with eight choice sets. The pork chops with five attributes were formed following a fractional factorial experimental design conducted using the software SAS (Statistical Analysis System), resulting in a set of 32 pork chop choices with different attribute combinations, and they were divided into four different versions with 8 choices in each version (The experimental design is presented in Appendix G). Price ranged from $4.49 to $11.22 per kg expressed per package weight in the survey) across the combination of attributes (The average price of this type of pork chop was $4.49 per lb at the time of the survey and each pork chop had the identical weight of 0.405kg). Each respondent was randomly assigned 8 choice sets from one of the four versions. Each choice set contained three alternatives: pork chop 1, pork chop 2, neither of the pork chops.

Figure 3.6: Example of A Pork Chop Choice Set From the Survey

Please select one pork chop or Option C for each one of the following choice sets.

Pork Chop A.

Pork Chop B.

Option C: I would not purchase either of these pork chops
Source: Obtained from the survey used in this thesis

3.5 Model specification

Discrete choice models were used to describe decision makers' choices among alternatives. The decision makers can be individuals, households, firms or any other decision-making unit, and the alternatives represent competing products, courses of action, or any other items or options over which choices must be made (Train, 2003).

Discrete choice models are usually derived under the assumption of decision makers' utility-maximizing behavior. Models that are derived in this way are called random utility models (RUM) (Train, 2003).

A decision maker n faces a choice among J alternatives. The utility of decision maker n chooses an alternative j is $U_{nj,}$ j=1,…, J. The decision maker chooses alternative j if and only if $U_{nj} > U_{ni}$ $\forall$ j $\neq$ i (Train, 2003).

However, since this utility is known to the decision maker but not by the researcher, the utility of the decision maker who obtains alternative j is decomposed as Unj = Vnj + εnj, where Vnj is the representative utility, εnj is a random term and captures the factors that affect utility but not included in Vnj (Train, 2003). Representative utility is denoted as $V_{nj} = V(X_{nj}, S_n)$ $\forall$ j, where X_{nj} is the attributes of the alternatives that decision maker faces, S_n is the attributes of the decision maker. Based on the utility function, the probability that decision maker n chooses alternative i is

$$Pni = Prob(Uni > Unj \ \forall \ j \neq i)$$

$$= Prob(Vni + \varepsilon ni > Vnj + \varepsilon nj \ \forall \ j \neq i)$$

$$= Prob(\varepsilon nj - \varepsilon ni < Vni - Vnj \ \forall \ j \neq i).$$

A conditional logit model is the most widely used discrete choice model (Train, 2003). The conditional logit model is obtained by assuming that εnj is independently and identically distributed iid extreme value (McFadden, 1974). The assumption sets the restriction that unobserved factors are uncorrelated over alternatives, and have same variance for all alternatives (Train, 2003).

Following McFadden (1974), the conditional logit choice probability that decision maker n chooses alternative i is:

$$P_{ni} = \frac{e^{Vni}}{\sum_j e^{Vnj}}$$

If utility is specified to be linear in parameters, that is $V_{nj} = \beta' X_{nj}$, where X_{nj} is a vector of observed variables relating to alternative j. The logit probabilities then become

$$P_{ni} = \frac{e^{\beta' \ Xni}}{\sum_j e^{\beta' \ Xnj}}$$

Mixed logit, also called random parameters mixed logit (RPL), is a highly flexible discrete choice model (McFadden and Train, 2000). It relaxes three limitations of the standard logit by allowing for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors (Train, 2003). RPL model assumes that the individual taste vectors are draws from a multivariate normal density, therefore, captures the heterogeneity in preferences (Adamowicz and Swait, 2011).

Assuming the utility function of decision maker is linear, the utility of person n from choosing alternative j can be written as:

$$U_{nj} = \beta'_n \ Xnj + \varepsilon nj,$$

where Xnj is observed variables that related to the alternative j and decision maker n, β_n is the coefficient of these variables for person n representing their tastes, and ε_{nj} is a random term that is iid extreme value (Train, 2003). In this case, the coefficient β varies with density $f(\beta)$ over decision makers rather than being fixed. The density $f(\beta)$ represents the mean and covariance of the β's in the whole population (Train, 2003).

The random parameters mixed logit probability can be written as:

$$P_{ni} = \int \left(\frac{e^{\beta' \, Xni}}{\sum_j e^{\beta' \, Xnj}}\right) f(\beta) \, d\beta,$$

The researcher specifies a distribution for the coefficients when estimating the random parameters. $f(\beta)$ is being specified to be normal or lognormal in most applications (Revelt and Train, 1998).

To estimate a random parameters mixed logit mode, it is important to decide which coefficients are assumed to be random and the type of distributions to use (Hoyos, 2010). Hosseini Matin (2014) used the pork attribute and the steak attribute as the random parameters when estimating a RPL model to reveal consumer preferences for pork produced from pigs and cattle bred using genomic information, respectively. Myae (2015) determined the alternatives with four different food-safety attributes as random parameters in the RPL to examine consumer preferences for CWD-related food safety attributes. Researchers could also use Lagrange Multiplier (LM) test or the t-statistic for standard deviations to determine the random parameters (Mariel et al., 2013).

In this study, alternative pork attributes (carnosine health claim, carnosine nutrient content claim, carnosine included in the NFT, protein nutrient content claim, and VCP label) are used as random parameters with a normal distribution. Price is used as a non-random parameter.

A latent class model, as another approach, is used to capture heterogeneity in consumers' response. A latent class model assumes that respondents belong to different classes (m=1,…,M) that are defined by a small number of segments (M) (Holmes et al., 2008). Following Train (2003), the latent class model choice probability can be written as:

$$P_{ni} = \sum_{m=1}^{M} S_m \left(\frac{e^{b\prime mXni}}{\sum_j e^{b\prime mXnj}}\right),$$

where S_m is the share of the population in segment m and can be estimated within the model along with the b's for each segment.

Criteria for selecting the optimal number of classes include Akaike Information Criterion (AIC) and the Bayes Information Criterion (BIC). The AIC is calculated as [-2(LS+KS)], where LS is the log likelihood and KS is the number of free parameters, for a model with S latent segments (Swait and Adamowicz, 2001). The BIC is calculated as [-2LS+KS*ln(N)] (Swait and Adamowicz, 2001).

Based on the characteristics of the data and the objectives of this study, the utility function of this study is:

$$U_{ij} = \beta_p\, Price + \beta_{HC}\, HC + \beta_{NC}\, NC + \beta_{NFT}\, NFT + \beta_{PC}\, PC + \beta_{VCP}\, VCP + \beta_{HC\text{-}socio}$$

$$HC*Socio\text{-}demographic + \beta_{NC\text{-}socio}\, NC*Socio\text{-}demographic + \beta_{NFT\text{-}socio}$$

$$NFT*Socio\text{-}demographic + \beta_{PC\text{-}socio}\, PC*Socio\text{-}demographic + \beta_{VCP\text{-}socio}\, VCP*Socio\text{-}demographic,$$

where HC is carnosine health claim; NC is carnosine nutrient content claim; NFT is carnosine included in the nutrition facts table; PC is protein nutrient content claim; VCP is Verified Canadian Pork label. According to the conceptual framework that was mentioned earlier, socio-demographic explanatory variables include age, gender, income, education, 'don't eat meat' dummy variable, whether respondents have children in the household (dummy), live in city (as opposed to town or rural, dummy, reside in Quebec (dummy), familiarity with genomics, and frequency of buying meat. The variables included are all in the "individual factors" (Sims, 1998) category of the

conceptual framework. The conditional logit model and random parameters mixed logit model were estimated with the data from 912 respondents.

Estimates of WTP (willingness to pay) can be calculated for each attribute using coefficients obtained from the conditional logit or random parameters mixed logit models. WTPs for each attribute are calculated using formula (Ndunda and Mungatana, 2013, p.51):

$$\text{WTP} = -\left(\frac{\beta_{attribute\ i} + \sum \beta_{\text{attribute } i} * \text{interactions}}{\beta_{Price}}\right)$$

Calculated using individual values of socio-demographic variables, individual WTPs will be clustered into groups based on the individual's level of nutrition knowledge (sum of the nutrition knowledge scale) and health consciousness (obtained from factor analysis) levels.

3.6 Chapter summary

This chapter covered the conceptual framework, data sources, data setup, descriptive statistics and model specifications. The survey was designed with several sections to elicit information about consumer food purchase behavior and attitudes towards technological development, and was completed by 992 Canadians with various backgrounds.

A choice experiment was included in the survey to reveal consumer preferences for pork chops, specifically for carnosine enhanced pork, with different attributes, which include a carnosine health claim, a carnosine nutrient content claim, and carnosine included in the nutrition facts table, a protein nutrient content claim, and the Verified Canadian Pork label.

Survey data were organized and recoded in Excel, and was coded into the formats that are

appropriate for SPSS and Nlogit, respectively. In the survey population, gender distribution was quite similar to the census population of 2006 and 2011. However, compared to the census populations, the respondents in the survey were slightly older, had higher education and lower income levels. In the survey, the average nutrition knowledge score was 15. Males obtained higher nutrition knowledge scores than those of females. Individuals who were in the age of 65 and above had the highest nutrition knowledge scores. Three factors – self-health awareness, personal responsibility and health motivation – were extracted from factor analysis of the health consciousness scale.

Conditional logit, random parameters mixed logit and latent class models were estimated with the dataset that contains 912 respondents. WTPs for pork attribute for the whole sample and eight selected respondents, and individual WTPs were calculated using coefficients from the conditional logit, random parameters mixed logit and latent class models.

Chapter 4: Regression Results and Welfare Measure

4.1 Introduction

This chapter presents the results of the econometric analysis of the data from the national survey conducted in 2015. Conditional logit (CL), random parameters mixed logit (RPL) and latent class model (LCM) were estimated to analyse the data and address the objectives. Willingness to pay (WTP) for five pork attributes was calculated in three ways: WTP for the whole sample population (obtained from conditional logit, random parameters mixed logit and latent class model), WTP for selected individuals (obtained from conditional logit model), the means of individual WTPs. These are the premiums above the 'normal' price of pork what was indicated in the choice experiment at the time of study.

4.2 Regression results

4.2.1 Conditional logit and random parameters mixed logit

Firstly, a basic model that included only attributes was estimated to explain consumer preferences for different pork attributes without accounting for the influence of socio-demographic factors. Table 4.1 presents the regression results for the basic model for both conditional logit and random parameters mixed logit models. From the sign and the significance of the coefficients, we can tell that Canadian consumers preferred pork chops with the protein nutrient content claim, the VCP label and carnosine included in the NFT to pork chops with

either the carnosine health claim or the carnosine nutrient content claim. However, the attribute carnosine included in the NFT was only significant in the random parameters mixed logit model. However, the attribute carnosine included in the NFT was only significant in the random parameters mixed logit model not in the conditional logit model. As mentioned earlier, the RPL is a highly flexible discrete choice model because it relaxes limitations (such as allowing for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors (Train, 2003)) of the standard logit model. Consumer preferences for carnosine included in the NFT is only significant in the RPL where we take the heterogeneity into account.

Table 4.1: Estimates of Conditional Logit and Random Parameters Mixed Logit Models (Basic Models with Attributes only)

		Conditional logit		Random parameters mixed logit	
	Definition	Coefficient	SE	Coefficient	SE
Price	Price	-0.231***	0.008	-0.355***	0.012
HC	Carnosine health claim	-0.482***	0.051	-1.016***	0.127
NC	Carnosine nutrient content claim	-0.323***	0.050	-0.568***	0.097
NFT	Carnosine included in the NFT	0.029	0.052	0.177**	0.080
PC	Protein nutrient content claim	0.240***	0.036	0.358***	0.065
VCP	Verified	0.370***	0.036	0.516***	0.073

	Canadian Pork label				
Neither pork chop	The choice of no pork rather than either of the alternatives	-1.995***	0.073	-3.294***	0.100
Standard Deviation Effects					
HC				2.863***	0.143
NC				2.064***	0.118
NFT				1.191***	0.104
PC				1.163***	0.083
VCP				1.392***	0.160
Model Statistics					
Log-likelihood		-7253.87		-6029.49	
Pseudo R-squared		0.0714		0.247	
McFadden Pseudo R-squared		0.0710		0.247	
# of Observations		7296		7296	

Note: ***,**,*, Significant at 1%, 5%, and 10% level

Source: Obtained from survey data of this thesis

Table 4.2: Likelihood Ratio Test Statistics for Model Specification Obtained from Conditional Logit Model

	Log likelihood	K(# of parameter)	chi-statistics	df	P-value	Conclusion
Base	-7253.8746	7				
Base plus demographic variables (age, gender, have children dummy, live in city dummy, education, income, live in Quebec dummy)	-7182.63	42	142.48928	35	0.000	reject null
Base plus demographic variables plus meat eating habit (don't eat meat dummy and meat purchase frequency)	-6954.4777	52	456.30456	10	0.000	reject null
Base plus demographic variables plus meat eating habit plus familiarity with genomics	-6936.7621	57	35.4313	5	0.000	reject null

Source: Obtained from survey data of this thesis

Consumers' meat eating habits, which can be identified as an individual factor that influences consumers' food choices according to the conceptual framework (Sims, 1998) were factored into the model. In this study, we included a dummy variable indicating whether the respondent eats meat or not and a variable indicating their frequency of purchasing meat in the regression models (interacted with attributes). We are expecting that carnosine enhanced pork maybe more desirable for respondents who consider meat an important component in their diet (i.e. consume meat and have a high frequency of purchasing meat).

Since genomic selection is one of the technologies that are related to the carnosine enhanced pork, consumers' familiarity with genomics, which is identified as one of the determinants that influenced the public perception of genomics (Pin et al., 2009), was included as a dependent variable in the regression models.

The influence of different sets of socio-demographic variables is tested by likelihood ratio tests, of which the results are reported in Table 4.2. We cannot reject the statistical significance of demographic variables (age, gender, have children dummy, live in city dummy, education, income, live in Quebec dummy), meat eating habit (don't eat meat dummy and meat purchase frequency), and familiarity with genomics. So the above dependent variables are selected as independent variables for econometric models.

Table 4.3 reports the results of the conditional logit and random parameters mixed logit regression for the model with socio-demographics variables interacted with the attributes.

Table 4.3: Estimates of Conditional Logit and Random Parameters Mixed Logit Models (with Interactions)

		Conditional logit		Random parameters mixed logit	
	Definition	Coefficient	SE	Coefficient	SE
Price	Price	-0.24***	0.008	-0.359***	0.012
HC	Carnosine health claim	-1.497***	0.459	-3.586***	1.115
NC	Carnosine nutrient content claim	-1.301***	0.447	-2.917***	0.863
NFT	Carnosine included in the NFT	-1.522***	0.453	-1.664**	0.676
PC	Protein nutrient content claim	0.198	0.341	0.067	0.563
VCP	Verified Canadian Pork label	0.067	0.340	0.102	0.605
Neither	Neither attribute are included	-2.133***	0.075	-3.324***	0.102
Carnosine health claim					
AgeHC	Age interacted with HC	-0.007*	0.004	-0.008	0.009
MaleHC	Male interacted with HC	0.523***	0.094	0.912***	0.235
ChdHC	Presence of children under 18 in the household (child) interacted with HC	-0.040	0.128	0.029	0.305
CityHC	If the respondent lives in city (city) interacted with HC	-0.128	0.095	-0.185	0.243
EduHC	Education interacted with HC	-0.028	0.026	-0.039	0.065
IncHC	Income (in thousands dollar) interacted with HC	-0.002	0.002	-0.006	0.004

NomeatHC	If the respondent doesn't eat meat (nomeat) interacted with HC	-0.115	0.243	-0.824	0.618
QcHC	If the respondent residents in Quebec (QC) interacted with HC	0.196*	0.103	0.489*	0.256
GenoHC	Familiarity with genomics (geno) interacted with HC	0.226***	0.059	0.447***	0.148
FoPHC	Frequency of purchasing meat (FoP) interacted with HC	0.364***	0.061	0.751***	0.148
Carnosine nutrient content claim					
AgeNC	Age interacted with NC	-0.005	0.004	-0.002	0.007
MaleNC	Male interacted with NC	0.337***	0.091	0.529***	0.184
ChdNC	Child interacted with NC	-0.156	0.124	-0.194	0.240
CityNC	City interacted with NC	-0.140	0.092	-0.149	0.193
EduNC	Education interacted with NC	0.001	0.025	0.020	0.050
IncNC	Income interacted with NC	-0.002	0.002	-0.004	0.003
NomeatNC	Nomeat interacted with NC	-0.820***	0.248	-1.680***	0.510
QcNC	QC interacted with NC	0.133	0.102	0.319	0.204
GenoNC	Geno interacted with NC	0.164***	0.058	0.258**	0.118

FoPNC	FoP interacted with NC	0.293**	0.061	0.505***	0.119
Carnosine included in the NFT					
AgeNFT	Age interacted with NFT	0.001**	0.004	-0.004	0.005
MaleNFT	Male interacted with NFT	0.080	0.093	0.167	0.143
ChdNFT	Child interacted with NFT	0.234*	0.126	0.266	0.193
CityNFT	City interacted with NFT	-0.087	0.095	0.020	0.150
EduNFT	Education interacted with NFT	0.026	0.025	0.018	0.039
IncNFT	Income interacted with NFT	0.001	0.002	-0.000	0.002
NomeatNFT	Nomeat interacted with NFT	-1.097***	0.260	-1.651***	0.367
QcNFT	QC interacted with NFT	0.017	0.103	0.077	0.158
GenoNFT	Geno interacted with NFT	-0.038	0.059	0.094	0.091
FoPNFT	FoP interacted with NFT	0.325***	0.060	0.444***	0.092
Protein nutrient content claim					
AgePC	Age interacted with PC	-0.001	0.003	-0.001	0.004
MalePC	Male interacted with PC	-0.032	0.070	-0.036	0.117
ChdPC	Child interacted with PC	0.166*	0.094	0.336**	0.160
CityPC	City interacted with PC	-0.016	0.070	-0.023	0.124
EduPC	Education interacted with PC	-0.040**	0.019	-0.055*	0.032

IncPC	Income interacted with PC	0.002*	0.001	0.003	0.002
NomeatPC	Nomeat interacted with PC	-0.748***	0.190	-1.315***	0.326
QcPC	QC interacted with PC	-0.022	0.077	-0.014	0.128
GenoPC	Geno interacted with PC	-0.023	0.044	-0.023	0.076
FoPPC	FoP interacted with PC	0.162***	0.046	0.294***	0.078
Verified Canadian Pork label					
AgeVCP	Age interacted with VCP	-0.003	0.003	-0.005	0.005
MaleVCP	Male interacted with VCP	-0.033	0.070	0.004	0.125
ChdVCP	Child interacted with VCP	-0.000	0.094	0.082	0.171
CityVCP	City interacted with VCP	-0.153**	0.070	-0.193	0.134
EduVCP	Education interacted with VCP	-0.011	0.019	-0.038	0.034
IncVCP	Income interacted with VCP	0.001	0.001	0.001	0.002
NomeatVCP	Nomeat interacted with VCP	-0.868***	0.189	-1.660***	0.346
QcVCP	QC interacted with VCP	0.183**	0.077	0.262*	0.138
GenoVCP	Geno interacted with VCP	0.098**	0.044	0.151*	0.081
FoPVCP	FoP interacted with VCP	0.136***	0.046	0.283***	0.082
Standard Deviation Effects					
HC				2.856***	0.145
NC				0.553***	0.116
NFT				0.605***	0.137

PC		0.258	0.171
VCP		1.079***	0.087
Model Statistics			
Log-likelihood	-6936.76	-5906.76	
Pseudo R-squared	0.112	0.263	
McFadden Pseudo R-squared	0.108	0.253	
# of Observations	7296	7296	

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

The higher Pseudo R-squared values in conditional and random parameters mixed logit models with interactions (0.07 for CL, 0.247 for RPL) as compared to the basic model (0.11 for CL, 0.263 for RPL) also suggested that the model with interactions provided better estimation results than the basic one. The McFadden Pseudo R-squared statistics for both conditional logit (0.108) and random parameters mixed logit (0.253) with interactions are statistically acceptable and indicate a decent goodness of fit of the models (Hensher et al., 2005).

The notable variables of significance were the frequency of purchasing meat, whether they eat meat or not, and their familiarity with genomics. Consistent with our expectation, respondents who purchased meat more frequently preferred pork chops with all attributes as compared to respondents who had a lower frequency of buying meat. Similarly, meat consumers preferred pork chops with the carnosine nutrient content claim, carnosine included in the NFT, the protein nutrient content claim, and the VCP label, but they had indifferent purchase preferences for pork chops with the carnosine health claim from non-meat eaters. Familiarity with genomics contributed to a higher possibility of purchasing pork chops with the carnosine health claim, the carnosine nutrient content claim, and the VCP label. Respondents with all levels of familiarity with genomics had indifferent purchase preferences for pork chops with carnosine

included in the NFT and the protein nutrient content claim.

Younger respondents were found to prefer pork chops with the carnosine health claim, whereas older respondents prefer pork chops that carnosine included in the NFT. Age had no impact on consumer purchase preferences for pork chops with a carnosine nutrient content claim, the protein nutrient content claim and the VCP label.

In this study, male respondents preferred pork chops with the carnosine health claim and the carnosine nutrient content claim than their female counterparts. Gender had no impact on consumer purchase preferences for pork chops with carnosine included in the NFT, the protein nutrient content claim and the VCP label. Studies show that men have lower perceptions[5] towards health and food safety related risks (Dosmen et al., 2001; Tonsor et al., 2009). For most of the respondents, it was their first time hearing about carnosine and related technology. Consumers may perceive risks coming from consuming functional pork. Dosmen et al., (2001) explained that women, for the most part, were responsible for the majority of household food purchases and preparations, and were more inclined to consider food safety risk than men.

Respondents who had children under 18 in their households preferred pork chops with the protein nutrient content claim and carnosine included in the NFT, and their purchase preferences for pork chops with the carnosine health claim, the protein nutrient content claim and the VCP label were indifferent from respondents who didn't have children in their households.

Pork chops with the VCP label were desired by respondents who resided in the non-metro

[5] "Risk perceptions represent a person's views about the risk inherent in a particular situation. Perceptions about food safety risk are what the individual believes would be the amount of health risk, if any, they would face from consuming a food product" (Schroeder et al. 2007. P1 from Tonsor, 2009).

area. Consistent with the findings from Kim et al. (2000) that the probability of using food labels increases with income, in this study, respondents with higher-income levels were more likely to purchasing pork chops with the protein nutrient content claim. However, income had no impact on purchase preferences for pork chops with other attributes.

Wang et al. (1995) and Nayga (1996) also reached the similar conclusions that food shoppers or main meal planners who have children in their household, reside in the nonmetro area, and have a higher income are more cautious about nutrient contents of food and thus more likely to utilize food labels for food choice. The reason for this result may be that consumers are more aware of the nutrient content of food by using food labels when they are responsible for the food of more family members, especially children in their households. Therefore, they are willing to devote more time on examining nutrition information from food labels (Wang et al., 1995 and Nayga, 1996). Nonmetro area residents generally have a slower life style and have more time to shop and are able to spend more time searching information from food labels than urban area residents do (Nayga, 1996).

Pork chops with the protein nutrient content claims were less desired by high-educated respondents. Education had no effect on consumer purchase preferences for pork chops with other attributes.

Respondents who resided in Quebec urban area preferred pork chops with the carnosine health claim and the VCP label. One of the features that distinguish the province of Quebec from rest of the provinces in Canada is its large French-speaking population (Kim, 1989). They have been found to exhibit numerous consumption behaviours and life styles distinct from the rest of

the mainly English-speaking population (Schaninger et al., 1985. Labrecque et al., 2011).

As mentioned earlier, the conditional logit model that excludes respondents who don't eat meat were also estimated. Regression results (presented in Appendix H to Appendix J) showed similar but less detailed and less significant coefficient estimates as compared to the conditional logit model with interactions presented in this thesis.

4.2.2 Latent class model

The log likelihood, ρ^2, number of parameters, AIC and BIC statistics are reported in Table 4.4. The two-class solution provides the best fit to the data since the changes of AIC (decrease), BIC (decrease), ρ^2 (increase) and log likelihood (increase) are the smallest from 1 to 2 class models, so the 2-class model was selected as the best model (Birol et al., 2006).

Table 4.4: Criteria for Selecting the Optimal Number of Segments

Class selection	Log likelihood	ρ^2	Parameters (P)	AIC	BIC
1-class	-7253.87	0.07	7	14521.7	14570.01
2-class	-6084.47	0.29	25	12218.9	12391.32
3-class	-5717.18	0.321	43	11520.4	11816.85
4-class	-5585.62	0.322	61	11293.2	11713.84

Source: Obtained from survey data of this thesis

The regression results of the 2-class model are reported in Table 4.5. The first part of the table displays the utility coefficients from pork attributes, where the second part reports class membership coefficients. The class membership coefficients for the second class were normalized to zero in order to identify the coefficients in class one. For respondents in class 1,

pork chops with carnosine included in the NFT, the protein nutrient content claim and the VCP label were preferred. Respondents in class 1 discounted the value of pork chops with the carnosine health claim, whereas respondents in class 2 discounted the value of pork chops with the carnosine health claim, the carnosine nutrient content claim and carnosine included in the NFT (all three carnosine food labels).

Class membership coefficients revealed that being male and having higher familiarity with genomics and frequency of purchasing meat increase the probability that the respondent belongs to class 1. Living in city and do not eat meat increase the probability that the respondent belongs to class 2.

Table 4.5: Estimates of 2-Class Latent Class Model

	Class 1		Class 2	
	Coefficient	SE	Coefficient	SE
Price	-0.286***	0.010	-0.202***	0.024
Carnosine health claim	-0.210***	0.064	-2.387***	0.250
Carnosine nutrient content claim	-0.038	0.062	-1.998***	0.188
Carnosine included in the NFT	0.195***	0.067	-.282**	0.118
Protein nutrient content claim	.364***	0.044	0.074	0.101
Verified Canadian Pork label	.520***	0.044	0.048	0.102
Neither	-3.478***	0.109	-0.651***	0.206
Constant	-0.858	0.839		
Age	-0.002	0.007		
Male	0.307*	0.185		
Child	0.258	0.245		
Live in city	-0.404**	0.186		
Education	-0.020	0.050		
Income	0.0007	0.003		
No meat	-1.299***	0.405		
Live in Quebec	0.170	0.201		

Familiarity with genomics	0.200*	0.117
Frequency of buying meat	0.595***	0.115

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

The latent class model captured heterogeneity in consumer responses. In order to show more about the difference between the respondents in each class, profiles of respondents belong to each class are presented in Table 4.6. A t-test was conducted between classes for each variable.

Table 4.6: Profiles of Respondents Belong to the Two Classes in Latent Class Model

Variable	Class 1	Class 2
Age	51	50
Male	53%[a]	45%
Presence of children under 18 in the household	21%[a]	16%
Education (in year)	14	14
Respondent lives in Quebec	29%	27%
Respondent lives in city	61%[a]	70%
Income (in $1000)	59.2	55.5
Respondent doesn't eat meat	2%[a]	13%
Familiarity with genomics	1.8[a]	1.7
Frequency of purchasing meat	3.7[a]	3.1
Frequency of grocery shopping	4.5	4.6
Natural health interest	18.6[a]	20
General health interest	26.2[a]	28.1
Pleasure	21.7[a]	21.3
World is worse off (1) or better off (10) because of science	7.1[a]	6.7
Nutrition knowledge	16.1	15.3
Health consciousness		
Self-health awareness	0.01	0.05
Personal responsibility	0.03	0.06

Health motivation	0.02	0.07

Note: a implies the statistically significant difference at 10% between two classes
Source: Obtained from survey data of this thesis

In class 1, there were more respondents who were male and had children in the household, and fewer respondents who didn't eat meat and lived in a city than class 2. Compared to respondents in class 2, respondents in class 1 had higher familiarity with genomics, frequency of purchasing meat, believed that the world is better off because of science, but they also had lower natural health interest and general health interest. However, the levels of nutrition knowledge and health consciousness were not statistically significantly different between the two classes.

4.3 Willingness to pay for pork attributes

Consumers' willingness to pay for pork attributes are calculated in three ways: WTP for the whole sample population (obtained from conditional logit, random parameters mixed logit and 2-class latent class model), WTP for selected individuals (obtained from conditional logit model), the means of individual WTPs. These are the premium above the 'normal' price of pork what was indicated in the choice experiment at the time of study.

4.3.1 WTP calculations for the whole sample population

Willingness to pay (WTP) for pork attributes calculated from the regression coefficients obtained from conditional logit and random parameters mixed logit is presented in Table 4.7. The negative WTP for the carnosine health claim and the carnosine nutrient content claim indicated that consumers discounted the values of the attributes associated with carnosine health claim and

carnosine nutrient content claim. It can be due to the claim mechanism or the carnosine attribute itself, since carnosine is not likely to familiar to the general public at his time. According to Romanowska (2009), consumers lack knowledge about government assessment processes leading to the approval of a nutrition claim (health claim and nutrient content claim) that can appear on food. Since, by law, most packaged foods in Canada is required to have a nutrition facts table, it is easy for consumers to recognize it and trust the value of the information in the nutrition facts table that includes carnosine over other food labels that indicates the health benefits of carnosine. However, consumers are willing to pay a positive premium for carnosine included in the NFT (only significant in random parameters mixed logit model and latent class model class 1 in Table 4.8), the protein nutrient content claim, and VCP label.

It seems that, in terms of carnosine pork, consumers preferred food labels, such as carnosine included in the NFT. Consumers were also found to have a higher WTP for pork chops that are identified as an excellent source of protein over pork identified in one of three ways to be a source of carnosine. This result is in line with the findings by Bech-Larsen and Scholderer (2007), who summarized that consumers preferred functional ingredients that were enriched with compounds that were well-known for their health benefits than enrichments which were unfamiliar to them.

Table 4.7: Consumers' WTP for Pork Attributes Obtained from Conditional Logit and Random Parameters Mixed Logit Models for Both Basic Model and Model with Interactions ($/package (0.405kg))

Attributes	Conditional logit		Random parameters mixed logit	
	Basic model	Model with interaction	Basic model	Model with interaction
Carnosine health claim	-2.08***	-2.06***	-2.86***	-3.06***
Carnosine nutrient content claim	-1.39***	-1.40***	-1.59***	-1.76***
Carnosine included in the NFT	0.12	0.12	0.49**	0.46***
Protein nutrient content claim	1.03***	0.97***	1.00***	0.99***
Verified Canadian Pork label	1.60***	1.51***	1.45***	1.42***

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

Table 4.8 reports the WTP for the pork attributes calculated from the two–class latent class model. The two classes contain 74.2% and 25.8% of the sample population, respectively. Compared to the respondents in class 2, respondents in class 1 had more significant and a higher WTP for the pork attributes. Respondents in class 1, the pro–label consumers, had a smaller negative WTP for the carnosine health claim, an insignificant WTP for the carnosine nutrient content claim, but a positive and significant WTP for carnosine included in the NFT, the protein nutrient content claim, and the VCP label. Whereas, respondents in class 2, the against–meat consumers, had a much larger negative WTP for all carnosine labels as compared to class 1 and an

insignificant WTP for the protein nutrient content claim and the VCP label.

Table 4.8: Consumers' WTP for Pork Attributes Obtained from 2-Class Latent Class Model ($/package (0.405kg))

Attributes	Class 1: pro–label consumers	Class 2: against–meat consumers
Percentage in each class	74.2%	25.8%
Carnosine health claim	-0.734***	-11.812***
Carnosine nutrient content claim	-0.134	-9.885***
Carnosine included in the NFT	0.684***	-1.396**
Protein nutrient content claim	1.273***	0.367
Verified Canadian Pork label	1.821***	0.240

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

4.3.2 WTP for selected respondents

Table 4.9 and Table 4.10 report the WTP for pork attributes calculated from the conditional logit model with interaction variables for eight arbitrarily selected representative respondents – a female/male respondent who has children/doesn't have children in their household, lives in Quebec/doesn't live in Quebec, lives in city, eats meat, has average age (51), average education level (14 years), average income ($58,000), average familiarity with genomics (2-not very familiar)and average frequency of purchasing meat (4- about once per week).

WTPs for the attributes carnosine health claim and carnosine nutrient content claim were negative or insignificantly different from zero for all eight selected respondents. Otherwise, the WTP for carnosine included in the NFT on a package of pork chops varied from $0 to $0.98 for

the four female representative respondents and $0.7 to $1.6 for the four male respondents; the WTP for the protein claim on a package of pork chops varied from $0.9 to $1.7 for females and $0.8 to $1.8 for males; the WTP for the VCP on a package of pork chops varied from $1.4 to $2 for females and $1.1 to $2.1 for males.

Comparisons were made on WTP between the attributes carnosine included in the NFT, the protein nutrient content claim, and the VCP label. In general, female respondents had higher WTP for the pork attributes than male respondents. Within the four same gender respondents, respondents who had children in their households had higher WTP for the pork attributes than those who did not; Quebec residents had higher WTP for the VCP label but lower WTP for the protein claim.

Table 4.9: Consumers' WTP for Pork Attributes for Arbitrarily Selected Female Respondents ($/package (0.405kg))

	has children, doesn't live in QC		no child, doesn't live in QC		has children, lives in QC		no child, lives in QC	
	CL	RPL	CL	RPL	CL	RPL	CL	RPL
Carnosine health claim	-3.7***	-4.8***	-3.5***	-4.8***	-2.9***	-3.4***	-2.7***	-3.5***
Carnosine nutrient content claim	-2.8***	-3.1***	-2.2***	-2.6***	-2.3***	-2.2***	-1.6***	-1.7***
Carnosine included in the NFT	0.7	0.9*	-0.1	0.2	0.8	1.1*	-0.1	0.4
Protein nutrient content claim	1.7***	1.9***	1.0***	1.0***	1.6***	1.9***	0.9***	0.9***
Verified Canadian pork label	1.3***	1.4***	1.3***	1.1***	2.0***	2.1***	2.0***	1.9***

Note: ***,**,*, Significant at 1%, 5%, and 10% level

Source: Obtained from survey data of this thesis

Table 4.10: Consumers' WTP for Pork Attributes for Arbitrarily Selected Male Respondents ($/package (0.405kg))

	has children, doesn't live in QC		no child, doesn't live in QC		has children, lives in QC		no child, lives in QC	
	CL	RPL	CL	RPL	CL	RPL	CL	RPL
Carnosine health claim	-1.5***	-2.2**	-1.4***	-2.3***	-0.7	-0.9	-0.6	-0.9
Carnosine nutrient content claim	-1.4***	-1.6**	-0.8**	-1.1**	-0.9	-0.7	-0.2	-0.2
Carnosine included in the NFT	1.1**	1.4**	0.1	0.7**	1.1*	1.6**	0.2	0.9*
Protein nutrient content claim	1.6***	1.8***	0.9***	0.9***	1.5***	1.8***	0.8**	0.8**
Verified Canadian Pork label	1.1***	1.4***	1.1***	1.2***	1.9***	2.1***	1.9***	1.9***

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

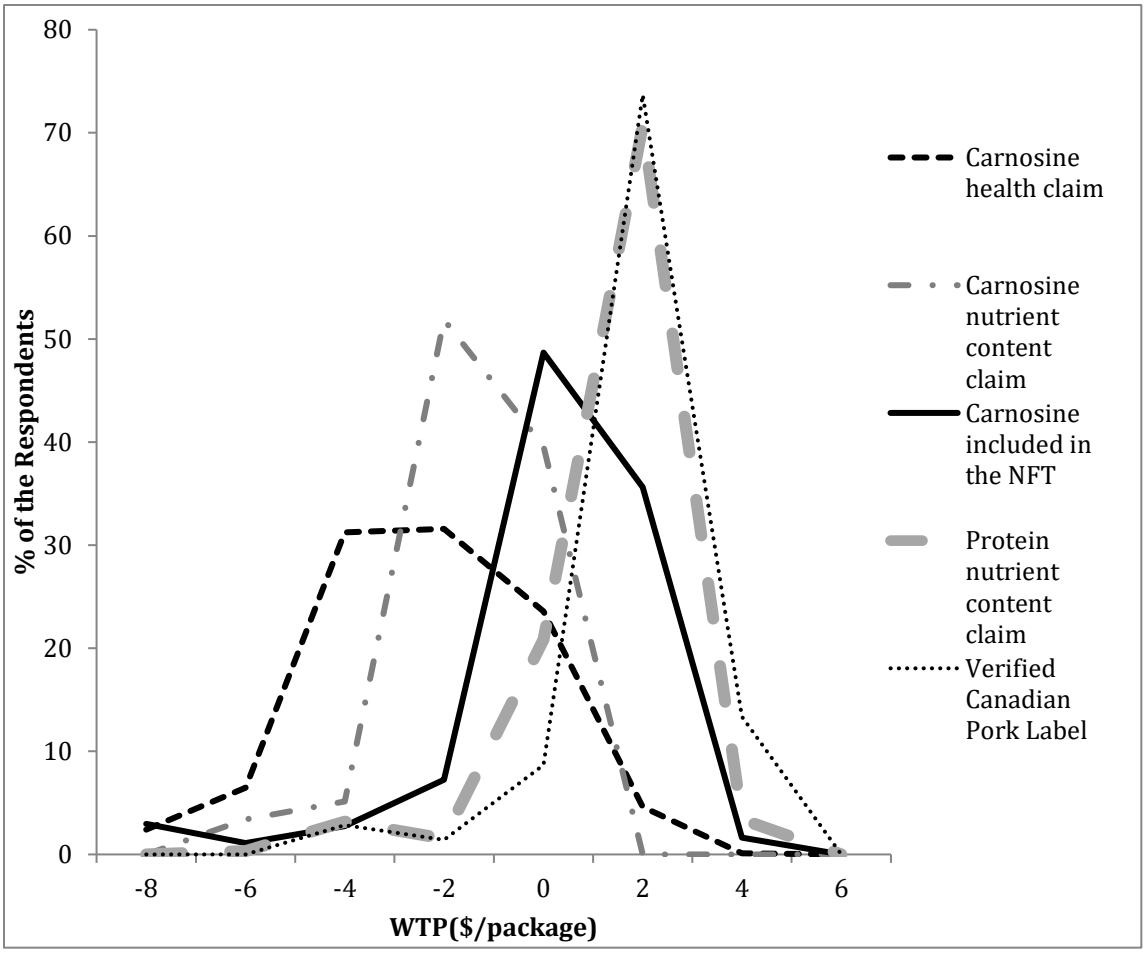
4.3.3 Mean of individual WTPs for pork attributes

In order to address the second objective – to examine the impact of nutrition knowledge and health consciousness on consumers' willingness to pay for functional pork with different food labels. An individual WTP is WTP calculated using actual values of the variables, obtained from conditional logit model with socio-demographic interactions, for each individual and is individual specifically.

The individual WTP was grouped by corresponding individual nutrition knowledge (sum of scores obtained from the five statements), self-health awareness, personal responsibility and health motivation (three health consciousness factor scores were obtained from the factor analysis), respectively. Mean value of the individual WTP of each group was calculated to present the WTP for the group.

In Figure 4.1, the distribution of individual WTP for the five pork attributes calculated from the conditional logit model with socio-demographic interactions are shown. In Table 4.11, the minimum, maximum and mean values, percentage of zero, positive and negative individual WTPs for each pork attribute are presented. Consistent with what the Figure 4.1 indicates, 95.3% of the individual WTPs for the carnosine health claim, 100% of the individual WTPs for the carnosine nutrient content claim were not positive. 48.7% of the individual WTPs for carnosine included in the NFT were zero, whereas 74.1% of the individual WTPs for the protein nutrient content claim and 87.1% of the individual WTPs for the VCP label were positive.

Figure 4.1: Distribution of Individual WTPs for Pork Attributes



Source: Obtained from survey data of this thesis

Table 4.11: Summary of the Means of Individual WTPs for Pork Attributes Obtained from Conditional Logit Model ($/package (0.405kg))

	Carnosine health claim	Carnosine nutrient content claim	Carnosine included in the NFT	Protein nutrient content claim	VCP label
Min	-8.71	-5.85	-8.37	-4.72	-4.29
Max	3.47	0	3.68	3.37	4.28
Mean	-2.03	-1.16	0.04	0.94	1.49
% of zero WTP	23.6%	39.6%	48.7%	41.6%	8.7%
% of positive WTP	4.7%	0	37.3%	74.1%	87.1%
% of negative WTP	71.7%	60.4%	14%	5%	4%

Source: Obtained from survey data of this thesis

As can be been in Table 4.12, nutrition knowledge score was separated into five groups: 0–5, 5–10, 10–15, 15–20, and 20–25. 49% of the respondents obtained a nutrition knowledge score of 15. There were more respondents (42.4%) who scored higher than the mean nutrition knowledge, which is 15, as compared to the respondents (8.6%) who scored lower. Self-health awareness score was separated into five groups: less than -2 (2%), -2 – -1.14 (8%), -1.14 – -0.28 (27%), -0.28 – 0.57 (37%), and 0.57 – 1.42 (26%). Personal responsibility score was separated into five groups: less than -2 (2%), -2 – -1.14 (9%), -1.14 – -0.28 (11%), -0.28 – 0.57 (38%), and 0.57 – 1.42 (40%). Health motivation score was separated into five groups: less than -2 (2%), -2 – -1.26 (6%), -1.26 – -0.52 (12%), -0.52 – 0.21 (39%), and 0.21 – 0.94 (41%).

A t-test between the mean values at the significance level of 10% was conducted between the five groups of nutrition knowledge, self-health awareness, personal responsibility, and health motivation, respectively. For example, for the attribute carnosine health claim, the means of

individual WTPs for respondents who were in nutrition knowledge group NK2 is statistically significantly different from the means of individual WTPs for respondents who were in nutrition knowledge group NK4; for the attribute protein nutrition content claim, there was no statistically significantly difference between the means of individual WTPs for all the self-health awareness groups.

Interestingly, the signs of the means of individual WTPs for the pork attributes are consistent with the WTPs calculated for the whole sample and for selected respondents. More specifically, WTPs for the carnosine health claim and the carnosine nutrient content claim were negative, whereas, WTPs for the protein nutrient content claim and the VCP labels were positive. WTPs for carnosine included in NFT vary between 0.

Table 4.12: Individual WTPs for Per Package of Pork Chops Based on Levels of Nutrition Knowledge, and Health Consciousness ($/package (0.405kg))

Nutrition knowledge	Group	# of respondents	Carnosine health claim	Carnosine nutrient content claim	Carnosine included in the NFT	Protein nutrient content claim	VCP
5	NK1	17	-2.44	**-1.87**[c]	-0.61	0.67	1.22
10	NK2	58	**-2.12**[f]	-1.26	0.13	1.04	1.61
15	NK3	428	**-2.23**[hi]	-1.16	**-0.08**[hi]	**0.88**[i]	**1.35**[hi]
20	NK4	373	**-1.80**	**-1.09**	**0.19**	0.98	**1.65**
25	NK5	36	**-1.78**	-1.36	**0.24**	**1.10**	**1.52**
Self-health awareness							
-2	SA1	20	-2.28	-1.29	-0.42	0.69	0.94
-1.14	SA2	76	-2.15	-1.13	0.11	0.99	1.40
-0.28	SA3	244	-2.07	**-1.04**[i]	0.15	1.02	1.45
0.57	SA4	339	-2.03	**-1.15**[j]	0.06	0.94	1.56

1.42	SA5	233	-1.94	**-1.28**	-0.08	0.85	1.53
Personal responsibility							
-2	PR1	15	-2.43	**-0.62**^{abcd}	-0.42	0.50	1.25
-1.22	PR2	79	-2.13	**-0.94**^{efg}	-0.25	0.95	1.42
-0.45	PR3	101	-2.00	**-0.92**^{hi}	0.13	0.91	1.42
0.31	PR4	350	**-1.82**^{j}	**-1.12**^{j}	**0.20**^{j}	**1.03**^{j}	1.58
1.08	PR5	367	**-2.21**	**-1.33**	**-0.05**	**0.87**	1.46
Health motivation							
-2	HM1	17	-2.20	**-0.66**^{acd}	-0.77	**0.26**^{bcd}	**0.83**^{bc}
-1.26	HM2	56	**-2.37**^{f}	**-0.98**^{g}	**-0.35**^{e}	0.82	1.33
-0.52	HM3	113	**-1.85**^{i}	**-0.93**^{i}	**0.28**^{i}	**1.09**^{i}	**1.54**
0.21	HM4	356	**-1.85**^{j}	**-1.09**^{j}	0.16	**1.00**	**1.58**
0.94	HM5	370	**-2.21**	**-1.34**	**-0.04**	**0.88**	1.45

Source: Obtained from survey data of this thesis

Note: a implies the statistically significantly difference at 10% between group 1 and group 2 for each category (i.e. nutrition knowledge at 5 and nutrition knowledge at 10);

b implies the statistically significantly difference at 10% between group 1 and group 3 for each category;

c implies the statistically significantly difference at 10% between group 1 and group 4 for each category;

d implies the statistically significantly difference at 10% between group 1 and group 5 for each category;

e implies the statistically significantly difference at 10% between group 2 and group 3 for each category;

f implies the statistically significantly difference at 10% between group 2 and group 4 for each category;

g implies the statistically significantly difference at 10% between group 2 and group 5 for each category;

h implies the statistically significantly difference at 10% between group 3 and group 4 for each category;

i implies the statistically significantly difference at 10% between group 3 and group 5 for each category;

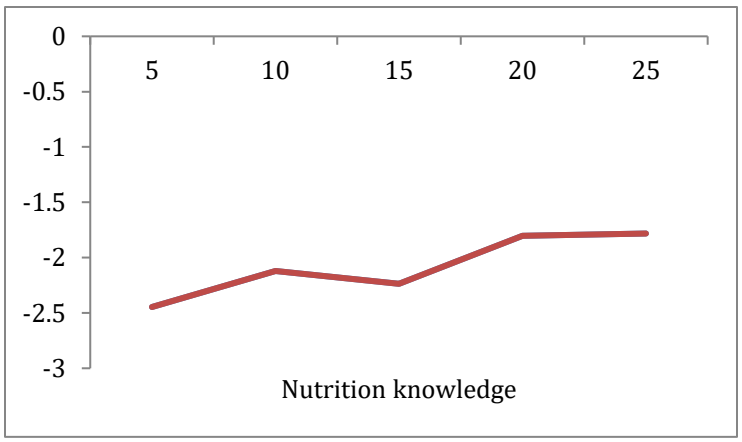
j implies the statistically significantly difference at 10% between group 4and group 5 for each category.

Numbers highlighted are statistically significantly different from one another.

In order to assess the effect of nutrition knowledge and health consciousness on consumer preferences, a model that includes nutrition knowledge and health consciousness as dependent variables was estimated (Likelihood ratio test results are presented in Appendix K and the regression results are presented in Appendix L). Results suggested that nutrition knowledge had a significantly positive effect on consumers' preference for pork chops with the carnosine health

claim, the carnosine nutrient content claim, and the Verified Canadian Pork label, whereas three factors of health consciousness had insignificant coefficients. Figure 4.2 to Figure 4.6 presents the association between nutrition knowledge and WTPs for pork attributes. Figures indication the association between health consciousness and WTPs for pork attributes are presented in Appendix M to Appendix Q.

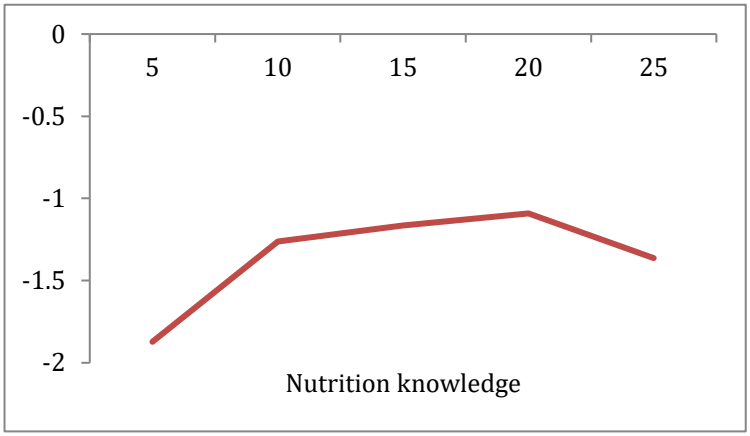
Figure 4.2: The Means of Individual WTPs for Carnosine Health Claim ($/package (0.405kg))



Source: Obtained from survey data of this thesis

The means of individual WTPs for the carnosine health claim went up along with the increasing levels of nutrition knowledge. Respondents who had higher nutrition knowledge were willing to pay a higher premium for the attribute carnosine health claim. For example, there was a WTP difference of $0.66 for per package of pork chop with carnosine health claim between respondents who had the highest and lowest levels of nutrition knowledge.

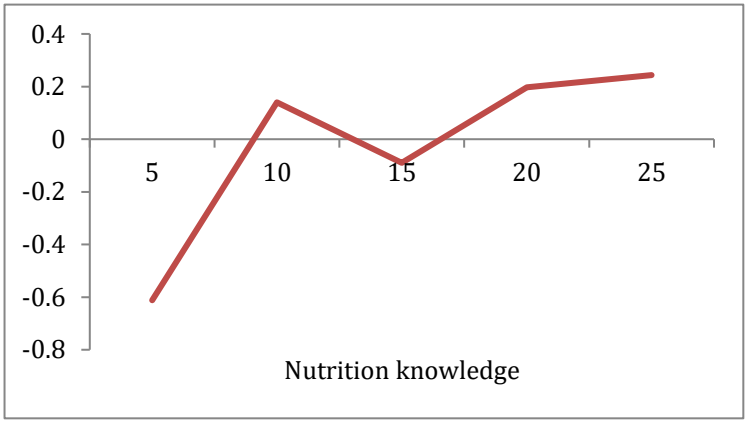
Figure 4.3: The Means of Individual WTPs for Carnosine Nutrient Content Claim ($/package (0.405kg))



Source: Obtained from survey data of this thesis

In terms of carnosine nutrient content claim, a positive relationship was observed between the means of individual WTPs and their levels of nutrition knowledge. It is also obvious that respondents who were in the fourth and fifth groups of nutrition knowledge had declined WTP for the attribute carnosine nutrient content claim. This may be due to the fact they are more aware of better food sources and possibly less expensive alternative sources of these nutrients (Xue et al., 2010)

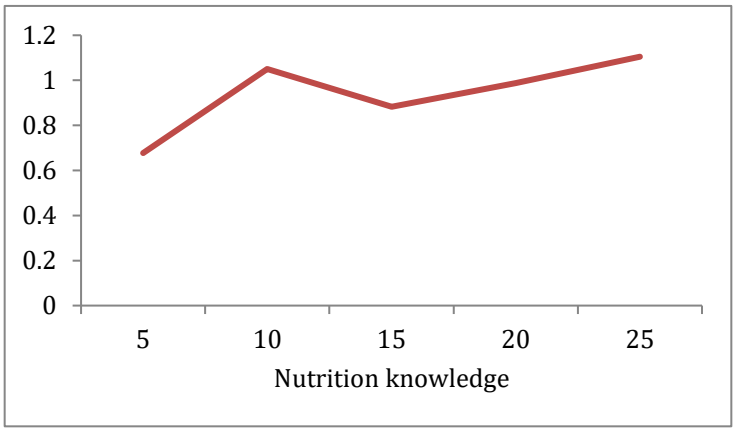
Figure 4.4: The Means of Individual WTPs for Carnosine Included in the NFT ($/package (0.405kg))



Source: Obtained from survey data of this thesis

From the graphs we can see that the means of individual WTPs for carnosine included in the NFT increased when the levels of individual nutrition knowledge increased.

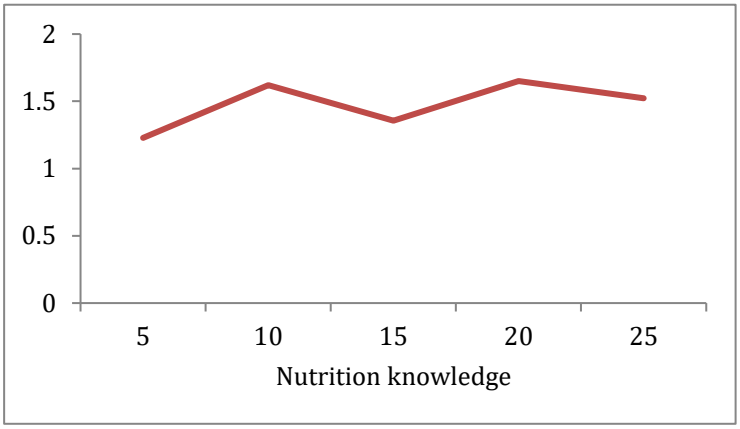
Figure 4.5: The Means of Individual WTPs for Protein Nutrient Content Claim ($/package (0.405kg))



Source: Obtained from survey data of this thesis

Figure 4.5 indicates that higher levels of nutrition knowledge contributed to a higher mean of individual WTPs for the protein nutrient content claim.

Figure 4.6: The Means of Individual WTPs for Verified Canadian Pork (VCP) label ($/package (0.405kg))



Source: Obtained from survey data of this thesis

Lastly, upward trends were observed from the graph in Figure 4.6. Respondents who had higher nutrition knowledge were willing to pay a higher premium for the VCP label.

4.5 Summary

The purpose of this chapter is to address the objectives of determining how socio-demographic factors, one's levels of nutrition knowledge and health consciousness, which were identified in the conceptual framework as factors influence food choices, impact consumers' preference for carnosine enhanced pork.

The regression results from the conditional logit, random parameters mixed logit and 2-class latent class model showed that the socio-demographic factors had a significant influence on consumers' preferences and heterogeneities existed among consumers with different socio-demographic characteristics. The latent class model captured the preference heterogeneity (another method is be to exclude the non-meat eaters form the regression analysis. Appendix H, I

and J). The latent class model allowed the segmentation of the respondents into classes where the people have similar preferences, it also allowed us to identify the distribution of responses to the experimental attributes and, therefore, summarize the characteristics of respondents who will respond more or less to the experimental attributes.

Consumers who were younger, male, Québec residents, and familiar with genomics had a higher probability of purchasing pork chops with the carnosine health claim; Being male and familiar with genomics contributed to a higher chance of purchasing pork chops with the carnosine nutrient content claim; consumers who were older, had children under 18 in the household preferred pork chops that included carnosine in the NFT. Consumers who purchased meat more frequently preferred pork chops with all of the attributes.

Latent class model segments the respondents into two classes – the pro–label consumers and the against–meat consumers. Class membership coefficients revealed that being male and having higher familiarity with genomics and frequency of purchasing meat increased the probability that the respondent belonged to class 1. Living in city and do not eat meat increased the probability that the respondent belonged to class 2.

In general, consumers (the whole sample population and selected respondents) were willing to pay a positive premium for carnosine included in NFT, the protein nutrient content claim and the VCP label and a negative premium for the carnosine health claim and the carnosine nutrient content claim. When segment the sample population into two classes, we found that respondents in class 1 had more significant and higher WTP for pork attributes, whereas respondents in class 2 had larger negative and more insignificant WTPs for pork attributes as compared to class 1.

Overall, the means of individual WTPs for the carnosine health claim, the carnosine nutrient content claim, carnosine included in the NFT, the protein nutrient content claim and VCP label were positively associated with one's nutrition knowledge score. The differences in magnitude between the means of WTPs for the carnosine label attributes and protein nutrient content claim may be due to consumers' unfamiliarity with the nutrient carnosine (Bech-Larsen and Scholderer, 2007).

However, consumers who had high nutrition knowledge (20–25) had slightly lower WTP for the carnosine nutrient content claim and the VCP label possibly due to the fact they might be more aware of better food sources and possibly less expensive alternative sources of these nutrients and pork attributes.

Chapter 5: Summary

5.1 Introduction

Functional foods are gaining in popularity. Carnosine enhanced pork, which can be produced through genomic selective breeding or animal feed, is a functional type of pork, with enhanced health attributes as compared to conventional pork. The aim of this thesis is to reveal the consumer purchase preferences for this functional pork. An overall discussion, research implications, and limitations will conclude this chapter.

5.2 Overall discussion

This thesis examined the preferences of Canadian consumers for carnosine enhanced pork, with different labeling attributes. Carnosine is a naturally occurring dipeptide that exhibits anti-aging properties and other health benefits. The labeling attributes for pork chops included in this study include whether there is a carnosine health claim, a carnosine nutrient content claim, whether carnosine is included in the nutrition facts table, a protein nutrient content claim, and a Verified Canadian pork label. Data were collected from an online national survey in 2015. A choice experiment was included in the survey to establish preferences for different product/label attributes.

The survey sample (992 individuals) has 50.4% females and 49.6% males. The sample consisted of respondents ranging from 18 to 65 plus years old, with an average age of 51. As compared to census 2006 and 2011 data, the respondents to this survey were slightly older. There were more respondents who resided in the Maritimes, Quebec and Manitoba in the survey than

that of the census population (both 2006 and 2011). Respondents had a mean level of education of 14 years, which is equivalent to a college completion. Respondents from the survey represented a higher education level but a lower income level than people in the census population (both 2006 and 2011) in general.

The two research objectives and results of this study are presented below.

Objective 1 was to examine the socio-demographic characteristics of Canadian consumers who had higher or lower preferences for carnosine enhanced pork with different food labels.

Using the online survey data set, conditional logit (CL), random parameters mixed logit (RPL) and latent class model (LCM) were employed to determine the effects of socio-demographic factors on consumers' purchase preferences for carnosine enhanced pork.

Regression results suggested that consumer preferences were very heterogeneous, with some of the variability stemming from consumers' socio-demographic characteristics and other variables. Results from the conditional logit and random parameters mixed logit regression models suggested that consumers who were younger, male, Québec residents and familiar with genomics (one of the possible techniques to increase the level of carnosine in the meat) preferred pork chops with a carnosine health claim. Being male and also being familiar with genomics contributed to a higher chance of purchasing pork chops with a carnosine nutrient content claim. Consumers who were older and had children under 18 in the household preferred pork chops with carnosine included in the nutrition facts table (NFT). Pork chops with a protein nutrient content claim were more desired by consumers who had children under 18 in the household, a lower level of education, and a higher level of income. Consumers who lived in rural areas,

resided in the province of Québec, and were familiar with genomics preferred pork chops with the Verified Canadian Pork (VCP) label. Consumers who purchased meat more frequently preferred pork chops with all label attributes. Latent class model results suggested two classes – the pro–label consumers and against–meat consumers, which contain 74.2% and 25.8% of the sample population, respectively. Class membership coefficients reveal that being male and having higher familiarity with genomics and higher frequency of purchasing meat increase the probability that the respondent belongs to class 1. Living in a city and not eating meat increases the probability that the respondent belongs to class 2. Specifically, 85% of the respondents who don't eat meat belong to class 2.

The average willingness to pay (WTP) for pork attributes calculated using coefficients from the three models is presented in Table 5.1.

Table 5.1: Consumers' Average WTP for Pork Attributes calculated from three models ($/package (0.405kg))

Attributes	CL		RPL		LCM class 1	LCM class 2
	Basic model	Model with interactions	Basic model	Model with interactions		
Carnosine health claim	-2.08***	-2.06***	-2.86***	-3.06***	-0.73***	-11.81***
Carnosine nutrient content claim	-1.39***	-1.40***	-1.59***	-1.76***	-0.13	-9.88***
Carnosine	0.12	0.12	0.49**	0.46**	0.68***	-1.39**

included in the NFT						
Protein nutrient content claim	1.03***	0.97***	1.00***	0.99***	1.27***	0.36
Verified Canadian Pork label	1.60***	1.51***	1.45***	1.42***	1.82***	0.24

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

The negative WTP for the carnosine health claim and the carnosine nutrient content claim indicated that consumers discounted the value of these attributes, on average, in all three models. Consumers in class 1 had an average WTP of $0 for the carnosine nutrient content claim. However, some consumers were willing to pay a positive premium for carnosine included in the NFT ($0.46/package from RPL and $0.684/package from LCM class 1), the protein nutrient content claim ($0.97/package from CL, $0.99/package from RPL, $1.283/package from LCM class 1), and VCP label ($1.51/package from CL, $1.42/package from RPL and $1.821/package from LCM class 1). Consumers in class 2 didn't prefer any of the pork attributes since 85% of the respondents in class 2 didn't eat meat.

Objective 2 was to investigate the role of nutrition knowledge and health consciousness as they affect the consumers' willingness to pay for the higher functional pork with different food labels.

The individual WTP values were grouped (and averaged) by corresponding individual

nutrition knowledge scores (sum of scores obtained from the five statements) and by the health consciousness score, broken down into three factors using factor analysis, (self-health awareness, personal responsibility, and health motivation).

The means of individual WTPs for the carnosine health claim, the carnosine nutrient content claim, carnosine included in the NFT, the protein nutrient content claim and VCP label were positively associated with one's nutrition knowledge score. The differences in magnitude between the means of WTPs for the two attributes may be due to consumers' unfamiliarity with the nutrient carnosine (Bech-Larsen and Scholderer, 2007).

However, likelihood ratio tests and regression results showed that three factors of health consciousness had an insignificant influence on consumer purchase preferences. Consumers who had high nutrition knowledge had slightly lower WTP for the carnosine nutrient content claim and the VCP label due possibly to their higher understanding of specific nutrients.

5.3 Implications

To date, few studies have evaluated the potential for developing functional foods from pork. This study contributes to the current knowledge about functional pork. As a contribution to the literature on functional foods, we evaluated a new product category (pork) and a new component with functional properties (carnosine).

Understanding how consumers make a decision about a new product is important, ex-ante. The results provide valuable insights for food companies and farming sectors on assessing the feasibility of the product. It allows producers to make better decisions on whether to alter

breeding or feeding animals. It allows food companies to make better decisions on allocating R&D investments for product development and designing future product marketing strategies specifically regarding whom to target. For example, based on our study, consumers who are young, male, familiar with genomics, and have a high frequency of purchasing meat are more likely to purchase a functional product like the carnosine enhanced pork. Since heterogeneity exists among consumers with different socio-demographic characteristics, functional pork can be designed for specific groups rather than being aimed at the whole marketplace.

Effective uptake of functional foods has the possibility of increasing public health, an important outcome for governments. The research allows the government to create regulations and information programs that may meet consumers' needs better in terms of food labeling. For example, in the context of carnosine, consumers preferred carnosine included in the NFT to the carnosine health claim or the carnosine nutrient content claim. It can be due to the claim mechanism or the carnosine attribute itself, which is not likely to be familiar to the general public at this time. It can also be due to the unfamiliarity with the concept of finding anti-aging properties, associated with health rather than appearance, being labeled on food products.

The necessity to have consumer familiarity with food technologies and with the nutrient of focus in a marketing campaign should also be emphasized. For example, consumers who were familiar with genomics preferred pork chops with the carnosine health claim and the carnosine nutrient content claim (and vice versa, possibly affected by the structure of the survey that focused more broadly on genomics prior to the stated preference exercise studied here). The negative WTP for carnosine attributes may have been due to the general lack of knowledge about

the nutrient carnosine. Approaches that increase consumers' nutrition knowledge about food in general, raise one's self-health awareness, personal responsibility and health motivations, and increase familiarity with food technology through social marketing and educational campaigns involving public information provision could contribute to healthier food decisions.

5.4 Limitations and future research

As the carnosine enhanced pork is a hypothetical product at the time of the survey and this study, it was beneficial to use choice experiments in this thesis to reveal consumer behaviour. However, the potential existence of hypothetical bias and strategic behavior should not be ignored.

In the pork survey, which provided the data of this study, information about carnosine was provided in a scientifically accurate form; however, it may cause obstacles in respondents' understanding about the health benefit of carnosine. It is unknown whether the survey language is one of the reasons for respondents' low interest in the pork attribute carnosine.

In this thesis, only a limited number of explanatory variables, out of all the potential factors influencing food choices indicated in the conceptual framework, were included in the model. Other explanatory variables were included in the survey from which this analysis was conducted. Including factors, such as consumers' animal attitudes (Schröder and McEachern, 2004), trust (Krystallis and Chryssohoidis, 2005) and food safety risk perceptions (Tonsor et al., 2009), can be a possible extension of this research if the conceptual framework were to be more broadly applied in the future. Redoing the survey without any mention of the technology required to

enhance the level of the nutrient might be a useful extra study. Providing more and different types of information (as treatments in the stated preference experiment) on carnosine and how it works might also allow the research to more accurately target the specific market segments who would respond most significantly to the introduction of this nutrient. Knowing the fact that consumers may have low interests in the attribute carnosine in pork chops; future studies that investigate the potential reasons of their low interest can be necessary. For example, does the use of genomic selection technology raises a red flag to consumers who prefer natural products? Other experimental methods, such as auctions, could be useful tools to assess consumer preferences for this type of functional food in future studies.

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Appendices

Appendix A: How to calculate protein rating

Protein rating = Protein in a reasonable daily intake * Protein efficiency ratio (PER) (Canadian Food Inspection Agency, 2016)

Calculating the protein rating of pork tenderloin roasted:

Percent (%) protein = 28 (Canadian Pork Council, 2013)

Reasonable daily intake = 100 g (Canadian Food Inspection Agency, 2016)

Protein in a reasonable daily intake = 0.28*100 g = 28 g

PER = 2.7 (Canadian Food Inspection Agency, 2016)

Protein rating = 28*2.7 = 75.6

Appendix B: Survey Instrument

Food and everyday life

1.

How often are you involved in the regular grocery shopping for your household?

Never	Once in a while	Occasionally	Frequently	Always
1	2	3	4	5
❒	❒	❒	❒	❒

2.

How often do you buy organic foods?

Never	Infrequently	Occasionally	Frequently	Every time I buy food
1	2	3	4	5
❒	❒	❒	❒	❒

3.

Which of the following best describes your food preferences?

1	❒	I eat meat from most animals, seafood and fish
2	❒	I eat seafood and fish but don't eat meat
3	❒	I do eat meat but I don't eat fish or seafood
4	❒	I am a vegetarian (I don't eat either meat or fish/seafood)
5.	❒	I am a vegan (I eat no animal products including dairy products, eggs, seafood, fish, white meat and red meat)

4.

Have you ever chosen not to purchase a particular food product for any reasons listed below:

	Yes	***No***
1.You were concerned that the food was unsafe to eat	❒	❒
2. You heard about environmental damage caused through production of the food	❒	❒
3. You were concerned about the treatment of animals in production of the product	❒	❒

4. For religious reasons ❒ ❒
5. You were concerned that it was a genetically engineered food ❒ ❒
6. Other – please describe_____ ❒ ❒

Food

5. How much trust do you have in the following groups or institutions regarding their responsibility for food in Canada? (scores range from 1 = no trust to 5 = absolute trust)

	No trust	Some trust	Moderate Trust	Trust	Absolute Trust
Farmers					
Food processors or manufacturers					
Research organizations/universities					
Pharmaceutical industry which provides drugs to treat animals					
Government agencies/public authorities					
Advocacy consumer organizations					
Advocacy environmental organizations					
Advocacy organizations for animal welfare					
Retailers					

6. How do you rate the health risks for consumers of regular consumption of the following?

	Very low risk	Low risk	Moderate risk	High risk	Very high risk	Don't Know
Vitamin and/or mineral food supplements						
Foods enriched with vitamins or minerals						
Foods with pesticide or other chemical residues						
Genetically modified food (GMOs)						
Preservatives and/or artificial coloring						
Meat/ fish with hormone or antibiotic residues						
Foods made with ingredients that are produced by nanotechnology						
Foods packaged in containers produced by nanotechnology to inhibit spoilage						

7. Please respond to the following statements**:**

	Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
Natural product interest					
1. I try to eat foods that do not contain additives					
2.R I do not care about additives in my daily diet.					
3. I do not eat processed foods, because do not know what they contain					
4. I would like to eat only organically grown vegetables					
5.R In my opinion, artificially flavoured foods are not harmful for my health.					
6.R In my opinion, organically grown foods are no better for my health than those grown conventionally					
General health interest					
1.R The healthiness of food has little impact on my food choices					
2. I am very particular about the healthiness of food I eat.					
3.R I eat what I like and I do not worry much about the healthiness of food.					
4. It is important for me that my diet is low in fat.					
5. I always follow a healthy and balanced diet.					
6. It is important for me that my daily diet contains a lot of vitamins and minerals.					
7.R The healthiness of snacks makes no difference to me.					
8.R I do not avoid foods, even if they may raise my cholesterol.					
Pleasure					
1.R I do not believe that food should always be source of pleasure					
2.R The appearance of food makes no difference to me.					
3. When I eat, I concentrate on enjoying the taste of food.					
4. It is important for me to eat delicious food on weekdays as well as weekends.					
5. An essential part of my weekend is eating delicious food.					
6.R I finish my meal even when I do not like the taste of a food.					

Science and Technological Development

8. In general, to what extent do you feel knowledgeable about scientific and technological developments? 1 means that "you have little knowledge", and 10 means that "you know a lot."

1	2	3	4	5	6	7	8	9	10

9. All things considered, would you say that the world is better off, or worse off, because of science and technology? 1 means that "the world is a lot worse off," and 10 means that "the world is a lot better off."

1	2	3	4	5	6	7	8	9	10

10. When you hear the word technology is your reaction:

Negative		Neutral		Positive	Don't Know
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

11. When you hear the word biotechnology is your reaction:

Negative		Neutral		Positive	Don't Know
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

12. How would you describe your familiarity with biotechnology?

Not at all Familiar	Not Very Familiar	Somewhat Familiar	Very Familiar
1	2	3	4
☐	☐	☐	☐

13. In general, to what extent do you support or oppose the use of products and processes that involve

biotechnology?

Strongly Oppose	Somewhat Oppose	Somewhat Support	Strongly Support
1	2	3	4
☐	☐	☐	☐

14. Would you buy fruit or vegetables that you know are genetically modified?

Definitely Not	Probably not	Neutral	Probably	Definitely
1	2	3	4	5
☐	☐	☐	☐	☐

15. Would you buy a food product with a genetically modified ingredient, for example, margarine, made with genetically modified canola oil?

Definitely Not	Probably not	Neutral	Probably	Definitely
1	2	3	4	5
☐	☐	☐	☐	☐

16. Before you filled out this questionnaire, did you ever….?

	No, never	Once or twice	On a few occasions	Yes, often
Read information about biotechnology				
Talk to someone about biotechnology				
Search for information about biotechnology in a library or on the internet				
Attend a public meeting where biotechnology was discussed				
Participate actively in discussions about biotechnology				

17. Please identify whether you agree or disagree with the following statements:

	Strongly disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly agree	Don't know
	1	2	3	4	5	6
The government is doing a good job with respect to regulation of biotechnology	☐	☐	☐	☐	☐	☐
The government is competent enough to deal with regulation of biotechnology	☐	☐	☐	☐	☐	☐
The government is acting in the public interest with regard to regulation of biotechnology	☐	☐	☐	☐	☐	☐
The government is too influenced by industry regarding biotechnology regulation	☐	☐	☐	☐	☐	☐
The government provides all relevant information about biotechnology and its regulation to the public	☐	☐	☐	☐	☐	☐
I feel confident that the Canadian government adequately regulates the use of biotechnology	☐	☐	☐	☐	☐	☐

Genomics is the study of the genes and genetic characteristics of organisms like plants, animals, and humans. Genes carry information that determines many of the features and characteristics of organisms. A genome is all of the genes in an organism. The Human Genome Project and the sequencing of the SARS virus are examples of research in Genomics related to humans. Similar research is identifying traits in crops and livestock.

18. Have you ever heard about genomics?
    1. _____ Yes
    2. _____ No

19. When you hear the word genomics is your reaction

Negative		Neutral		Positive	Don't Know
1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

20. How would you describe your familiarity with genomics?

Not at All Familiar	Not Very Familiar	Somewhat Familiar	Very Familiar
1	2	3	4
☐	☐	☐	☐

21. Please rate your attitude towards the study of *genomics* for each seven point scale item.

		1	2	3	4	5	6	7	
1	Important								Unimportant*
2	Boring								Interesting
3	Relevant								Irrelevant*
4	Exciting								Unexciting*
5	Means nothing to me								Means a lot to me
6	Appealing								Unappealing*
7	Fascinating								Uninteresting*
8	Worthless								Valuable
10	Not necessary								Necessary

22. Please identify whether you agree or disagree with the following statements:

Statement	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree
	1	2	3	4	5
I worry about changes to the countryside, such as the loss of native plants and animals					
There is nothing I can personally do to help stop the losses in the world's biodiversity					
We can afford to lose some of the world's biodiversity					
Biodiversity losses in animals domesticated for food production are less serious than similar losses in wildlife					

23. To what extent do you feel knowledgeable about environmental problems? 1 means that "you have little knowledge", and 10 means that "you know a lot."

1	2	3	4	5	6	7	8	9	10

24. Please identify whether you agree or disagree with the following statements:

	Strongly Disagree	Mildly Disagree	Neither agree nor disagree	Mildly Agree	Strongly Agree
Human beings can progress only by conserving nature's resources					
Human beings can enjoy nature only if they make wise use of its resources.					
Human progress can be achieved only by maintaining ecological balance.					
Preserving nature at the present time means ensuring the future of human beings					
We must reduce our consumption levels to ensure well-being of the present and future generations					

25. Please indicate which one of the following statements corresponds most with your view on nature: **only one answer is possible**

_____ Environmental problems can only be controlled by enforcing radical changes in human behavior in society as a whole.

_____ Environmental problems are not entirely out of control, but the government should dictate clear rules about what is and what is not allowed.

_____ We do not need to worry about environmental problems because in the end, these problems will always be resolved by technological solutions.

_____ We do not know whether environmental problems will magnify or not.

Animal Attitudes, Anthropomorphism

26. Please identify whether you agree or disagree with the following statements:

Statement	Strongly Disagree	Mildly Disagree	Neither Agree or Disagree	Mildly Agree	Strongly Agree
1.It is morally wrong to hunt animals for sport					
2.Wild animals, such as mink and raccoon, should not be trapped so that their skins can be made into fur coats					
3.There is nothing morally wrong with hunting wild animals for food					
4.I think people who object to raising animals for					

meat are too sentimental						
5.I think it is perfectly acceptable for cattle and hogs to be raised for human consumption						
6.Basically, humans have the right to use animals as we see fit						
7.The slaughter of whales and dolphins should be immediately stopped even if it means some people will be put out of work						
8.I sometimes get upset when I see wild animals in cages at zoos.						
9.Too much fuss is made over the welfare of animals these days when there are many human problems that need to be solved						
10.Continued research with animals is necessary if we are ever to be able to conquer diseases such as cancer, heart disease and AIDS.						
11.It is unethical to breed purebred dogs for pets when millions of dogs are killed in animal shelters each year.						
12.The production of inexpensive meat, eggs and dairy products justifies maintaining animals under crowded conditions						
13.One of the worst things someone can do is to hurt a defenceless animal						

27. How important or unimportant are the following to the welfare of pigs that are reared for food production?

Item	Not Important At All		Important		Extremely Important	Don't Know
	1	2	3	4	5	6
Healthy living conditions						
Skilled attention						
Clean environment						
Environment free from disease						
Medical treatment when the pig is sick						
Comfortable living						

conditions						
Nutrition to strengthen the pig's immune system						
Adaptation of the housing system to the needs of the pig						
Food to satisfy the pig and to optimize its growth and health						
Space to allow the pig to be on its own						
Variation or diversity in the living environment						
Prevention of stressful situations						
Providing an environment that allows the animals to experience little or no fear						

28. How satisfactory or unsatisfactory are the current conditions under which pigs are being raised in Canada?

Item	Extremely Unsatisfactory		Neutral		Highly Satisfactory	Don't Know
	1	2	3	4	5	6
Healthy living conditions						
Skilled attention						
Clean environment						
Environment free from disease						
Medical treatment when the pig is sick						
Comfortable living conditions						
Nutrition to strengthen the pig's immune						

system						
Adaptation of the housing system to the needs of the pig						
Food to satisfy the pig and to optimize its growth and health						
Space to allow the pig to be on its own						
Variation or diversity in the living environment						
Prevention of stressful situations						
Providing an environment that allows the animals to experience little or no fear						

29. Do you eat pork?

1. _____ Yes
2. _____ No

If no then please go to question 31.

Genomic Analysis

Genomics is the study of the genes and genetic characteristics of organisms like plants, animals, and humans. The study of genomics in hogs can allow for: the identification of specific genes that are linked to disease susceptibility (there are a number of current diseases within the hog industry including PCVAD, PRRS and PED, for example), the identification of specific genes that could be linked to enhanced feed efficiency (also leading to reduced manure) or the identification of genes linked to particular compounds in hogs/pork that could be beneficial for both hog and consumer health (one example is carnosine).

With knowledge of the presence (absence) of any of these genes, selective breeding (selecting particular boars or semen and particular sows that genetics suggest would produce progeny with the desired traits) could produce hogs with significantly lower probabilities of contracting disease, or high probabilities of increasing feed efficiency or higher probabilities of increased levels of human health beneficial components of the meat.

Hog Diseases

Porcine Circovirus Associated Diseases (PCVAD), Porcine Reproductive and Respiratory Syndrome (PRRS) and Porcine Epidemic Diarrhea (PED) are three highly infectious diseases that occur in pig populations. They

have serious implications for both hogs and hog farmers. PCVAD is associated with weight loss or decreased rate of weight gain, paleness or jaundice, and gauntness and a failure to grow in pigs. PRRS has been linked to reductions in farrowing rates (number of piglets born per sow), increased numbers of stillbirths and in some cases, abortion storms in sows and death in pigs. PED is associated with watery diarrhea and significant deaths of piglets. The highly contagious nature of the diseases usually makes it necessary that all hogs in an affected production enterprise be destroyed. Economic costs are very high for hog producers. There is no possibility that the diseases can be transferred to people through eating pork from animals with low or indistinguishable levels of the diseases.

Feed Efficiency

Feed is one of the largest inputs in any livestock operation. Producing hogs with higher levels of feed efficiency would reduce the feed required per pound (KG) of animal being fed. With knowledge of the presence (absence) of feed efficiency genes, selective breeding can produce hogs that are more efficient converters of feed into meat, reducing greenhouse gases (reduced manure production) and improving farm profitability.

Enhanced Health Attributes of Hog/Meat

Carnosine, a natural molecule (or compound) present in the muscle of animals and humans, has been observed to exert anti-aging activity at cellular and whole animal levels (including potentially people who may consume sufficient quantities in meat). Carnosine is available in fish and meat products only and has been shown to be in available in high quantities in pork. The therapeutic potential of carnosine has been tested in numerous diseases in which ischemia or oxidative stress are involved. For several pathologies, such as diabetes and its complications, ocular disease, aging, and neurological disorders, promising preclinical and clinical results have been obtained. Selective breeding based on genomic information could be used to breed hogs with higher levels of carnosine which would be available in the pork from those hogs.

In what follows we will present you with information about three packages of pork chops, as sold in grocery stores. Currently, the average price of this type of pork chop is $4.49 per lb. (Only one answer is possible)

30. 1

“Pork Chop **A**“	**“Pork Chop B”**	**Pork Chop C**	**Option D**
 This pork chop is produced in a Canadian family hog farm.	 This pork chop is produced in a Canadian family hog farm.	 This pork chop is produced in a Canadian family hog farm.	I would not purchase any of these pork chops

The farm satisfies all of the criteria as Canadian Quality Assured (CQA®) for on farm safety protocols. The hogs are fed 100% grain (no animal by-products)	The farm satisfies all of the criteria as Canadian Quality Assured (CQA®) for on farm safety protocols. The hogs are fed 100% grain (no animal by-products) In addition this hog is raised on a farm where the hogs have been selectively bred to have a significantly lower probability of having a number of hog contagious diseases.	The farm satisfies all of the criteria as Canadian Quality Assured (CQA®) for on farm safety protocols. The hogs are fed 100% grain (no animal by-products) In addition the hogs have been selectively bred to have higher levels of carnosine, a compound that has been shown to have anti-aging properties, In their pork.	
	No antibiotics used in production	Antibiotics are only used when prescribed by a veterinarian to treat a disease or infection	
$9.90 per kg	$14.85 per kg	$24.72 per kg	
Pork Chop A	**Pork Chop B**	**Pork Chop C**	**Option D**

31. How risky do you consider *the use of genomic information, to undertake selective breeding* for disease resistance, feed efficiency or increased carnosine in hogs, to be for your health? (should be randomized and 1/3 should see disease resistance, 1/3 should see feed efficiency and 1/3 should see increased carnosine – the same selection to be used in question 32)

Not at All Risky	Some Risk	Moderate Risk	Risky	Very Risky
1	2	3	4	5
☐	☐	☐	☐	☐

32. How beneficial do you consider the *use of genomic information to undertake selective breeding* for disease

resistance, feed efficiency or increased carnosine in hogs to be for your health?

Not at All Beneficial	Some Benefits	Moderate Benefits	Beneficial	Very Beneficial
1	2	3	4	5
☐	☐	☐	☐	☐

33. For you, the use of *genomic information to undertake selective breeding to reduce disease susceptibility* in hogs is: (will be randomized 1/3 of the sample should see reduced disease susceptibility, 1/3 should see increased feed efficiency and 1/3 should see increased carnosine)

		1	2	3	4	5	6	7	
1	Useless								Useful
2	Worthless								Valuable
3	Harmful								Beneficial
4	Foolish								Wise
5	Awful								Nice
6	Disagreeable								Agreeable
7	Unpleasant								Pleasant

34. Please identify whether you agree or disagree with the following statements.

	Statement	Strongly Disagree	Mildly Disagree	Neither Agree or Disagree	Mildly Agree	Strongly Agree
		1	2	3	4	5
1	Animal vaccinations cannot be seriously harmful; otherwise, authorities would ban them					
2	There is a good reason why certain animal vaccinations are recommended					
3	Overall, animal vaccinations deliver more					

	benefits than harm					
4	We live in such a hygienic environment that animal vaccinations are redundant					
5	For serious animal diseases, requirements for farmers to vaccinate should be in place					
6	Vaccination is a better strategy than destroying the affected animals					
7	Animal vaccinations are another important factor that is threatening the environment					
8	Consuming meat from vaccinated animals can result in my becoming immune to the illness					

35. Would you eat pork, ham or bacon from pigs vaccinated against a pig disease that is not dangerous for people (e.g., foot and mouth disease) but can be very serious for pigs?

Yes	No	Don't Know
1	2	3
☐	☐	☐

Carnosine, a natural molecule (or compound) present in the muscle of animals and humans, has been observed to exert anti-aging activity at cellular and whole animal levels (including potentially for people who may consume sufficient quantities in meat). Carnosine is available in fish and meat products only and has been shown to be in available in high quantities in pork. The therapeutic potential of carnosine has been tested in numerous diseases in which ischemia or oxidative stress are involved. For several pathologies, such as diabetes and its complications, ocular disease, aging, and neurological disorders, promising preclinical and clinical results have been obtained. Carnosine levels in pork can be increased through what hogs are fed or by selectively breeding hogs with higher levels of existing carnosine.

36

Please select one pork chop or Option C for each one of the following choice sets. Make your decision as if these were the only pork chops available in the grocery store.

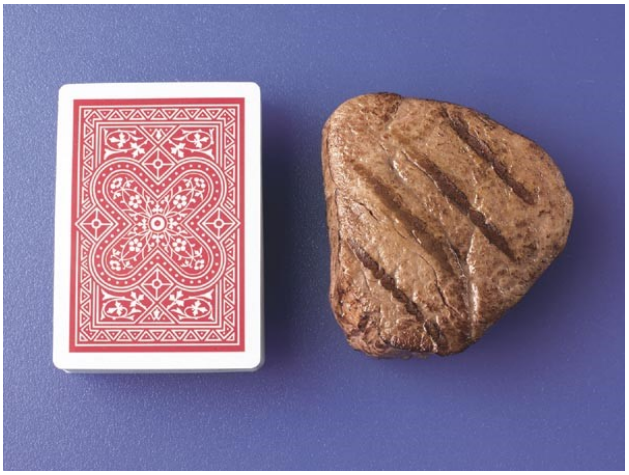
Please select one pork chop or Option C for each one of the following choice sets.

Pork Chop A.

Pork Chop B.

Option C.
I would not purchase either of these pork chops

37. Please respond to each of the statements



100 gms of pork approximate size

	Statement	Strongly Disagree/ Very Uncertain	Disagree/ Uncertain	Neutral	Agree/ Certain	Strongly Agree/ Very Certain
1	In a 100 gm portion of pork there is only 2 % of your recommended daily value of sodium.					
2	In a 100 gm portion of pork, there are 25-29 gms of protein.					
3	In a 100 gm portion of pork, there is 6% of your recommended daily intake of iron.					
4	In a 100 gm portion of a grilled pork loin centre chop there are approximately 174 calories.					
5	In a 100 gm portion of a grilled pork loin centre chop there is only 3.8 gms of fat about 5% of your recommended dairy value of total fat.					

Section 3: Background Questions

38. Over the past week, how many days did you…?

	Not at all	**Once**	**Twice**	**Three times**	**More than three times**
	1	**2**	**3**	**4**	**5**
Watch the national news on television					
Watch the local news on television					
Listen to talk radio about news issues					
Read the front section of a national newspaper such as the Globe and Mail, National Post					
Read the front section of a local newspaper?					
Read a newsmagazine					
Read the news on the Internet					
Use the internet to search for information on a topic related to food, agriculture, science or technology.					
Use Facebook to search for information on a topic related to food, agriculture, science or technology					
Use Twitter to search for information on a topic related to food, agriculture, science or technology					
Use any other social media site to search for information on a topic related to food, agriculture, science or technology					
Use the internet to search for recipes					

39. In the past year, how often have you attended a regular service at a place of worship?

Never	Once in a while	Occasionally	Frequently (more than once per month)	Regularly (once per week)
1	2	3	4	5
❒	❒	❒	❒	❒

40. Do you, or someone you are related to, own or work on a ranch or farm?

1. ❒ Yes
2. ❒ No

41. Do you have familiarity with livestock production?

1. ❒ Yes
2. ❒ No

42. Do you currently live/work on a hog farm?

1. ❒ Yes
2. ❒ No

43. Approximately how often do you purchase meat, such as beef, pork, or poultry?

Never	A Few Times a Year	About once per month	About once per week	Every day
1	2	3	4	5

44. When you buy meat, is it usually from …	(One ONLY)	
a supermarket,	❒	**1**
a butcher's shop	❒	**2**
another small shop	❒	**3**
a farmer's market	❒	**4**
or another way (directly from a farm or through acquaintances)	❒	**5**

45. Please describe your pork eating experience (if you eat pork)

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The last time I ate pork I thought the meat was extremely good					
2	On average I always find eating pork to be an enjoyable experience					
3	I have never had a bad experience with pork quality in a meal					

46. In which of the following age groups do you fall?

1. ❒ 18-20
2. ❒ 21-24
3. ❒ 25-29
4. ❒ 30-39
5. ❒ 40-49
6. ❒ 50-64
7. ❒ 65+

47. Generally speaking, would you say that most people can be trusted?		
Most people can be trusted	Can't be too careful in dealing with people	Don't know
1	2	3
❒	❒	❒

48. Would you say that most people would try to take advantage of you if they got the chance or would they try to be fair?

Most people would try to take advantage of me	Most people would be fair	Don't know

1	2	3
❒	❒	❒

49. Would you say that most of the time people try to be helpful or that they are mostly looking out for themselves?

People mostly look out for themselves	People mostly try to be helpful	Don't know
1 ❒	2 ❒	3 ❒

50. When you decide whether an action taken by someone is right or wrong, to what extent are the following considerations relevant to your thinking?

	Not at all relevant	Not very relevant	Slightly relevant	Somewhat relevant	Very relevant	Extremely relevant
Whether or not the person suffered emotionally						
Whether or not the person protected someone weak or defenceless						
Whether or not the person was cruel						
Whether or not some people were treated differently than others						
Whether or not the person acted unfairly						
Whether or not the person was denied their rights						

51. Please state your agreement/disagreement with the following statements

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
HC1: I'm very self-conscious about my health.					
HC2: I'm generally attentive to my inner feelings about my health.					

HC3: I reflect about my health a lot.					
HC4: I'm concerned about my health all the time.					
HC5: I notice how I feel physically as I go through the day.					
HC6: I take responsibility for the state of my health.					
HC7: Good health takes active participation on my part.					
HC8: I only worry about my health when I get sick. (R)					
HC9: Living life without disease and illness is very important to me.					
HC10: My health depends on how well I take care of myself.					
HC11: Living life in the best possible health is very important to me.					

52. Please indicate if you are:

1. ❒ Male
2. ❒ Female

53. Including yourself, how many people live in your household?

1. ❒ 1
2. ❒ 2
3. ❒ 3
4. ❒ 4
5. ❒ 5 or more

54. How many children younger than 18 live in your household?

1. ❒ No children < 18 years live in my house
2. ❒ 1
3. ❒ 2
4. ❒ 3

5. ❒ 4
6. ❒ More than 4

55. What is the highest level of education you've achieved? **ONLY ONE ANSWER POSSIBLE**

1. ❒ Elementary school
2. ❒ Secondary (high) school
3. ❒ Technical/ business school/Community college
4. ❒ University
5. ❒ Post graduate studies (Masters or PhD)

56. Which region do you live in? **ONLY ONE ANSWER POSSIBLE**

1. ❒ Maritimes
2. ❒ Quebec
3. ❒ Ontario
4. ❒ Manitoba
5. ❒ Saskatchewan
6. ❒ Alberta
7. ❒ British Columbia
8. ❒ Yukon, Northwest Territories, Nunavut

57. Do you live in a city, in a town or in the countryside? **ONLY ONE ANSWER POSSIBLE**

1. ❒ In a city (>100.000 inhabitants)
2. ❒ In a town (> 10.000 inhabitants)
3. ❒ In the countryside/rural district

58. What is the approximate range of your total household income? **ONLY ONE ANSWER POSSIBLE**

1. ❒ $ 24,999 or under
2. ❒ Between $ 25,000 and $ 39,999
3. ❒ Between $ 40,000 and $ 64,999
4. ❒ Between $ 65,000 and $ 79,999

5. ❒ Between $ 80,000 and $ 99,999
6. ❒ Between $ 100,000 and $ 119,999
7. ❒ $ 120,000 or more

Appendix C: Net Favorable Percentage Table for Health and Taste Attitude Scale

Natural product interest	Mean	SD	Min	Max	NFP	Response is defined as
1.I try to eat foods that do not contain additives	3.5	0.9	1	5	0.4	Natural
2.R I do not care about additives in my daily diet.	3.2	1.1	1	5	0.2	Natural
3. I do not eat processed foods, because do not know what they contain	2.9	1.0	1	5	-0.1	Natural
4. I would like to eat only organically grown vegetables	2.9	1.1	1	5	0	Natural
5.R In my opinion, artificially flavoured foods are not harmful for my health.	3.4	0.9	1	5	0.3	Natural
6.R In my opinion, organically grown foods are no better for my health than those grown conventionally	2.8	1.0	1	5	-0.1	Natural
General health interest						
1.R The healthiness of food has little impact on my food choices	3.4	1.0	1	5	0.3	Natural
2. I am very particular about the healthiness of food I eat.	3.4	0.9	1	5	0.3	Natural
3.R I eat what I like and I do not worry much about the healthiness of food.	3.2	1.0	1	5	0.2	Natural
4. It is important for me that my diet is low in fat.	3.3	0.9	1	5	0.3	Natural
5. I always follow a healthy and balanced diet.	3.1	0.9	1	5	0.1	Natural
6. It is important for me that my daily diet contains a lot of vitamins and minerals.	3.5	0.8	1	5	0.5	Natural
7.R The healthiness of snacks makes	3.4	1	1	5	0.3	Natural

no difference to me.						
8.R I do not avoid foods, even if they may raise my cholesterol.	3.0	1	1	5	0	Natural
Pleasure						
1.R I do not believe that food should always be source of pleasure	3.2	1	1	5	0.2	Natural
2.R The appearance of food makes no difference to me.	3.6	0.9	1	5	0.5	Natural
3. When I eat, I concentrate on enjoying the taste of food.	3.8	0.7	1	5	0.7	Natural
4. It is important for me to eat delicious food on weekdays as well as weekends.	3.9	0.7	1	5	0.8	Natural
5. An essential part of my weekend is eating delicious food.	3.4	0.8	1	5	0.3	Natural
6.R I finish my meal even when I do not like the taste of a food.	3.4	1	1	5	0.3	Natural

Source: Obtained from survey data of this thesis

Appendix D: Net Favorable Percentage Table for Science and Technological Development

	Scale	Mean	SD	Min	Max	NFP	Response is defined as
Knowledgeable about scientific and technological developments	1 means that "you have little knowledge", and 10 means that "you know a lot."	5.36	2.481	1	11	-4.33468	Neutral
Would you say that the world is better off, or worse off, because of science and technology	1 means that "the world is a lot worse off," and 10 means that "the world is a lot better off."	7.03	2.193	1	11	43.44758	Very favorable
Reaction to the word technology	1 means "negative", and 5 means "positive"	3.77	0.969	1	6	50.50403	Very favorable
Reaction to the word biotechnology	1 means "negative", and 5 means "positive"	3.51	1.231	1	6	15.32258	Slightly favorable
Familiarity with biotechnology	1 means "not at all familiar", and 4 means "very familiar"	2.05	0.744	1	4	-45.7661	Very unfavorable
Do you support or oppose the	1 means "strongly	2.55	0.607	1	4	11.69355	Neutral

use of products and processes that involve biotechnology	oppose", and 4 means "strongly support"						
Would you buy fruit or vegetables that you know are genetically modified	1 means "definitely not", and 5 means "definitely"	2.64	1.073	1	5	-24.6976	Slightly unfavorable
Would you buy a food product with a genetically modified ingredient	1 means "definitely not", and 5 means "definitely"	2.72	1.092	1	5	-16.5323	Slightly unfavorable
Have you ever heard about genomics	1 means "yes", and 2 means "no"	1.63	0.482	1	2	-26.8145	Slightly unfavorable
Reaction to the word genomics	1 means "negative", and 5 means "positive"	3.55	1.268	1	6	10.08065	Neutral
Familiarity with genomics	1 means "not at all familiar", and 4 means "very familiar"	1.71	0.783	1	4	-63.7097	Very unfavorable

Source: Obtained from survey data of this thesis

Appendix E: Example of data set-up for TSP

ID	Choice	p1	p2	p3	HelC1	HelC2	HelC3	NutriC…	NFT…	Proti…	VCP…	neither…
5	1	0	10.01	10.01	0	0	0	0	0	0	0	1
5	1	0	10.01	8.01	0	1	1	0	0	0	0	1
5	1	0	8.01	10.01	0	0	0	0	0	0	0	1
5	1	0	6.01	8.01	0	0	0	0	0	0	0	1
5	2	0	4.01	6.01	0	1	0	0	0	0	0	1
5	1	0	10.01	8.01	0	1	0	0	0	0	0	1
5	1	0	10.01	6.01	0	0	1	0	0	0	0	1
5	2	0	4.01	10.01	0	0	0	0	0	0	0	1
6	2	0	8.01	8.01	0	0	1	0	0	0	0	1
6	2	0	6.01	10.01	0	0	1	0	0	0	0	1
6	2	0	4.01	4.01	0	0	0	0	0	0	0	1
6	3	0	8.01	4.01	0	0	1	0	0	0	0	1
6	2	0	6.01	8.01	0	0	0	0	0	0	0	1
6	2	0	4.01	10.01	0	0	0	0	0	0	0	1
6	2	0	4.01	6.01	0	0	0	0	0	0	0	1
6	3	0	10.01	4.01	0	0	0	0	0	0	0	1
7	3	0	6.01	4.01	0	1	0	0	0	0	0	1
7	2	0	6.01	4.01	0	0	0	0	0	0	0	1
7	1	0	4.01	4.01	0	1	1	0	0	0	0	1
7	2	0	4.01	8.01	0	0	1	0	0	0	0	1
7	3	0	10.01	6.01	0	0	0	0	0	0	0	1
7	3	0	8.01	4.01	0	0	0	0	0	0	0	1
7	3	0	6.01	6.01	0	1	0	0	0	0	0	1
7	2	0	6.01	10.01	0	0	0	0	0	0	0	1

Source: Obtained from survey data of this thesis

Appendix F: Example of data set-up for Nlogit

ID	alt	nalt	choice	helc	nutric	nft	proti	vcp	p	neither
5	1	3	1	0	0	0	0	0	0	1
5	2	3	0	0	1	0	0	1	10.01	0
5	3	3	0	0	0	0	1	0	10.01	0
5	1	3	1	0	0	0	0	0	0	1
5	2	3	0	1	0	0	0	1	10.01	0
5	3	3	0	1	0	0	0	1	8.01	0
5	1	3	1	0	0	0	0	0	0	1
5	2	3	0	0	1	0	1	1	8.01	0
5	3	3	0	0	0	1	1	1	10.01	0
5	1	3	1	0	0	0	0	0	0	1
5	2	3	0	0	0	0	0	1	6.01	0
5	3	3	0	0	1	0	1	0	8.01	0
5	1	3	0	0	0	0	0	0	0	1
5	2	3	1	1	0	0	1	0	4.01	0
5	3	3	0	0	0	1	0	1	6.01	0
5	1	3	1	0	0	0	0	0	0	1
5	2	3	0	1	0	0	1	0	10.01	0
5	3	3	0	0	0	1	1	0	8.01	0
5	1	3	1	0	0	0	0	0	0	1
5	2	3	0	0	0	0	1	1	10.01	0
5	3	3	0	1	0	0	0	0	6.01	0
5	1	3	0	0	0	0	0	0	0	1
5	2	3	1	0	0	1	0	0	4.01	0
5	3	3	0	0	1	0	1	1	10.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	1	0	1	0	0	0	8.01	0
6	3	3	0	1	0	0	0	0	8.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	1	0	0	1	1	0	6.01	0
6	3	3	0	1	0	0	1	0	10.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	1	0	1	0	0	1	4.01	0
6	3	3	0	0	0	0	0	1	4.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	0	0	0	1	1	0	8.01	0
6	3	3	1	1	0	0	0	1	4.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	1	0	0	1	0	1	6.01	0
6	3	3	0	0	0	1	0	1	8.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	1	0	0	0	0	0	4.01	0
6	3	3	0	0	0	1	0	0	10.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	1	0	1	0	1	0	4.01	0
6	3	3	0	0	1	0	1	0	6.01	0
6	1	3	0	0	0	0	0	0	0	1
6	2	3	0	0	0	0	0	0	10.01	0
6	3	3	1	0	0	1	1	1	4.01	0

Source: Obtained from survey data of this thesis

Appendix G: Experimental Design of 2015 Pork Survey

Set	PorkChop	Carnosine	Protein	welfare	Price
1	PorkChop1	Excellent Carnosine	No protein	Conventional	$8.98
	Porkchop2	Carnosine Health	No protein	Conventional	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
2	PorkChop1	Nutrition Facts	Excellent Protein	Conventional	$6.74
	Porkchop2	Carnosine Health	Excellent Protein	Conventional	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
3	PorkChop1	Excellent Carnosine	No protein	Pork Code of Conduct	$4.49
	Porkchop2	Nothing	No protein	Pork Code of Conduct	$4.49
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
4	PorkChop1	Nutrition Facts	Excellent Protein	Conventional	$8.98
	Porkchop2	Carnosine Health	No protein	Pork Code of Conduct	$4.49
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
5	PorkChop1	Nutrition Facts	No protein	Pork Code of Conduct	$6.74
	Porkchop2	Nutrition Facts	No protein	Pork Code of Conduct	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
6	PorkChop1	Nothing	No protein	Conventional	$4.49
	Porkchop2	Nutrition Facts	No protein	Conventional	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
7	PorkChop1	Excellent Carnosine	Excellent Protein	Conventional	$4.49
	Porkchop2	Excellent Carnosine	Excellent Protein	Conventional	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
8	PorkChop1	Nothing	No protein	Conventional	$11.22
	Porkchop2	Nutrition Facts	Excellent Protein	Pork Code of Conduct	$4.49
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
9	PorkChop1	Carnosine Health	Excellent Protein	Pork Code of Conduct	$6.74
	Porkchop2	Excellent Carnosine	Excellent Protein	Pork Code of Conduct	$4.49

	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
10	PorkChop1	Excellent Carnosine	Excellent Protein	Pork Code of Conduct	$6.74
	Porkchop2	Nutrition Facts	No protein	Conventional	$4.49
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
11	PorkChop1	Carnosine Health	No protein	Pork Code of Conduct	$4.49
	Porkchop2	Carnosine Health	Excellent Protein	Conventional	$4.49
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
12	PorkChop1	Nothing	Excellent Protein	Pork Code of Conduct	$4.49
	Porkchop2	Carnosine Health	Excellent Protein	Pork Code of Conduct	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
13	PorkChop1	Nutrition Facts	Excellent Protein	Pork Code of Conduct	$11.22
	Porkchop2	Nothing	Excellent Protein	Pork Code of Conduct	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
14	PorkChop1	Nothing	Excellent Protein	Conventional	$8.98
	Porkchop2	Nothing	Excellent Protein	Conventional	$4.49
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
15	PorkChop1	Carnosine Health	No protein	Conventional	$6.74
	Porkchop2	Nothing	No protein	Conventional	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
16	PorkChop1	Nothing	Excellent Protein	Conventional	$6.74
	Porkchop2	Nothing	No protein	Pork Code of Conduct	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
17	PorkChop1	Excellent Carnosine	No protein	Pork Code of Conduct	$11.22
	Porkchop2	Nothing	Excellent Protein	Conventional	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
18	PorkChop1	Carnosine Health	No protein	Pork Code of Conduct	$11.22
	Porkchop2	Carnosine Health	No protein	Pork Code of Conduct	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
19	PorkChop1	Excellent Carnosine	Excellent Protein	Pork Code of Conduct	$8.98
	Porkchop2	Nutrition Facts	Excellent Protein	Pork Code of Conduct	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
20	PorkChop1	Nothing	No protein	Pork Code of Conduct	$6.74
	Porkchop2	Excellent Carnosine	Excellent Protein	Conventional	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
21	PorkChop1	Carnosine Health	Excellent Protein	Conventional	$4.49
	Porkchop2	Nutrition Facts	No protein	Pork Code of Conduct	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
22	PorkChop1	Carnosine Health	Excellent Protein	Conventional	$11.22
	Porkchop2	Nutrition Facts	Excellent Protein	Conventional	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
23	PorkChop1	Nothing	Excellent Protein	Pork Code of Conduct	$11.22
	Porkchop2	Carnosine Health	No protein	Conventional	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
24	PorkChop1	Nutrition Facts	No protein	Conventional	$4.49
	Porkchop2	Excellent Carnosine	Excellent Protein	Pork Code of Conduct	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
25	PorkChop1	Carnosine Health	Excellent Protein	Pork Code of Conduct	$8.98
	Porkchop2	Excellent Carnosine	No protein	Conventional	$11.22
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
26	PorkChop1	Carnosine Health	No protein	Conventional	$8.98
	Porkchop2	Nothing	Excellent Protein	Pork Code of Conduct	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
27	PorkChop1	Nutrition Facts	No protein	Pork Code of Conduct	$8.98
	Porkchop2	Nutrition Facts	Excellent Protein	Conventional	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
28	PorkChop1	Excellent Carnosine	Excellent Protein	Conventional	$11.22
	Porkchop2	Excellent Carnosine	No protein	Pork Code of Conduct	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
29	PorkChop1	Nothing	No protein	Pork Code of Conduct	$8.98
	Porkchop2	Excellent Carnosine	No protein	Pork Code of Conduct	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
30	PorkChop1	Excellent Carnosine	No protein	Conventional	$6.74
	Porkchop2	Carnosine Health	Excellent Protein	Pork Code of Conduct	$6.74
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
31	PorkChop1	Nutrition Facts	Excellent Protein	Pork Code of Conduct	$4.49
	Porkchop2	Nothing	No protein	Conventional	$8.98
	None				

Set	PorkChop	Carnosine	Protein	welfare	Price
32	PorkChop1	Nutrition Facts	No protein	Conventional	$11.22
	Porkchop2	Excellent Carnosine	No protein	Conventional	$4.49
	None				

Appendix H: Estimates of Conditional Logit Model with Attributes Only (Without Respondents Who Don't Eat Meat)

		Conditional logit	
	Definition	Coefficient	SE
Price	Price	-0.241***	0.008
HC	Carnosine health claim	-0.514***	0.053
NC	Carnosine nutrient content claim	-0.333***	0.051
NFT	Carnosine included in the NFT	0.038	0.053
PC	Protein nutrient content claim	0.253***	0.037
VCP	Verified Canadian Pork label	0.384***	0.037
Neither	Neither attribute are included	-2.215***	0.076
Model Statistics			
Log-likelihood		-6719.4	
Pseudo R-squared		0.07	
# of Observations		6912	

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

Appendix I: Estimates of Conditional Logit Model with Interactions (Without Respondents Who Don't Eat Meat)

		Conditional logit	
	Definition	Coefficient	SE
Price	Price	-0.201***	0.008
HC	Carnosine health claim	-0.568***	0.263
NC	Carnosine nutrient content claim	-1.420***	0.432
NFT	Carnosine included in the NFT	-1.550***	0.436
PC	Protein nutrient content claim	0.556*	0.308
VCP	Verified Canadian Pork label	0.549***	0.123
Neither	Neither attribute are included	-1.666***	0.064
Carnosine health claim			
AgeHC	Age interacted with HC	-0.003	0.003
MaleHC	Male interacted with HC	0.499***	0.092
ChdHC	Presence of children under 18 in the household (child) interacted with HC	-0.009	0.053
CityHC	If the respondent lives in city (city) interacted with HC	-0.057	0.068
EduHC	Education interacted with HC	-0.017	0.019
IncHC	Income (in thousands dollar) interacted with HC	-0.001	0.001
NomeatHC	If the respondent doesn't eat meat (nomeat) interacted with HC	-0.144	0.245
QcHC	If the respondent residents in Quebec (QC) interacted with HC	0.001	0.003
GenoHC	Familiarity with genomics (geno) interacted with HC	0.182***	0.053
FoPHC	Frequency of purchasing meat (FoP) interacted with HC	0.029***	0.009
Carnosine nutrient content claim			
AgeNC	Age interacted with NC	-0.004	0.003
MaleNC	Male interacted with NC	0.353***	0.092
ChdNC	Child interacted with NC	-0.151	0.118
CityNC	City interacted with NC	-0.123	0.090
EduNC	Education interacted with NC	0.013	0.025
IncNC	Income interacted with NC	-0.001	0.001

NomeatNC	Nomeat interacted with NC	-0.836***	0.249
QcNC	QC interacted with NC	0.144	0.095
GenoNC	Geno interacted with NC	0.157***	0.058
FoPNC	FoP interacted with NC	0.277***	0.058
Carnosine included in the NFT			
AgeNFT	Age interacted with NFT	0.003	0.003
MaleNFT	Male interacted with NFT	0.080	0.093
ChdNFT	Child interacted with NFT	0.232*	0.120
CityNFT	City interacted with NFT	-0.069	0.092
EduNFT	Education interacted with NFT	0.035	0.025
IncNFT	Income interacted with NFT	0.001	0.001
NomeatNFT	Nomeat interacted with NFT	-1.106***	0.262
QcNFT	QC interacted with NFT	0.006	0.096
GenoNFT	Geno interacted with NFT	-0.033	0.058
FoPNFT	FoP interacted with NFT	0.289***	0.057
Protein nutrient content claim			
AgePC	Age interacted with PC	0.002	0.002
MalePC	Male interacted with PC	-0.073	0.070
ChdPC	Child interacted with PC	0.209**	0.091
CityPC	City interacted with PC	0.002	0.069
EduPC	Education interacted with PC	-0.039**	0.019
IncPC	Income interacted with PC	0.003***	0.001
NomeatPC	Nomeat interacted with PC	-0.760***	0.191
QcPC	QC interacted with PC	0.043	0.074
GenoPC	Geno interacted with PC	0.004	0.042
FoPPC	FoP interacted with PC	-0.008	0.005
Verified Canadian Pork label			
AgeVCP	Age interacted with VCP	0.000	0.002
MaleVCP	Male interacted with VCP	-0.042	0.065
ChdVCP	Child interacted with VCP	0.007	0.027

CityVCP	City interacted with VCP	-0.040	0.039
EduVCP	Education interacted with VCP	-0.003	0.012
IncVCP	Income interacted with VCP	0.0012	0.001
NomeatVCP	Nomeat interacted with VCP	-0.882***	0.190
QcVCP	QC interacted with VCP	0.001	0.001
GenoVCP	Geno interacted with VCP	-0.037	0.023
FoPVCP	FoP interacted with VCP	-0.005**	0.002
Model Statistics			
Log-likelihood		-6936.76	
Pseudo R-squared		0.09	
# of Observations		7296	

Note: ***,**,*, Significant at 1%, 5%, and 10% level
Source: Obtained from survey data of this thesis

Appendix J: Consumers' WTP for Pork Attributes Obtained from Conditional Logit Models (Without Respondents Who Don't Eat Meat) ($/package (0.405kg))

Attributes	Basic Model	Model With Interactions
Carnosine health claim	-2.129***	-6.585***
Carnosine nutrient content claim	-1.383***	-5.557***
Carnosine included in the NFT	0.159	-6.879**
Protein nutrient content claim	1.049***	-0.117
Verified Canadian Pork label	1.592***	-0.087

Source: Obtained from survey data of this thesis

Appendix K: Likelihood Ratio Test Statistics for Model Specification

	Log likelihood	K(# of parameter)	Chi-statistics	df	P-value	Conclusion
Base	-7253.8746	7				
Base plus demographic variables (age, gender, have children dummy, live in city dummy, education, income, live in Quebec dummy)	-7182.63	42	142.48928	35	0.000	Reject the null
Base plus demographic variables plus meat eating habit (don't eat meat dummy and meat purchase frequency)	-6954.4777	52	456.30456	10	0.000	Reject the null
Base plus demographic variables plus meat eating habit plus familiarity with genomics (Model I)	-6936.7621	57	35.4313	5	0.000	Reject the null
Model I plus self-health awareness	-6934.07	62	5.43002	5	0.365	Can’t reject the null
Model I plus personal responsibility	-6933.3996	62	6.72496	5	0.241	Can’t reject the null
Model I plus health motivation	-6935.8225	62	1.87912	5	0.865	Can’t reject the null
Model I plus self-health awareness, personal responsibility, health motivation	-6930.5485	72	12.42706	15	0.646	Can’t reject the null
Model I plus nutrition knowledge (Model II)	-6914.4202	62	44.68384	5	0.000	Reject the null
Model II plus self-health awareness, personal responsibility, and health motivation	-6908.8056	77	55.9129	15	0.000	Reject the null

Source: Obtained from survey data of this thesis

Appendix L: Estimates of Conditional Logit Model with Nutrition Knowledge and Health Consciousness

		Conditional logit	
	Definition	Coefficient	SE
Price	Price	-0.24***	0.008
HC	Carnosine health claim	-1.890***	0.498
NC	Carnosine nutrient content claim	-1.764***	0.491
NFT	Carnosine included in the NFT	-1.794***	0.491
PC	Protein nutrient content claim	0.052	0.371
VCP	Verified Canadian Pork label	-0.515	0.371
Neither	Neither attribute are included	-2.140***	0.075
Carnosine health claim			
AgeHC	Age interacted with HC	-0.007*	0.004
MaleHC	Male interacted with HC	0.512***	0.094
ChdHC	Presence of children under 18 in the household (child) interacted with HC	-0.055	0.129
CityHC	If the respondent lives in city (city) interacted with HC	-0.120	0.096
EduHC	Education interacted with HC	-0.029	0.026
IncHC	Income (in thousands dollar) interacted with HC	-0.002	0.001
NomeatHC	If the respondent doesn't eat meat (nomeat) interacted with HC	-0.144	0.245
QcHC	If the respondent residents in Quebec (QC) interacted with HC	0.196*	0.103
GenoHC	Familiarity with genomics (geno) interacted with HC	0.215***	0.059
FoPHC	Frequency of purchasing meat (FoP) interacted with HC	0.354***	0.062
NKHC	Nutrition knowledge interacted with HC	0.027*	0.014
H1HC	Self-health awareness interacted with HC	-0.056	0.051
H2HC	Personal responsibility interacted with HC	-0.095*	0.051
H3HC	Health motivation interacted with HC	-0.42	0.076
Carnosine nutrient content claim			

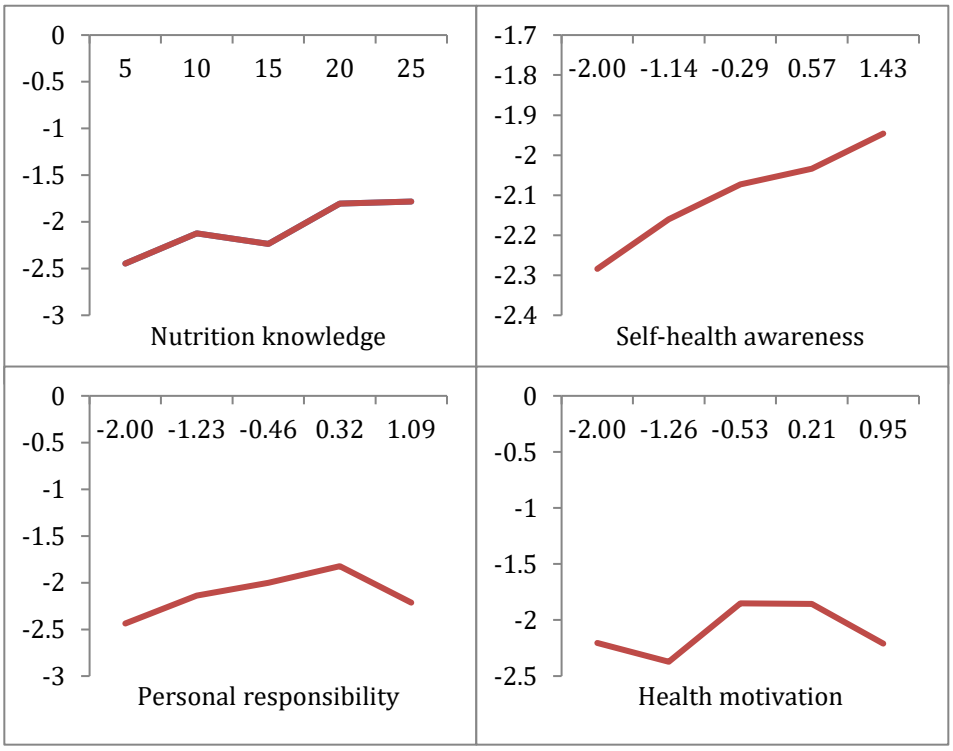
AgeNC	Age interacted with NC	-0.006	0.004
MaleNC	Male interacted with NC	0.330***	0.092
ChdNC	Child interacted with NC	-0.184	0.125
CityNC	City interacted with NC	-0.137	0.093
EduNC	Education interacted with NC	-0.000	0.025
IncNC	Income interacted with NC	-0.002	0.001
NomeatNC	Nomeat interacted with NC	-0.836***	0.249
QcNC	QC interacted with NC	0.129	0.102
GenoNC	Geno interacted with NC	0.149**	0.059
FoPNC	FoP interacted with NC	0.288***	0.061
NKNC	Nutrition knowledge interacted with NC	0.035**	0.013
H1NC	Self-health awareness interacted with NC	-0.050	0.050
H2NC	Personal responsibility interacted with NC	0.000	0.049
H3NC	Health motivation interacted with NC	-0.008	0.077
Carnosine included in the NFT			
AgeNFT	Age interacted with NFT	0.001	0.004
MaleNFT	Male interacted with NFT	0.070	0.094
ChdNFT	Child interacted with NFT	0.221*	0.128
CityNFT	City interacted with NFT	-0.078	0.095
EduNFT	Education interacted with NFT	0.025	0.026
IncNFT	Income interacted with NFT	0.000	0.002
NomeatNFT	Nomeat interacted with NFT	-1.106***	0.262
QcNFT	QC interacted with NFT	0.016	0.103
GenoNFT	Geno interacted with NFT	-0.046	0.060
FoPNFT	FoP interacted with NFT	0.326***	0.060
NKNFT	Nutrition knowledge interacted with NFT	0.019	0.014
H1NFT	Self-health awareness interacted with NFT	-0.070	0.051

H2NFT	Personal responsibility interacted with NFT	-0.000	0.051
H3NFT	Health motivation interacted with NFT	0.002	0.077
Protein nutrient content claim			
AgePC	Age interacted with PC	-0.000	0.002
MalePC	Male interacted with PC	-0.045	0.070
ChdPC	Child interacted with PC	0.155	0.095
CityPC	City interacted with PC	-0.018	0.071
EduPC	Education interacted with PC	-0.039**	0.019
IncPC	Income interacted with PC	0.002*	0.001
NomeatPC	Nomeat interacted with PC	-0.760***	0.191
QcPC	QC interacted with PC	-0.024	0.077
GenoPC	Geno interacted with PC	-0.025	0.044
FoPPC	FoP interacted with PC	0.160***	0.046
NKPC	Nutrition knowledge interacted with PC	0.009	0.010
H1PC	Self-health awareness interacted with PC	0.060	0.038
H2PC	Personal responsibility interacted with PC	-0.029	0.038
H3PC	Health motivation interacted with PC	0.007	0.057
Verified Canadian Pork label			
AgeVCP	Age interacted with VCP	-0.003	0.003
MaleVCP	Male interacted with VCP	-0.045	0.070
ChdVCP	Child interacted with VCP	-0.034	0.095
CityVCP	City interacted with VCP	-0.150**	0.071
EduVCP	Education interacted with VCP	-0.011	0.019
IncVCP	Income interacted with VCP	0.001	0.001
NomeatVCP	Nomeat interacted with VCP	-0.882***	0.190
QcVCP	QC interacted with VCP	0.177**	0.078
GenoVCP	Geno interacted with VCP	0.077*	0.045

FoPVCP	FoP interacted with VCP	0.128***	0.046
HCVCP	Nutrition knowledge interacted with VCP	0.042***	0.010
H1VCP	Self-health awareness interacted with VCP	-0.018	0.038
H2VCP	Personal responsibility interacted with VCP	0.000	0.038
H3VCP	Health motivation interacted with VCP	-0.008	0.057
Model Statistics			
Log-likelihood		-6936.76	
Pseudo R-squared		0.11	
# of Observations		7296	

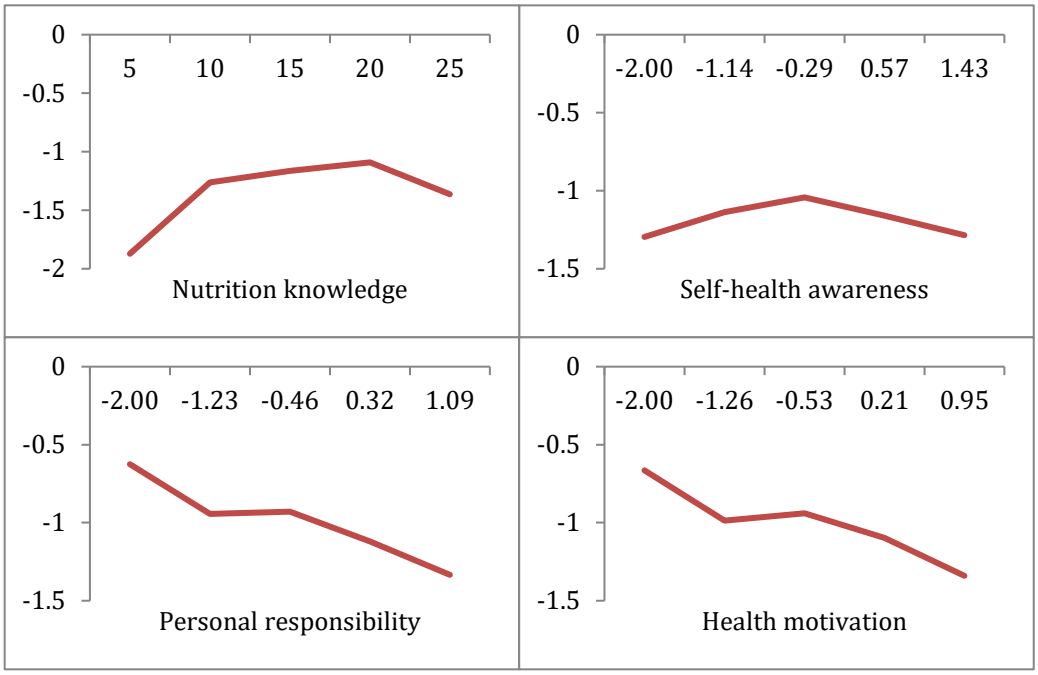
Source: Obtained from survey data of this thesis

Appendix M: The Means of Individual WTPs for Carnosine Health Claim ($/package (0.405kg))



Source: Obtained from survey data of this thesis

Appendix N: The Means of Individual WTPs for Carnosine Nutrient Content Claim ($/package (0.405kg))

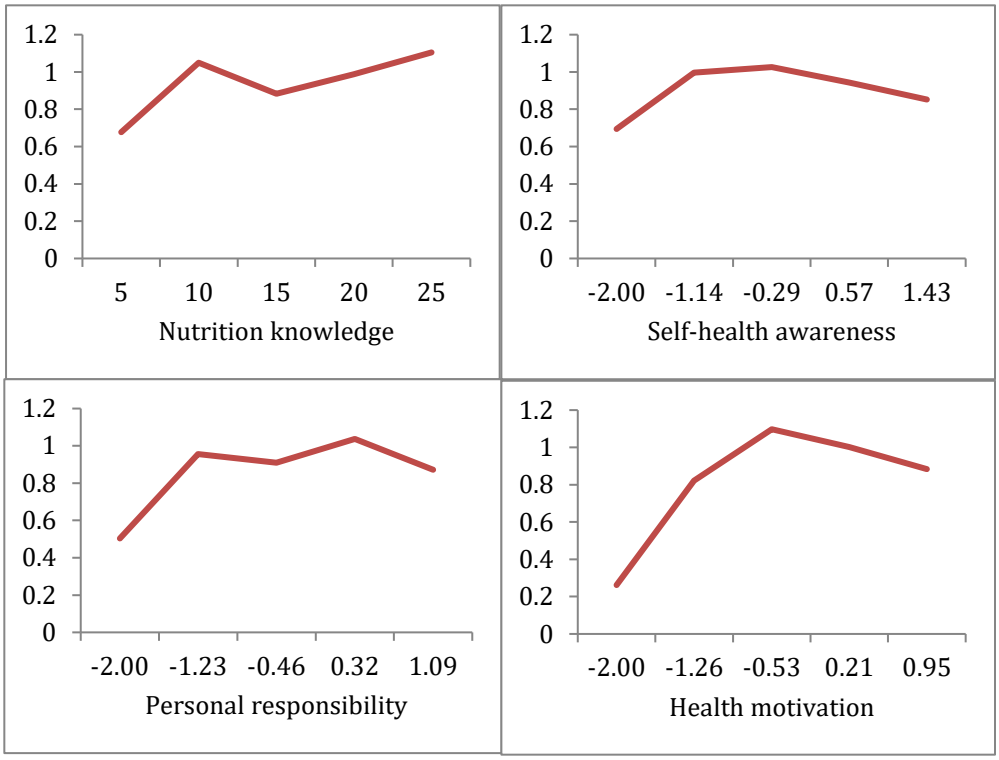


Source: Obtained from survey data of this thesis

Appendix O: The Means of Individual WTPs for Carnosine Included in the NFT ($/package (0.405kg))

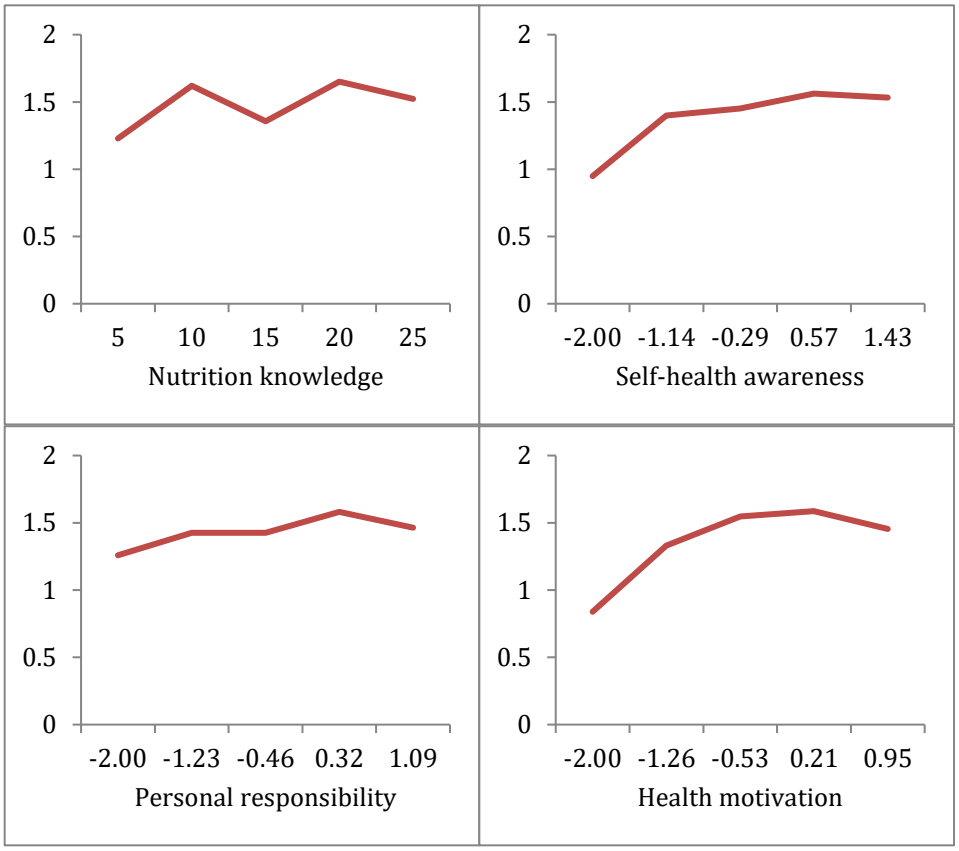
Source: Obtained from survey data of this thesis

Appendix P: The Means of Individual WTPs for Protein Nutrient Content Claim ($/package (0.405kg))



Source: Obtained from survey data of this thesis

Appendix Q: The Means of Individual WTPs for Verified Canadian Pork (VCP) label ($/package (0.405kg))



Source: Obtained from survey data of this thesis