University of Alberta

Sensory profiles and consumer acceptance of organic and conventionally grown wheat grain when baked as bread

by

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Abstract

Grain from paired samples of the hard red spring wheat cultivar 'Park' grown on both conventionally and organically managed land were milled and baked into 60% whole wheat bread. Organic grain contained more wholemeal protein than conventional grain, but conventional flour produced stronger bread dough and larger loaf volume than organic flour. A descriptive analysis panel perceived organic bread to be more 'dense' with smaller air cells in the crumb. Consumers liked organic bread more ($p \leq 0.05$) than conventional bread under both blind and labelled conditions. Environmental information about organic production did not impact consumer preference changes for organic bread, but health information coupled with sensory evaluation increased the liking of organic bread. Consumer characteristics of education, income, frequency of bread consumption and pro-environmental attitudes also played a significant role in preference changes for organic bread.

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Chapter 1: Introduction and literature review

This thesis focuses on the descriptive sensory profiles and consumer acceptability of bread made from Canadian wheat, produced under organic and conventional management systems. In Chapter 1, a review of the relevant literature was completed covering the organic market, consumer and trained sensory evaluation, the effects of information on food acceptance, and finally, consumer choice as affected by attitudes and consumer characteristics.

Chapter 2 describes the first research study in which a descriptive sensory profile was developed for organic and conventional wheat when baked into 60% whole wheat bread, and compared to that of a commercially baked 60% whole wheat bread. This chapter is written and formatted for publication in the 'Journal of Food Science'.

Chapter 3 describes the second research study wherein a consumer panel was conducted to examine the effects of health or environmental information on consumer acceptance of organic and conventional 60% whole wheat bread. More specifically, consumer characteristics such as socio-demographics, attitudes towards health and environmental issues, and purchase and consumption behaviours were used to predict changes in consumer perceptions of whole wheat bread products in the presence of information. This chapter is written and formatted for publication in 'Food Quality and Preference'.

Finally in Chapter 4, a summary of the entire research project is presented, including recommendations for future directions in the area of sensory and consumer science.

1.1. Introduction

Organically-grown food is not a new development. The principles of organic agriculture have been around since the early 20th century when Rudolf Steiner described "biodynamic farming" (Bourn and Prescott 2002). Organic agriculture promotes ecosystem health and is a food production system that is environmentally, socially and economically sustainable (Bourn and Prescott 2002; Mason and Spaner 2006). This is achieved through the reduction of external inputs such as synthetic pesticides and fertilizers, plant and animal growth regulators, the prophylactic use of antibiotics, some preservatives and artificial additives in food products, and genetically modified plants or animals (Sydness 1991; Mason and Spaner 2006).

In Canada, there are over 3500 organic farms comprising approximately 1.5% of the total agricultural land in the country (Yussefi 2004). Organically produced wheat grain accounts for more than 170 thousand acres in western Canada with a value of over $44 million (CDN) (Macey 2003; 2005).

1.1.1. Organic market in Canada

Worldwide sales of organic food and drink were valued at US$23 billion in the year 2002 (Sahota 2004), and this value is expected to increase to US$100 billion by the year 2010 (Lockie and others 2004). In 2002, the greatest number of consumers of organic food and drink were in Western Europe and North American with sales of US$10.5 and US$11.75 billion, respectively (Sahota 2004). The Canadian market for organic food and drink is worth approximately US$1 billion annually, but is a value representing only 6.5% of the total North American market (Vansittart 2002; Mason and Spaner 2006).

Most Canadian organic wheat is produced in western Canada, and much of that production is exported to Europe, the US and Japan (Wasicuna and Harrison 2000). In return the US supplies 85-90% of our total organic food (Cunningham 2002). There is a great opportunity for local producers to market their products in Canada, and reduce the need to import processed organic foods from the US.

In Canada, 71% of consumers have purchased organic products at least once, 40% purchase organic products fairly often, and 18% are regular consumers and purchase products frequently (Vansittart 2002). Retail supermarkets in Canada have embraced the growing organic market and already provide consumers with a wide variety of organic products (Hein 2006). In a recent study, Lockie and others (2004) found that convenience and limited availability of organic foods were major limitations to increasing rates of organic food consumption in consumers. In Canada, 80% of the retail market is controlled by eight major supermarket chains (Hollingsworth 1999). Increased availability at these retail markets could rapidly increase organic food consumption in Canada in a short period of time (Hollingsworth 1999). With solid scientific research on Canadian consumers' attitudes and perceptions of organic foods, Canadian organic growers and food processors may become able to market products to Canadian consumers and take advantage of the growing organic market.

1.1.2. Consumer motivations for choosing organic foods

The increased demand for organic foods appears to stem from consumer concern over intensive farming systems and the safety of food produced (Williams 2002). Sixty-four percent of Canadians believe that organic foods are safer and healthier than conventional products (Cunningham 2002). According to the classifications of Cunningham (2002), 'classic organic consumers buy products out of concern for the environment; whereas 'new organic consumers are more concerned with the health and nutritional value of the food they purchase. There is a growing trend of consumers willing to pay higher prices for what they feel to be a superior product (Thompson 2001) with 68% of consumers willing to pay an additional 10% for organic products (Cunningham 2002).

The motivation for choosing an organic product over a conventional one is often based on a set of credence attributes (Grunert and others 2000; van den Heuvel and others 2006); preference based on the belief that organic food products are produced in a manner that protects the environment, treats animals humanely, and may contain more nutrients. The presence or absence of these characteristics is not easily perceived by the consumer even after purchase or use of a product (Yiridoe and others 2005).

Characteristics of the consumer can also influence food choice. Socio-demographic variables (Thompson 1998), ethics and values (Dreezens and others 2005) and attitudes and beliefs towards health or the environment (Magnusson and others 2003; Lockie and others 2004; Chryssohoidis and Krystallis 2005) can influence how and why consumers are motivated to purchase organic products. But beyond these factors, taste is still the most important product attribute that influences consumer food choice (Wandel and Bugge 1997; Glanz and others 1998; Chryssohoidis and Krystallis 2005; Radder and le Roux 2005). There is a need to understand differences between organic and conventional products and consumer motivations for their purchase, including attitudes, beliefs, and contextual effects such as the presence of information about organic production.

Comprehensive reviews completed by Borne and Prescott (2002) and Woese and others (1997) provide an in depth review of studies comparing organic and conventional products for sensory characteristics and nutritional and physiochemical properties. The current review furthers the examination of studies on sensory evaluation of organic and conventionally grown food and is supplemented with an in-depth review of the factors that influence consumer choice. This includes the effects of information, as well as consumer attitudes, preferences and behaviours.

In order to appreciate the findings of previous research in sensory science, it is necessary to complete a detailed review of techniques used to conduct experimental work. This is required so as to understand the assumptions and conclusions researchers have drawn from the data. The nature of the discipline lends itself to be viewed by non-sensory scientists as unstructured and simplistic, but in reality the techniques are well defined and structured with guidelines provided by internationally recognized organizations. Researchers in sensory science have made significant advancements in the methods used for evaluation over the past 25 years, and thus a study completed in the 1970's may have used techniques with less rigor than the ones currently used. Consequently, the extensive discussion presented in this review is essential to properly evaluate sensory science trials in previous research on organic versus conventional comparisons and the effects of information on product acceptance.

1.2. Sensory evaluation of organic foods

There are numerous reasons why consumers may choose to buy organic products including health, nutritional value, environmental concern, and lifestyle considerations (Lockie and others 2004; Kihlberg and others 2005). However, many researchers have reported that for most consumers, whether they choose to buy organic or not, taste and perceived sensory quality of a food product are still the most important aspects to consider when making their food choice (Cunningham 2002; Kihlberg and others 2005). For this reason, it is very important to evaluate the sensory quality of organic products and compare them to conventional products in a controlled setting. Through the use of various sensory and consumer science techniques, one can discover the source of consumer perceived differences between organic and conventional food products. Previous research studies examining the differences between organic and conventional products have used both preference and acceptance testing with consumer panels, as well as descriptive analysis techniques with trained panels. Studies of both types are discussed below. In most cases, the researchers were interested in identifying *if* any sensory differences existed between organically and conventionally produced foods as a preliminary measure. Thus, many researchers have yet to divulge into why those differences may exist.

1.2.1. Trained panels

Descriptive analysis is a sophisticated sensory tool that allows the researcher to produce objective descriptions of food products based on perceived sensory attributes (Lawless and Heymann 1998). These attributes may include appearance, aroma, texture, and flavour. The technique requires panelists to be trained in a carefully chosen scientific language prior to evaluating a product, so they are able to articulate their perception of the product's attributes in precise language (Lawless and Heymann 1998). In this way, differences between food products can be quantified by the researcher (Lawless and Heymann 1998). Physical reference standards are used to precisely define product attributes (both quality and quantity) for experimental repeatability. The intensities of each physical reference standard are place on a scale (150mm unstructured line scale) along with the product of interest. For further information on trained panel management and panelist performance, the reader is referred to Lawless and Heymann (1998) for a complete explanation.

Lawless and Heymann (1998) suggest that 10-12 panelists are needed for a successful trained panel. Also, it is important to assess their reproducibility immediately after training to determine if panelists are consistent in their evaluations. Depending on the product, different lengths of time are needed to train the panelists with the key sensory attributes to achieve consistent and repeatable evaluations (Lawless and Heymann 1998). With proper training, panelists should evaluate food products objectively. If adequate training is not provided, panelists may evaluate food products more like consumers, allowing preference to bias their judgement. This may lead to poor results and a waste of valuable time and research funding. In organic food product evaluation, several trained panels have been completed successfully (Cayuela and others 1997; Hogstad and others 1997; Haglund and others 1999; Johansson and others 1999) while others have lacked one of the important elements such as time of training or number of samples evaluated (Maga and others 1976; Fjelkner-Modig and others 2000; Weibel and others 2000).

1.2.1.1. Fruits and vegetables

Fruits and vegetables have been widely studied within organic versus conventionally grown comparisons of nutritional content and sensory quality. Most of the sensory studies on these commodities examine one or more fruits or vegetables. Maga and others (1976) examined sensory properties of spinach using triangle tests and observed no significant difference between the flavour of organic and conventional samples. Although they mention that the panel of 25 assessors had previous training in sensory evaluation, the testing was carried out similar to a consumer evaluation. No information was given on the type of training the panelists had received nor on the hours of training.

The next generation of descriptive analysis sensory studies comparing organic and conventional fruits and vegetables were in the late 1990's with studies on strawberries, carrots and tomatoes. Cayuela and others (1997) used a trained panel of 14 assessors to compare strawberries grown with ecological (organic) cultivation practices and strawberries grown under conventional conditions. They reported that organically grown strawberries had more intense colour and brightness, were juicier, and had a more intense 'strawberry' flavour compared to conventionally grown fruits. The number of people used to assess the products was sufficient in this study, but the number of hours used to train the panel was not mentioned.

Hogstad and others (1997) examined the sensory quality of carrots grown with different levels of organic or conventional fertilizer using a trained panel of seven and then nine assessors over the course of two consecutive years. They reported that carrots grown with minimal to no fertilizer (organic or conventional) had greater 'total flavour strength' and less 'crispness' compared to those grown with high amounts of fertilizer.

Haglund and others (1999) compared carrots grown under ecological (organic) and conventional systems with a 6-person trained panel and reported that conventionally produced carrots had a higher intensity for 'crunchiness', 'sweetness', and 'carrot-taste', whereas the organic carrots had a higher intensity for 'hardness' and 'bitterness'. The panelists had 18 hours of training over 5 days, which is sufficient considering the number of samples and attributes they were asked to evaluate. The researchers also analyzed the panel performance, which is an important step when human subjects are being used as an analytical tool. Individual panelist reproducibility over each attribute evaluation is very important in descriptive analysis (Lawless and Heymann 1998).

Johansson and others (1999) used a seven person trained panel to develop the attribute profile of four varieties of tomatoes grown under either organic or conventional systems and reported that the two conventional varieties were significantly different from the two organic varieties in all attributes except 'bitterness'. The organically grown tomatoes were lower in 'firmness' and 'juiciness', but higher in 'red colour'. There were no significant differences in 'acidulous', 'sweet' or 'bitter' taste in the tomatoes from the two growing systems.

Carrots, cabbage, onions, peas and potatoes were grown in organic and integrated production systems by Fjelkner-Modig and others (2000), and then examined by a trained panel (n=6-8) for sensory differences. The researchers reported that there was no influence of the growing system on sensory properties for each of the vegetables. Four attributes were examined on a 5-degree intensity scale for each of the vegetables that had been frozen and semi-fabricated before evaluation.

In another research study completed by Weibel and others (2000), organically grown 'Golden Delicious' apples were compared to conventional apples using a trained panel of 14 individuals. Organically grown apples were reported to have significantly 'firmer' fruit flesh and higher scores for 'overall taste quality' than conventionally grown apples, but sensory results from this study were poorly described. The researchers used five pairs of integrated and organic farms where the distance between the farms within a pair was less than 1km apart. Although they had a good direct comparison between organic and conventional samples, the trained panel was asked for their preference between apples, which is not the intended focus of a trained panel.

1.2.1.2. Meat

The sensory characteristics of meats such as beef, pork, and chicken have also been examined with descriptive analysis. Younie and others (1990) used a trained panel of 12 individuals to assess the differences between organically and conventionally reared steers. Five attributes were quantified, including colour, 'juiciness', texture, 'beef' flavour and 'flavour intensity'. Although the trend of higher scores was in favour of organically reared meat samples, none of the perceived sensory differences were significant.

Jonsall and others (2002) used a trained panel with eight assessors to investigate the effects of genotype and rearing system on sensory characteristics of pork meat and reported that organic pork loins only differed from conventionally produced pork loins on two of six attributes; lower juiciness and higher crumbliness. For this panel, the judges were trained sufficiently, all having previous experience with meat assessment.

In a study by Jahan and others (2004), researchers compared the sensory quality of breast meat from organically produced chicken to that of free range, corn-fed and conventionally raised chicken as the control. The researchers observed that breast meat from organically raised chicken was only differentiated from conventionally raised chicken on texture attributes. The researchers used conventional and free choice profiling to generate descriptive terms. Conventional profiling is similar to traditional descriptive analysis in that assessors use a common "frame of reference" for attribute description (Lawless and Heymann 1998). With the number of attributes generated in this study, three days of training for the panel may not have been sufficient time to familiarize each individual with all attributes. The amount of time used to train panelists on each day was not specified.

More recently, Walshe and others (2006) compared organic and conventional reared steer meat using descriptive analysis and reported that there were no differences between the two treatments for all sensory attributes evaluated. Even though the organic samples were significantly higher in fat, and lower in moisture than the conventional samples, this did not play a role in the descriptive sensory profile of the steak. Ten panelists were trained for 12 hours over 6 sessions to evaluate the descriptive profile of each steak sample for flavour, aroma and texture. In addition to the sensory analysis, the researchers assessed compositional differences and shelf life stability using MAP packaging.

1.2.1.3. Wheat

Organic wheat is more difficult to evaluate than fruit or vegetables, as it must be incorporated into a food product such as bread before it can be evaluated with sensory techniques. In a comparison of wholemeal wheat breads, Haglund and others (1998) used a trained panel of six people and reported that sensory attributes of colour and aroma were affected by the farming system. Organically grown wheat gave a significantly darker colour and stronger aroma in the final bread product compared to the conventionally grown wheat when baked as bread.

A research group from Uppsala University in Sweden completed the two most recent studies comparing organic and conventional wheat using descriptive analysis techniques. In the first publication of their study, Kihlberg and others (2004) evaluated the influence of farming system (organic vs. conventional), milling (stone vs. roller), and kneading (high vs. low intensity) on sensory qualities of whole wheat bread. They reported that farming system had no influence on sensory quality. Instead, the greatest effect on sensory quality of whole wheat bread was from the grain milling technique. The wheat was harvested for this study in September 1998, and eight assessors evaluated bread samples after 7 hours of training for descriptive analysis techniques. This is sufficient time to train a panel of assessors, but the number of samples that they had to evaluate was very large. Over a period of 7 days, the panel evaluated 48 different samples in two replicates.

In the second publication of their wheat research, Kihlberg and others (2006) baked white bread instead of whole-wheat pan bread, varied the baking technique, and used wheat harvested in 2 consecutive years (1999 and 2000) for the comparison. They reported again that farming system alone had no significant effect on any of the sensory attributes evaluated, but the year of harvest affected attributes of overall aroma, deformability, and toughness of the crust. Ten panelists were trained for 19 hours over 8 sessions to evaluate the descriptive profile of white bread. There were 21 bread samples baked for evaluation, and they were evaluated by the panel in triplicate over a five-day period. The large number of samples the panel evaluated is still a concern, as panelist fatigue may occur and panelist reliability may be compromised.

Overall the results from research studies using descriptive sensory analysis techniques are inconsistent and do not identify products from one farming system over another as having more intense flavor. When trained panels using descriptive analysis assessed differences in sensory quality, both organic and conventional products have demonstrated stronger desirable attributes. It is important to examine the descriptive analysis sensory technique used to evaluate the products, as it is a common source of variation that can be controlled by the researcher.

1.2.2. Consumer panels

In addition to descriptive analysis evaluations, it is also important to understand whether a consumer "likes a product, prefers it over another product, or finds the product acceptable based on the sensory characteristics" (Lawless and Heymann 1998). Under blind-labelled evaluation conditions, true preferences for organic and conventional products can be acquired without the bias of conceptual claims that are often present on labels (Lawless and Heymann 1998). Unlike market research, the sensory evaluation test controls contextual factors such as information and label so that the investigator can ascertain consumer perceptions of the food product based on sensory properties alone (Lawless and Heymann 1998). Consumers recruited for an untrained panel should be screened to ensure they are familiar with the test product (Lawless and Heymann 1998). Choosing individuals who like and consume the product is important for product familiarity, as well as to avoid a neophobic reaction (Lawless and Heymann 1998). Previous studies using consumer sensory evaluation tests have compared organic and conventional vegetables and fruit, meats such as pork, as well as wheat grain when baked into bread.

1.2.2.1. Fruit and vegetables

In a study by Schutz and Lorenz (1976) researchers compared four vegetables, namely lettuce, green beans, broccoli and carrots that were grown under three conditions (depleted soil, commercial fertilization, or organic fertilization). They reported no differences in acceptability among the treatments for lettuce and green beans. For carrots, the commercial and depleted soil treatments were preferred over the organic. Broccoli was the only organically grown vegetable that was preferred over the commercial and depleted soil treatments when the source of the vegetable was unknown to the consumer. Fifty consumer subjects evaluated each vegetable for acceptability during separate sessions using the 9-point hedonic scale, and this was followed by a second evaluation where labelling was incorporated, but completed only for samples from organic and commercial conditions.

Sensory qualities of vegetables from biodynamic and conventional cultivation systems were compared by Hansen (1981). This author reported that only a few of the tasters could differentiate between treatments. Also, there was no consistent trend for overall taste superiority of biodynamic vegetables over conventional vegetables. Differences were assessed using the triangle test and overall 'taste' was evaluated on a 1 to 10 scale. The authors mention the panel was composed of experienced tasters, but there is no indication of panel size or that these individuals were trained (Hansen 1981), thus the tasters should be classified as a group of consumers.

Basker (1992) conducted separate consumer panels for each of five fruits (banana, orange, grapefruit, grape, and mango) and four vegetables (tomato, carrot, spinach, and sweet corn), with total participation ranging from 32 to 66 people for each panel. Overall, no difference in preference was reported between organic and conventional treatments of grapefruit, grape, tomato, carrot, spinach, and sweet corn. Organically grown bananas were the only fruit preferred for taste over their conventionally grown counterpart, whereas for mango and orange, the conventionally grown was preferred for taste over the organically grown. It should be noted that ripeness was not controlled in this evaluation, and may have played a role in the results.

Johansson and others (1999) observed that tomato variety and information about the growing system had a greater influence on preference than growing conditions (organic or conventional). The researchers conducted a consumer preference test with 177 consumers using a seven point hedonic scale (+3 to –3). Blinded tomato samples were evaluated in the first test and then samples were provided with information on the growing system in the second test.

Organic (with or without compost) and conventionally grown red skinned potatoes were compared for sensory quality by Wszelaki and others (2005) using a triangle test and a panel of 15 untrained consumers. For potato samples with skin, researchers reported no detectable difference between the two organic treatments, but panelists did detect a difference between conventional and organic treatments. The organic treatments had a less intense, but more 'bitter' taste compared to conventional.

1.2.2.2. Meat

Consumer sensory evaluation of meat from organic and conventional sources has not been widely studied. This may be due to the fact that it is difficult to raise animals under both organic and conventional regimes while maintaining a good comparison for experimental study. The amount of time it takes to reach maturity may differ between the two systems, and thus the experimental factors such as meat storage time is not controlled between samples. This can increase the variability of the study. In addition, the logistics of preparing a meat product for consumption in a consumer setting is more difficult compared to fruit, vegetables or bread products.

Consumer preference for pork of two different genotypes raised under organic or conventional management systems was investigated by Jonsall and others (2002). They reported that consumers did prefer one genotype of pork loin to another, but that preference did not differ for pork loin raised under organic or conventional systems. Two hundred consumers were recruited for the study in a supermarket over the course of two days. Participants were asked which sample they preferred in two separate tests; one for genotype and one for rearing system.

Dransfield and others (2005) compared taste preference for pork chops raised by "indoor" and "outdoor" methods by conducting a consumer panel of 144 people recruited in France and Britain. The pork chops were assessed by consumers for 'overall appreciation' on an unstructured line scale and scored from 0 to 10. The researchers reported that pork from both outdoor and indoor production systems were similar in eating quality as was shown by their 'overall appreciation' ratings. The term organic was avoided in this study due to the various definitions it may hold for different consumers.

1.2.2.3. Wheat

Large-scale production of bread products for consumer evaluations requires extensive preparation of grain milling and baking processes before the panel can be carried out. For organic and conventional comparisons, production methods must be held constant between the two, but the raw materials must be kept separate and the equipment cleaned between processing of each treatment (organic or conventional).

Currently in the literature there is only one study where a consumer panel was conducted to compare preferences for bread made from organic and conventionally grown wheat grain. A consumer panel with 480 European consumers was conducted by Kihlberg and others (2005) to examine preference for bread baked from organic and conventionally grown wheat grain. They reported that liking scores were higher for organic bread when samples were labelled with information on the farming system. Each of the 4 bread samples was evaluated for liking on a 150mm unstructured line scale, but there was no blind evaluation to determine liking without information.

Overall, consumer sensory evaluation studies comparing organic and conventional products are varied in their methodology, and thus their results are inconsistent with one another. It is important to examine the contextual effects and other consumer characteristics as factors that may play a significant role in acceptance or preference evaluations by consumers (Rozin and Tuorila 1993). This point is discussed further in the next section of this Chapter. In addition to the research studies examined in this paper, The Soil Association has written a review of "significant results" in the organic agriculture area (Heaton 2001). Although it examines other consumer and trained panel evaluations completed, the results are vague and conclusions are loosely drawn about taste differences.

1.3. Effect of information on sensory evaluation of food products and consumer choice

Evaluation of food quality begins with appearance, but the type of information received by the consumer about a food is also important (von Alvensleben and Meier 1990). Quality cues perceived by the consumer are taken from 1) actual information, described as direct product (physical, sensory, brand) and product environment (atmosphere of retail store), and 2) stored product image, described as other characteristics of the product that fulfill consumer needs (von Alvensleben and Meier 1990).

Previous studies have examined the effects of labelling a product "Healthy", as well as providing nutritional content information such as fat or fibre content of a food product (Mialon and others 2002; Wansink and others 2004). Information as to the origin of a food product or the process by which it was made have also been examined (Siret and Issanchou 2000; Stefani and others 2006). The receptiveness of each consumer to different types of information will vary (Kähkönen and others 1997). Individuals will only absorb the information they think is important for making their choice, and ignore the rest as unnecessary or redundant (Kähkönen and others 1997). Contextual effects surrounding food acceptance are discussed by Rozin and Tuorila (1993). They mention that the environment in which the food is consumed can also have an effect on food acceptance, due to the context of the situation.

1.3.1. Effect of information on preference and acceptance of food products

1.3.1.1. Organic products

The effect of information about organic production on consumers' liking and preference has been examined for various food products. Dransfield and others (2005) reported inconsistent results for pork preference when European consumers were given information about the rearing system, but did find that consumers were willing to pay up to a 12% premium when meat was labelled with the consumers' country of origin. Oude Ophuis (1994) observed that both label information and prior experience with organic products had a favourable influence on the sensory evaluation of "free range" pork meat.

Information also had a positive effect on consumers' preference for organically grown tomatoes over conventionally grown tomatoes (Johansson and others 1999). The greatest increase in preference, as a result of providing information about the farming system, was for samples least liked in a blind evaluation (Johansson and others 1999). In another study, information about organic production of wheat increased consumer preference for organic bread samples (Kihlberg and others 2005). These researchers also reported that the greatest increase in preference was for samples least liked during the blind evaluation. Consumers' ideas and attitudes towards organic farming were postulated to be the cause of the observed change in sample preference (Kihlberg and others 2005). In all 4 studies comparing organic and conventional foods, the effect of information on origins of organic products increased overall consumer acceptability of organic products.

1.3.1.2. Non-organic products

1.3.1.2.1. Information on health and nutrition contents

Nutritional information is commonplace in retail settings. Providing this information during sensory evaluation can have varying effects. Placing "Healthy" and "Diet" labels on six low calorie entrées and desserts increased the liking of less healthy desserts, but had no effect on the entrées (Wansink and others 2004). The researchers suggest a positive 'halo' effect can be created by the presence of healthy labels and, in turn, generate expectations of the product. Thus, there was no effect of label on consumers' taste perception of the entrées because they were already considered healthy foods (Wansink and others 2004). Similarly, when comparing functional food concepts, van Kleef and others (2005) reported that health claims were not effective for all food product concepts evaluated as some food products were already considered healthy alternatives. Goerlitz and Delwiche (2004) reported that information on the nutritional benefits of soy-enhanced tomato juice had no impact on product acceptance when compared to two commercially available tomato juices. When foods were perceived to be healthy by the consumer, there was no impact of nutritional information or health claims on product acceptance.

Conversely, Mialon and others (2002) found that information on dietary fibre content of bread and English muffins (white, fibre enriched, or multigrain) increased the acceptance ratings of fibre enriched breads and English muffins, but decreased the acceptance ratings of white bread and English muffins. Consumers were likely decreasing their expectation of the sensory characteristics upon receiving information on dietary fiber content, thus relying more on the information than sensory appeal for overall acceptance (Mialon and others 2002).

High-fat products such as ice cream and chocolate bars are traditionally well liked for their pleasing sensory characteristics (Kähkönen and Tuorila 1999b). Reduced-fat products may receive lower acceptance ratings from consumers due to the removal of sensory aspects of smoothness and mouth feel created by fat globules (Kähkönen and Tuorila 1999b). Nevertheless, by providing information on reduced fat content, consumers may increase their acceptance of the product because of attitudes towards reduced fat products and beneficial effects on health (Kähkönen and others 1996).

For products with traditionally high fat contents such as a fat spread or frankfurter sausage, information on the fat content enhanced the pleasantness ratings of the low fat alternatives (Kähkönen and others 1996; Kähkönen and others 1997; Kähkönen and others 1999a). However, for a healthy food such as fat free strawberry yogurt, the label had no significant effect on acceptability ratings of the product (Kähkönen and others 1997). Following these studies Kähkönen and Tuorila (1999b) also performed a consumer survey that confirmed the findings of their previous work; the effects of information about fat content on the expectation of pleasantness and actual sensory acceptability are product specific.

It is apparent that sensory appeal of a product (regular or low fat) can be more important for consumer acceptance than the nutritional information provided. In a study evaluating consumer liking of sausages (12% or 20% fat) under blind and labelled conditions, Solheim (1992) reported that sensory quality was more important for consumer liking than the nutritional information provided on the fat content. Likewise, Bower and others (2003) compared a new fat spread with proven health benefits to an established fat spread, and observed that consumers' liking scores were not influenced by label information on the nutritional benefits; fat spread preference was based on sensory appeal alone.

Some consumers are not willing to trade taste attributes for health benefits in a reduced fat product (Guinard and Marty 1997). When families of consumers were segmented into groups ('mothers', 'fathers', 'adolescents', and 'children'), Guinard and Marty (1997) observed no significant differences in degree of liking among eight foods with modified fat contents for all groups except one; 'regular' ice cream was liked more than 'fat free' ice cream for the 'mothers' group. This is consistent with Bogue and Ritson (2004), who reported that full-fat cheddar cheese was viewed as a food for enjoyment and thus reduced-fat cheddar cheese did not receive higher acceptance ratings. However, if consumers have strong beliefs about the benefits of eating healthy, it may sway their sensory judgements. Aaron and others (1994) reported no consistent effect of nutritional information on overall liking of low and high fat spreads, but did observe an interaction between the attitudes (towards eating full fat spreads) and consumer beliefs (that is, the importance of health benefits) with label information, in which sensory judgements would shift in the direction of beliefs.

1.3.1.2.2. Information on brand, processing methods, and product origin

Product branding is important to food and beverage companies as it can set their product apart from others through information provided on a label. By evaluating the effects of brand labels under controlled experimental conditions, it is possible to estimate consumer expectations of product acceptance. Lange and others (2002) observed that liking did not differ among 5 brut non-vintage Champagnes when evaluated under blind conditions. After presentation of brand label, there were significant changes in preference following the hierarchy of the market. The preference evaluation of this type of product (Champagne and/or wine) seems to be more affected by the information given on the label than the sensory properties experienced by the consumer (Lange and others 2002).

Information provided to the consumer about processing methods can also influence quality expectations of food products. Siret and Issanchou (2000) observed that ingredient information for a pâté product that evoked a traditional or a non-traditional processing method had a greater effect on increasing the expected liking scores (before tasting) of pâté than the actual liking scores (after tasting occurred). When liking of beer was evaluated under blind, expected, and labelled information conditions, Caporale and Monteleone (2004) observed that sensory properties were most important in perceived product quality, but that information about the ingredients or manufacturing process used still had the potential to change consumer liking.

One of the basic underlying motives for choosing a food is the knowledge of the nature of its origin (Martins and others 1997). Caporale and others (2006) observed that information concerning origin of extra virgin olive oils had a positive effect on expectations, some leading to assimilation upon tasting (taste confirmed expectations), and others disconfirmation (taste did not meet expectations). The impact of information about origin may be due to consumers' regional product preferences based on prior experiences and emotions (Caporale and others 2006). Stefani and others (2006) observed that consumers' expectations and liking for spelt were more positively affected by information when the origin was reduced from a large undefined area of production (such as Italy), to a small precisely defined area of specialty production (such as Garfagnana, a small valley of the Apennines in Italy).

1.3.2. Influence of information and sensory attributes on purchase intent and willingness to pay (WTP) for food products

1.3.2.1. Purchase intent and WTP

Estimates of consumers' WTP can be elicited from actual market transactions (revealed preferences) or from survey data (stated preferences) (Wertenbroch and Skiera 2002). Stated preferences are evaluated by asking the consumer to make single or repeated choice of whether they would purchase a good at a given price (WTP) (Wertenbroch and Skiera 2002). In contrast, more recent research has evaluated incentive-compatible estimates of WTP derived from real transactions in the form of an experimental Vickery auction (Wertenbroch and Skiera 2002). In research studies involving food products, WTP evaluations range from basic purchase intent questions in a consumer survey (Bower and others 2003; Magnusson and others 2003) to experimental Vickery auctions, with consumers bidding with real money to elicit their actual WTP (Lange and others 2002; Stefani and others 2006).

The effects of information on purchase intent or WTP has been evaluated in addition to sensory acceptance of food products (Lange and others 2002; Bower and others 2003; Dransfield and others 2005). Consumers were willing to pay more for the new fat spread with proven health benefits when combined with higher liking during the sensory evaluation (Bower and others 2003). When pork meat was labelled with either the consumers' 'home country', or 'raised outside', there was a 5% increase in consumers' WTP (Dransfield and others 2005). Lange and others (2002) reported that both hedonic evaluations and auctions lead to similar results in terms of product differences for Champagnes.

Other researchers investigating the effect of information on product acceptance have focused on evaluating purchase intent only and have forgone evaluating consumers preference based on sensory appeal. Carneiro and others (2005) explored the effects of brand, price, nutritional information, and type of soybean on consumers' purchase intent. They reported that price was the only significant factor; soybean oils with a lower price label received a higher purchase intention from all participants. This study was conducted in the absence of taste evaluation, and so consumers have no indication of the sensory aspects of the product. As was discussed in the previous section of this chapter, sensory appeal may have much more influence on choice than label information alone.

1.3.2.2. Effects of sensory variables on WTP

Enneking and others (2006) used the type of sweetening system to produce 4 'taste' attributes and observed that sugar was the preferred sweetener, and 'taste' had a significant impact on product choice and purchase decisions for soft drinks. McCluskey and others (2006) evaluated consumers' WTP for apples with respect to sensory attributes, and observed that firmer and sweeter apples increased consumers' WTP. Ara (2003) used combinations of "eating quality" variables to describe the sensory characteristics of rice for consumers, and investigated WTP. Sensory information included softness, white colour, smell, and purity. If none of the variables were present, rice was considered of 'bad' eating quality, whereas a combination of one or more of the variables was considered 'fair' or 'good' quality. Rice with all 4 sensory variables was considered 'excellent' eating quality. The researchers observed that when "eating quality" was decreased from 'good' to 'bad', there was a decrease in WTP, whereas when "eating quality" was increased from 'bad' or 'fair' to 'excellent', WTP increased (Ara 2003). These two studies demonstrate that sensory variables, whether they are experienced or not, play a significant role in the willingness to pay for food products.

1.3.3. Information presentation

According to Torjusen and others (2004) how information is presented on a label, as well as the source of the information, can affect consumer perception of a product. In addition to clear and simple information provided on the label, some consumers also wanted more in depth information about organic production methods (Torjusen and others 2004).

1.3.3.1. Written vs. oral

The way that information is presented, whether it be written or oral, can affect the extent of reception and understanding by the consumer. Soler and others (2002) presented information on organic farming through either written text or oral explanation and investigated the effects on consumers' WTP for organic olive oil. Consumers were more likely to trust the information on organic farming when provided verbally, and thus were more willing to pay the premium for the organic olive oil.

1.3.3.2. Source of information

Labels are often the main source of communication between the producer and consumer (Torjusen and others 2004). The source of information found on a label, whether from a government organization, producer, or consumer group, plays a role in the amount of trust that consumers place in the quality of their food product. Differences in culture and the role of food in society often determine which organizations can be trusted (Torjusen and others 2004).

In a Canada-wide survey concerning functional foods, West and others (2002) observed that consumers were more confident in the information provided by consumer/environmental groups than from government or food manufacturers. Consumer and Environmental groups often provide negative information to increase consumer scepticism, but are also the most likely to provide false information to the consumer (West and others 2002). Hayes and others (2002) found that negative information provided on a food irradiation processing technique had a greater effect on consumers' WTP for pork than did the positive information. This was true even if the negative information was sourced from a consumer group and written in a non-scientific manner (Hayes and others 2002).

Consumers must trust the source of the label information communicating the nutritional content or process of production; otherwise the product may not satisfy the need they are looking to fill (Grunert and others 2000). According to McCluskey (2000), products that have high quality credence attributes such as organic foods require third party monitoring of certification as well as repeat-purchase relationships with consumers to be successful.

1.4. Effects of consumer characteristics, values and attitudes on preference for organic food

Consumer characteristics such as socio-demographics, values, and attitudes have been postulated to have a significant effect on consumer behaviour and thus food choice (Thompson 1998; Magnusson and others 2003). Attitudes towards health and environmental issues can affect consumer perception of organically grown food, and in turn create the motivation to purchase a product. Many researchers have concluded that consumers' concern for their health is the primary motivation for choosing organic products (Ekelund 1989; Tregear and others 1994; Schifferstein and Oude Ophuis 1998; Baker and others 2004), while others cite environmental concern as most important (Wandel and Bugge 1997; Storstad and Bjørkhaug 2003).

The behaviour of choosing organic foods is influenced by internal values, which in turn induce attitudes towards the issues surrounding organic production practices, as well as the perceptions that individual products portray to the consumer through information (Magnusson and others 2003; Lockie and others 2004; Chryssohoidis and Krystallis 2005). In some cases, researchers have been able to predict consumer behaviour through demographic characteristics, and by segmenting individuals into groups based on those characteristics, discover the most probable motivations for a given behaviour (Wandel and Bugge 1997; Thompson 1998). Others have specifically evaluated the values and attitudes of consumers towards health issues, environmental issues, and organic foods in general, and assessed the motivation for choosing organic foods (Magnusson and others 2003; Saba and Messina 2003; Baker and others 2004; Lockie and others 2004; Finch 2005). There are distinct differences in values, attitudes and behaviours among consumers from North American countries compared to those in European countries (Jolly and others 1989; Tregear and others 1994); one cannot assume that the motivation for purchasing organic food is the same between the two sets of consumers. Therefore, it is important to discern differences in basic values and attitudes towards issues surrounding organic production to better understand consumer motivation and tailor the marketing of organic products to target consumers.

A review was recently completed by Yiridoe and others (2005) highlighting the economic perspective of consumer perceptions and preferences of organic and conventional food product comparisons. They reported that organic and non-organic consumers in the UK had similar understanding of what constitutes 'organic' food, whereas in the U.S. there were substantial differences in how buyers and non-buyers rated organic quality compared to conventionally grown products (Yiridoe and others 2005).

The current discussion is an extension of previous work, but focuses on those studies examining factors influencing consumer food choice pertaining to the research completed in our experimental work. More specifically, this review will focus in on differences between European and North American consumers found in current literature.

1.4.1. European consumers

Research interest in the organic foods movement has expanded over the last 20 years with the majority of research on consumers' values, attitudes, and preferences for organic food conducted in European countries.

Consumer preference evaluations reveal product attributes that are desired in organic food as well as the basic motivations behind purchasing organic food. 'Freshness' was the most important quality attribute for consumers in Sweden (Ekelund 1989), and Norway (Wandel and Bugge 1997), while 'taste' was an important attribute for consumers in Sweden (Shepherd and others 2005), Norway (Wandel and Bugge 1997), and Ireland (Roddy and others 1994), with many consumers who considered organic foods to 'taste better than conventional'.

Another motivation for choosing organic produce was the 'lack of pesticide residues' for Irish consumers (Roddy and others 1994), the 'absence of chemicals' for Swedish consumers (Ekelund 1989), and the 'avoidance of chemicals' for Danish consumers (Wier and others 2003).

Other research studies have focused on the environmental concerns of consumers as motivation for choosing organic foods. The 'environmental benefits of organic farming' was the main motivation for Norwegian consumers and farmers to buy organic foods (Storstad and Bjørkhaug 2003), while consumers from Ireland (Roddy and others 1994) and the UK (Tregear and others 1994) felt that organic production was 'kinder to the environment' and caused less environmental damage than conventional farming practices. Wandel and Bugge (1997) observed that consideration for environmental aspects depended on socio-demographic characteristics of the Norwegian consumer. Women and those in the highest education group were more likely to consider environmental aspects a priority, whereas young consumers valued 'environmental' and 'animal welfare' aspects (Wandel and Bugge 1997). Although most researchers found environmental benefits to be a positive attribute of organic food, Wier and others (2003) observed that 66% of Danish consumers felt organic agriculture practices were no better for the environment than conventional practices.

Health concerns and perceived nutritional benefits are other common motivations for choosing organic foods. Irish consumers in two separate studies (Ekelund 1989; Roddy and others 1994), Swedish consumers (Magnusson and others 2003), and 45% percent of UK consumers (Tregear and others 1994) purchased organic food out of concern for their personal health or a perceived benefit to human health from consuming organic foods. For Norwegian consumers, 'nutritional value' was an important attribute of organic food (Wandel and Bugge 1997), while consumers in Greece considered organic foods healthier than conventional (Botonaki and others 2006). Health conscious consumers in Greece were also willing to pay more for organic foods (Botonaki and others 2006).

Cost was a factor that hindered consumers' purchase of organic foods. According to Wandel and Bugge (1997), consumers in Norway were interested in buying ecologically friendly foods but were not willing to pay the higher cost. Likewise, cost was the most common reason for not purchasing organically grown food among UK consumers (Tregear and others 1994).

Some consumers had positive attitudes towards buying organic foods not reflected in their purchase intent or behaviour (Shepherd and others 2005). Researchers suggest that organic foods were not perceived to be any better than conventional foods. According to Storstad and others (2003), consumers of conventionally produced foods were not interested in buying organically grown food because conventional was "good enough".

For consumers who did purchase organic products, Schifferstein and Oude Ophuis (1998) found that it was difficult to determine whether individual health consciousness or responsibility to the environment was more important to consumers in the Netherlands. They concluded that organic food consumption is a way of life, not any one particular motivation.

Rather than evaluating basic motivations, other researchers have assessed consumers' attitudes towards organic foods. Attitude towards environmental questions was a significant predictor of organic consumption for consumers in Norway (Storstad and Bjørkhaug 2003), while Swedish consumers who performed environmentally friendly activities such as recycling were more likely to purchase organic foods (Magnusson and others 2003). Greek consumers with positive health attitudes were more likely to pay a premium for organic food, while consumers who consider convenience an important factor for buying food were less likely to pay a premium for organic food products (Botonaki and others 2006).

Attitudes of Italian consumers (n = 947) towards eating organic fruits and vegetables were a significant predictor of their intent to eat organic food (Saba and Messina 2003). But, Italian consumers who perceived more benefits than risks with the use of pesticides had a less positive attitude towards organic foods (Saba and Messina 2003)

Thirteen percent of Irish consumers (n = 927) had positive attitudes towards organic food and a strong likelihood to purchase organic food (Roddy and others 1996). Saher and others (2006) suggest that positive attitudes towards organic foods for consumers in Denmark were related to individual sets of values, and these values were rooted in more fundamental personal attributes.

In light of this fact, recent research has expanded to qualitative techniques which explore consumers' personal values and attitudes to explain the behaviour behind organic food consumption. The laddering technique was used by Baker and others (2004) to map the personal values of UK and German consumers and explore organic food choice. The connection between organic food and the environment was absent for the UK group of consumers while German consumers were remarkably aware of environmental issues. Although there were similarities between the groups for values placed on health, well-being, and enjoyment of life, there were distinct differences in the product attributes sought by the two groups of consumers to fulfil those values (Baker and others 2004). German consumers valued 'taste' and 'quality', while UK consumer's valued 'healthiness' and 'non-genetically modified'.

The list of values (LOV) scale that segments consumers based on their personal values was used by Chryssohoidis and Krystallis (2005) to survey organic consumers in Greece (n = 205). This scale makes the distinction between internal and external values, and allows the researcher to better understand the specific values that motivate consumers to choose organic food. 'Self respect' and 'enjoyment of life' internal values corresponding to healthiness and better taste of organic foods were main motivators for purchasing organic food in Greece. The external value "belonging", relating to environmental protection through organic cultivation, was less important to these consumers.

Dreezens and others (2005) surveyed consumers in The Netherlands (n = 100) to ascertain the specific values that play a role in predicting attitudes towards organically grown and genetically modified foods. They observed that consumers who valued power (dominance, submission) rated organically grown foods negatively and genetically modified foods positively, whereas those consumers who valued universalism (welfare for all people and protection of nature) rated organically grown foods positively (Dreezens and others 2005).

For Swedish consumers (n = 184) both age and values had a significant effect on the liking of organic bread (Kihlberg and Risvik 2006). The personal values of younger consumers (≤30) were associated with 'openness to change', and 'self-enhancement', whereas personal values of the older consumers (>30) were more associated with 'conservation' and 'self-transcendence' (Kihlberg and Risvik 2006).

When reviewing the extensive research with European consumers regarding attitudes and preferences for organic foods, it is apparent that countries differed. It is important to note that some countries have relatively high levels of organic production (e.g. Denmark, Sweden), while others have lower levels of organic production (e.g. Greece, Spain) (Shepherd and others

2005). As the amount of organic production increases, research interest in consumer behaviour and the motivation for choosing organic food will also increase.

Some of the earlier research studies report that they collected consumers' attitudes towards organic foods, when in reality they collected basic motivations behind the preference for organic products (Ekelund 1989; Tregear and others 1994; Wandel and Bugge 1997). More recent work has delved into the human psyche, and through qualitative research techniques (such as laddering interviews) revealed the personal values behind those motivations for choosing organic food (Chryssohoidis and Krystallis 2005; Dreezens and others 2005; Kihlberg and Risvik 2006). Expanding research programs and increased funding has allowed more complex evaluation of organic food choice.

1.4.2. Australian consumers

Research interest about consumers' preferences and attitudes is an emerging field in Australia, and is quickly advancing into more complex evaluations of food choice among organic consumers. Lockie and others (2004) observed that 40% of Australian consumers (n = 1212) had consumed some type of organic food in the previous year, indicating that consumption of organic food is becoming a mainstream activity in Australia. Age and education had a significant effect on organic consumption, with older and more educated consumers less likely to consume organic food. In assessing consumers' attitudes, researchers found that consumers who were concerned about "natural foods" as well as the "sensory and emotional appeal" of food had the propensity to consume greater amounts of organic food compared to those who were concerned with the "convenience" of purchasing and preparing their food. The most unexpected result of this study was that "healthy food values" had no significant impact on increasing consumption of organic food (Lockie and others 2004).

1.4.3. North American consumers

Fewer studies on consumers' preferences and attitudes towards organic food have been completed in North America than Europe. Studies range in scope from a basic evaluation of consumer preferences for organic food (Jolly and others 1989), to more complex evaluations of consumers' values and attitudes towards the issues surrounding organic food production (Finch 2005).

Consumers of organic products in California (n = 1950) valued attributes of 'safety' and 'freshness' more than the 'general health benefits' when ranking the importance of product characteristics, while the main concerns limiting the purchase of organic foods were 'cost' and 'availability'(Jolly and others 1989). Consumers in upstate New York (n = 350) were less concerned with 'price' but more concerned with 'food safety' (Goldman and Clancy 1991). The main motivation for Canadian consumers to choose organic food was 'taste', followed by 'nutrition and health' considerations (Cunningham 2002). Consumers in Georgia (n = 381) were more likely to prefer organically grown produce if they were nutritionally conscious, were concerned about pesticides, and wanted their produce tested for residues (Huang 1996).

In a review of research studies completed in the U.S.A., Thompson (1998) explored the effects of consumer characteristics on demand for organic food and WTP for organic food. Evidence from national studies suggests that there is a positive correlation between education and organic purchasing (Thompson 1998). However, when undergraduate education was set apart from graduate studies, there was a lower probability of buying organic and a decreased WTP with higher graduate education. The author also reports that families with more children had an increased probability of buying organic produce, but suggested that future studies should include the age of the children. Huang (1996) also observed that highly-educated, white consumers with large families were more likely to tolerate sensory defects in organic products, although it is also suggested that sensory quality is one of the most important factors that could enhance the marketing potential of organic produce.

Higher income levels were generally linked to increased purchase of organic foods, although no concrete conclusions could be drawn as a few notable studies observed a decreased WTP for organic products with increased income (Thompson 1998). The choice of shopping location influenced which factors affected consumers' propensity to purchase organic foods. There was a significant effect of consumer characteristics in upscale shops that was not found in the discount stores (Thompson 1998). Age, gender and marital status were also examined in this review, and the author concluded that effects of age on organic purchase were more likely to emerge in certain segments of the population, whereas the limited evidence on gender and marital status suggests that there is little influence on organic purchase alone, but that together they might explain more of the variation (Thompson 1998).

Consumers' attitudes towards product defects (insects or blemishes) in upstate New York affected the stated WTP for organic produce, and consumers' were willing to pay 50 to 100% of conventional produce prices for residue free produce (Goldman and Clancy 1991).

Similar to European studies, researchers are exploring consumers' personal values and attitudes using more advanced techniques to understand organic purchasing motivations. Consumers from the Midwest region of the U.S.A. (n = 160) were surveyed to investigate the influence of consumer values on purchase behaviour for organic foods (Finch 2005). A predictive model was used to suggest that market choices of consumers are determined by multiple consumption values, rather than product attributes. There is a complex interaction of values (social, functional, conditional, and emotional) that shape consumers purchase decisions. Each individual makes relative tradeoffs for values that are important when making a purchase decision (Finch 2005).

We have used North American consumers as the basis of classification of the aforementioned studies. Although there are many similarities between the consumers in U.S.A. and those in Canada, there have yet to be any notable research studies on the attitudes and values of Canadian consumers. There is much work to be completed to reach the level of understanding and experimental work that is currently being completed in European countries.

The EU countries have stringent organic certification standards for plant products that have been in place since 1993 (EU Regulations 2092/91), while those from livestock productions came into force in 2000 (EU Regulation 1804/99) (Yussefi 2004). The US National Organic Program (NOP) requiring all organic food products to meet the same standards and be certified under the same certification process was officially implemented in Oct. 21, 2002 (Robinson 2004). The Canadian General Standards Board has just completed The National Standard of Canada for organic production (CAN/CGSB-32.310-2006 Sept 2006), but the regulations still need to go through approval by the Canadian government, which is expected to take until the end of 2006.

The level of research completed in each country is reflective of the certification standards. With unclear labels of organic products, many consumers are confused as to their origin. This may lead to fewer consumers purchasing organic products, and thus less research interest in their motivations for buying organic products. Attitudes and values research is an emerging field that should be further explored with Canadian and American consumers with respect to organic foods.

1.5. Limitations to previous research

The number of research studies examining sensory differences in organic and conventionally produced food is relatively small. A comprehensive review by Bourn and Prescott (2002) reported that "when one considers only those studies using large appropriate comparison methods, suitable panelists, and exercising reasonable control over confounding factors, the number [of studies] is considerably lower" than the total number studies completed on organic versus conventional comparisons.

The main drawback of many research studies comparing conventional and organically grown foods is the inconsistent source of samples. These sources have included controlled research plots, working farms, storage facilities, and retail outlets (Williams 2002). According to Harker (2004), there is "little possibility of obtaining meaningful data on organic versus non-organic production systems if products are sourced from retailers", as manipulation of quality may occur in the supply chain between the farm and retail store. Differences in maturity at harvest, freshness, or cultivars may confound research due to the lack of information in retail outlets (Harker 2004). The results of comparative studies gathering samples directly from the farm may be limited to the specific location the tests were completed (Woese and others 1997). This means that comparison of organically and conventionally produced food completed in Europe cannot be directly applied to food production in Canada.

Amidst the knowledge that European consumers' attitudes and purchase behaviours are unlike those of their Canadian counterparts, and organic agricultural products in Europe can not be compared to those in Canada, it is essential that more research is conducted on Canadian organic products, as well as Canadian consumers' attitudes and purchase behaviours in the organic market.

1.6. Research Proposal

Currently, there is no published research comparing the quality of organic and conventional wheat grain grown in Canada when baked as bread. There is also limited research on the effects of information on consumer perception of organically produced grain products in Canada.

The **goals of this research project** were to provide scientific insight about the sensory and overall quality difference between organic and conventionally grown Canadian wheat bread products, and to develop an understanding of the effects of information about organic production methods on western Canadian consumers' perceptions of organic wheat products.

For the proposed research, **objectives** are to:

1) Compare the physiochemical properties of organic and conventionally grown wheat and flour,
2) Describe and compare the appearance, aroma, texture, and flavour attributes of 60% whole wheat bread baked from organically and conventionally produced wheat using the sensory evaluation technique of descriptive analysis,

3) Determine impact of information on the perceived liking of this wheat product, focusing on either health or environment aspects of organic production methods as motivation for choosing organics,

4) Assess the role of other non-sensory factors, such as consumer characteristics, on changes in consumer preference for 60% whole wheat bread made from organically grown wheat.

Hypotheses for this research project are that:

1) The physiochemical properties are similar between organic and conventionally grown wheat and flour, when paired samples are compared,

2) The sensory aspects such as appearance, aroma, texture, and flavour are similar between organically and conventionally produced wheat when baked as 60% whole wheat bread,

3) Consumer preference for organic products will increase liking of organic wheat bread when consumers are given positive information about organic production from either health or environmental aspects,

4) Other non-sensory factors will predict the propensity of increased preference for organic bread.

The unique approach to this research is the direct comparison of bread formulated from paired samples of organic and conventionally grown Canadian Spring wheat grain. Our wheat variety was grown in plots approximately 1km apart under the two different production systems, thus allowing a valid comparison between the organic and conventional wheat and food products formulated from them.

This research project furthers the understanding of how focused information on health or environmental issues can affect the liking of a food product. More specifically, the project examines how short paragraphs of targeted information on health or environmental aspects of organic production methods can influence liking of organic food products. The length and source of information provided to consumers were unique to this project.

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Chapter 2: Sensory profiles of bread made from paired samples of organic and conventionally grown wheat grain.

2.1. Introduction

Organic agriculture is a system of agricultural production which attempts to promote ecosystem health. Many external inputs (such as synthetic pesticides and fertilizers, plant and animal growth regulators, the prophylactic use of antibiotics, some preservatives and artificial additives in food products and genetically modified plants or animals) are therefore prohibited (Sydness 1991, Robinson 2004). Proponents of organic agriculture believe it to be an environmentally, socially and economically sustainable food production system (Bourn and Prescott 2002; Mason and Spaner 2006). Due to the inability to use synthetic inputs, organically managed crops may be subjected to increased crop stress from weed pressure, soil nutrient deficiencies and environmental effects (Entz and others 2001; Jones 2003; Ryan and others 2004).

In Canada, there are over 3500 organic farms comprising approximately 1.5% of the total agricultural land in the country (Yussefi 2004). Over 1 million acres of crop land in Canada is dedicated to organic production, with an additional 57 thousand acres in transition to organic production standards (Macey 2005). Organically produced wheat accounted for almost 70 thousand hectares acres in western Canada with a value of over $44 million (CDN) in 2004 (Macey 2003; 2005).

Grain quality analyses may be used to compare organically and conventionally produced wheat. Such analyses commonly include chemical analysis of the grain and / or the physiochemical analysis of the flour (Kent and Evers 1994). Grain protein content is an important predictor of breadmaking quality as high amounts may indicate better dough strength, depending on the strength of the gluten matrix (Kent and Evers 1994). Some researchers have reported higher protein levels in conventionally grown wheat grain (Poutala and others 1993; Starling and Richards 1993), while others have observed no difference between organic and conventionally grown wheat (Shier and others 1984; Ryan and others 2004; Mason and others 2006). Preston and others (2001) reported that environment had the largest effect on protein content of Canadian western red spring (CWRS) wheat. Falling number, kernel hardness, and flour yield are additional wheat quality traits that have been less frequently investigated in comparative studies between organically and conventionally grown wheat. They, nevertheless, are important characteristics contributing to baking quality of the flour (Gooding and others 1999).

In addition to grain quality, the sensory quality of bread made from differing wheat sources can be compared using descriptive analysis to create a profile of key sensory attributes (Lawless and Heymann 1998). Employing descriptive analysis to compare wholemeal European-grown wheat bread, Haglund and others (1998) reported that colour and aroma were affected by the farming system (organic vs. conventional). Organically grown wheat gave a darker colour and stronger aroma in the final bread product, compared to the conventionally grown wheat counterpart (Haglund and others 1998). Kihlberg and others (2004) evaluated the influence of farming system (organic vs. conventional), milling technique (stone vs. roller), and kneading level (high vs. low intensity) on sensory qualities of whole wheat bread in Sweden. They reported that farming system had no influence on sensory quality, but the milling technique affected textural qualities of the whole wheat bread (Kihlberg and others 2004). Kihlberg and others (2006) baked white bread from wheat grown in both organic and conventional farming systems, harvested in 2 consecutive years (1999 and 2000), using different baking techniques. Farming system alone had no effect on any of the sensory attributes evaluated, but the year of harvest altered 'overall aroma', 'deformability', and 'toughness of the crust' (Kihlberg and others 2006).

One limitation of previous research comparing organically and conventionally grown foods is the inconsistent source of samples. These sources have included controlled research plots, working farms, storage facilities, and retail outlets (Williams 2002). According to Harker (2004), there is "little possibility of obtaining meaningful data on organic versus non-organic production systems if products are sourced from retailers", as manipulation of quality may occur in the supply chain between the farm and retail store. Differences in maturity at harvest, freshness, or cultivars may confound research due to the lack of information in retail outlets (Harker 2004).

The unique approach to the present research is the direct comparison of bread formulated from paired samples of organic and conventionally grown Canadian Hard Red Spring wheat grown in the same year in close proximity on similar soils. In addition, no research has thus far been reported comparing sensory attributes of organically produced bread wheat in western Canada, an important source of globally traded wheat. Hard red wheat produced in the semi-arid prairie regions of Canada is generally both harder and higher in protein content than European grown counterparts. This is due to both the environment and the genetic background of western Canadian Spring wheat (Mason and Spaner 2006).

The objectives of this research project were to:

1) Compare the physiochemical properties of organically and conventionally grown wheat and flour produced in western Canada,
2) Describe and compare the colour, texture, taste, and aroma attributes of bread baked from organic and conventionally produced wheat using the trained panel sensory evaluation technique of descriptive analysis.

2.2. Materials and methods

2.2.1. Wheat management systems

The hard red spring wheat cultivar 'Park' was grown in 2005 at the Edmonton Research Station in Edmonton, AB, Canada (53° 34′ N, 113° 31′ W) on both conventionally and organically managed land, situated less than one km apart (Table 2-1). The organically managed land had lower soil pH and N, and higher soil P and organic matter than the conventionally managed land (Table 2-1). In general, nutrient levels were adequate to optimal at both sites, with differences being mainly to do with greater weed pressure on organic land. The conventional land had fertilizer added at 28 kg ha^{-1} as ammonium phosphate banded with the seed. The organic land had compost (comprised of dairy manure, sawdust, wood chips and straw) added at a rate of 50 – 62 t ha^{-1}.

Fields were seeded into cultivated and harrowed soil that was tilled both in the autumn and in the spring prior to seeding. Organically managed land had an additional tillage operation performed to kill weeds immediately before seeding. Grain was seeded with 23 cm row spacings with a self-propelled, no-till, double-disk plot seeder (Fabro Enterprises Ltd., Swift Current, SK, Canada). Herbicides were used in the conventionally managed land at locally recommended rates, while no weeding was conducted on organically managed land.

Following harvest, wheat grain was placed in large drying chambers (60°C) for approximately 24 hours to lower the moisture content before dry storage. A 2 mm mesh sieve (Canadian Standard Sieve Series No.10.) was used to remove foreign materials from the grain samples. Grain samples were stored in the seed storage facilities in the Crops & Land Resource Centre at the Edmonton Research Station until required for quality analysis or further processing.

2.2.2. Evaluation of wheat quality

Five replicate 500 g samples from each management system were analyzed for chemical and physical properties at the Cereal Research Centre, Agriculture and Agri-Food Canada, in Winnipeg, MB, Canada. Measurements included wholemeal protein content, particle size index, flour yield, and falling number. Grain samples were ground using a UDY Cyclone Sample Mill (UDY Corporation, Fort Collins, CO, USA) with a 1.0 mm screen. Ground samples were then used to determine wholemeal protein content and particle size index using an Instalab 600 Series Near-Infrared Reflectance Analyzer (DICKEY-john Corporation, Auburn, IL, USA). Flour yield was determined using a Brabender Quadrumat Junior Mill (C.W. Brabender Instruments, South Hackensack, NJ, USA) according to the Approved Method 26-50 (AACC 2000). Falling number tests were conducted according to Approved Method 56-81B (AACC 2000).

Mixograph parameters were determined using a 10 g fixed bowl mixograph (K&S Tool and Die Ltd., Winnipeg, MB) at 60% water absorption. Automated data collection and analyses were performed as described by Pon and others (1989). Measurements included mixing development time (min), peak height, total energy under the graph (Newton metres, Nm), energy to peak, peak bandwidth, and bandwidth energy.

2.2.3. Flour milling

The moisture content of the stored wheat was analyzed using a Sartorius Moisture Analyzer (model MA30, Data Weighing Systems, Inc, Elk Grove, IL, U.S.A.). Before conditioning, organically and conventionally grown wheat grain had moisture contents of 7.0% and 13.9%, respectively. Moisture content was raised to 16% before milling for both samples. Grain samples were milled separately using a Buhler Mill (Model MLU-202, Buhler Inc., Uzwil, Switzerland), with an average extraction rate of 72%. Sixty percent of the bran and shorts collected during milling were added back to the flour portion and blended to create 60% whole wheat flour. All wheat conditioning, flour milling and bread manufacture were completed at the Leduc Food Processing Development Centre in Leduc, AB, Canada.

2.2.4. Bread manufacture

The bread formulation for both organic and conventional samples (Table 2-2) was adapted from ‘Food for Fifty’ (Molt 2000). Ingredients were mixed using a Blakeslee Mixer (Blakeslee DB-80 QT Mixer, Blakeslee USA, Chicago, IL, U.S.A.) for 1 min at speed 1 (low) to blend, followed by 10 min at speed 2 (medium) to develop the gluten network and knead the dough. The dough was proofed for 1 h 5 min (27°C and 80% RH) using a Plantinous Sterling Series Temperature and Humidity Chamber (with SCP-220 instrumentation, Espec North America, Hudsonville, MI, U.S.A.) followed by a punch down step and a second proof for 40 min (27°C and 80% RH). The dough was divided into 510g portions, formed into loaves using a Bloemhof Moulder (model 860-1, Bloemhof Inc., Edmonton, AB, Canada), and placed into loaf pans (454g size) sprayed with non-stick cooking spray. Loaves were proofed for 25 min (35°C and 90% RH) and baked at 190°C for 30 min using a Baxter Oven (Advantage Rotating Rack oven, model V16-340-1, Orting, Wash., U.S.A.). Bread loaves were cooled for 1 h (30 min in pans, 30 min on parchment paper) and then packed into polyethylene bags. Sample loaves were placed in a commercial freezer at –18°C within 2 h of baking and were stored there until required for sensory evaluation.

2.2.5. Sensory evaluation

Nine panellists (7 females and 2 males, undergraduate and graduate students) were recruited from the University of Alberta campus in Edmonton, AB, Canada, to participate in the descriptive analysis sensory panel. Potential panellists were selected based on ISO standard 8586-1 (ISO 1993). The sensory evaluation protocol for this experiment was approved by the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board.

Descriptive analysis training and evaluation used for this panel were based on the generic descriptive analysis methods described by Lawless and Heymann (1998). The training phase consisted of 10-one hour sessions over 3 consecutive weeks to develop and refine terminology to describe the key sensory attributes of whole wheat bread. First, panelists were introduced to the principles of descriptive analysis. This was followed by the preliminary generation of descriptive terms for whole wheat bread samples. As the training progressed, descriptive terms were defined through panel discussion and redundant terms were excluded by panel consensus. A preliminary score card was developed to evaluate attribute intensities on 15 cm unstructured line scales. The endpoint labels for the intensity scale were "Not at all" on the left to "Very" on the right for each attribute (Table 2-3). Panellist discussions also determined the order of appearance for each term.

Overall, these discussions resulted in 14 descriptive terms covering appearance, aroma, texture and flavor attributes of whole wheat bread (Table 2-3). In addition, a variety of reference standards were tested by the panel during the training sessions. The reference standards chosen by panel consensus were placed on the line scale to denote relative intensities of an attribute (Table 2-4). After the final training sessions where panellists practiced evaluating samples using the intensity scale, an assessment of their reliability and validity (Lawless and Heymann 1998) was completed before carrying out the formal evaluation.

The panelists evaluated 3 treatments of 60% whole wheat bread: Organic wheat bread (ORG), conventional wheat bread (CONV), and commercial wheat bread (COM). The commercial 60% whole wheat bread was obtained from a local grocery store, and was held in the same conditions as the experimental loaves (described above). The commercial loaves were included to provide an experimental comparison to the 60% whole wheat breads that are available in the consumer market.

Bread loaves were removed from frozen storage and thawed at room temperature overnight. A manual bread slicer and serrated knife were used to cut 1.4 cm thick slices from each 454g loaf. Each panelist was given 1 full slice of each treatment for evaluation. Samples were presented to panelists on 6 inch Styrofoam plates covered with plastic wrap and labelled with randomized 3-digit codes to represent each treatment. Filtered water was given to panelists as a palate cleanser during evaluation. Panelists were asked to expectorate the bread samples after evaluation. For visual assessment of crumb and crust colour, bread samples were place under controlled lighting conditions (Macbeth Skylight at Daylight setting, Kollmogen Corp., Newburgh, NY, U.S.A.).

The test location for the formal evaluation was the sensory laboratory on the University of Alberta campus where panelists were assigned to individual booths with computers. The panel room was illuminated with white incandescent lighting for evaluation. A balanced block design was used to evaluate each of the 3 treatments (ORG, CONV, COM) in triplicate. Three bread samples were presented per session over the course of 3 days of evaluation. Data from each panelist was collected using a computerized data acquisition system (Compusense *five*, version 4.2, Compusense Inc., Guelph, ON, Canada) for sensory evaluation.

2.2.6. Statistical analysis

For grain quality, data were analyzed within the Mixed Procedure of SAS (version 9.1, SAS Institute, Cary, N.J. U.S.A., 1999). Farming system was considered a fixed effect, with replicate considered random. Where the P-values indicated a significant difference between treatment means, Tukey's honestly significant difference (HSD) was used to examine significant differences ($p \leq 0.05$).

Within each of the 14 attributes described by the sensory panel, mean, median and standard deviation were tabulated for each sample using EXCEL® (Microsoft, Redwood, Wash., USA). Outliers were eliminated if the individual evaluation score was more than 1.5 times the standard deviation of the median for that particular sample. The median was used instead of the mean to remove any bias caused by outliers in the data (O'Mahony 1986). If two or more of the evaluation scores from the three replicate scores were removed, the panelist was removed completely from the data set for that attribute, across all samples. The Mixed Procedure of SAS was used to perform analysis of variance (ANOVA) on each attribute. Replication was considered a random effect for this analysis, while panelist and treatment were considered fixed.

Where the P-values indicated a significant difference between treatment means, Tukey's honestly significant difference (HSD) was used to examine significant differences ($p \leq 0.05$).

2.3. Results and discussion

2.3.1. Grain quality

The wholemeal protein content of the organically produced wheat was greater ($p \leq 0.05$) than conventional wheat (Table 2-5). This result confirms the findings of Kihlberg and others (2004), but is in contrast to the results of previous studies where researchers found protein content did not differ between organic and conventional wheat grain (Ryan and others 2004; Mason and others 2006). Nevertheless, both organic and conventional wheat grain in the present study were quite high in protein and only differed by about 1%. They are both excellent quality grains for making yeast leavened bread as they have protein contents greater than 12% (Halverson and Zeleny 1988).

Wheat grain proteins can be fractionated into gluten and non-gluten proteins (Wrigley and Bietz 1988). Gluten proteins are viscoelastic in nature and determine the physiochemical behaviour of the flour (Bloksma and Bushuk 1988). Wheat grains with the same concentration of total protein can produce flours that behave very differently during baking operations due the qualitative differences in the gluten proteins (Halverson and Zeleny 1988). Thus, the quality of the protein from the endosperm portion of the grain is one of the most important characteristics determining baking quality (Kent and Evers 1994).

According to Borghi and others (1995), wheat grain protein concentration can range from 8 to 20%, much of which is determined by environmental influences (Borghi and others 1995). Jenner and others (1991) found that crop stress can shorten the duration of starch deposition into the wheat kernels, which increases the ratio of protein to starch, and ultimately increases the protein percentage in the grain. In our study, this may have been due to the fact that the organically grown wheat had a much lower yield potential (actual data not recorded), which may lead to greater concentration of protein in the kernel (Mason and Spaner 2006).

In addition to protein concentration, the same cultivar of wheat grain grown at two different locations, or under two different management systems may have similar protein concentrations but different bread making quality (Borghi and others 1995). The partitioning of high and low molecular weight proteins may be different between organically and conventionally grown wheat, which may be related to the stresses associated with organic production (Ames and others 2003; Mason and others 2006).

Soil nutrient analyses completed before the grains were planted revealed that nitrogen content was very high on both organic and conventional land (Table 2-1). The soil in the Parkland region of the prairies (where this study was conducted) is inherently very rich in nutrients and organic matter (Keyes and others 1999), and thus with adequate moisture will produce grains with high protein content regardless of management system. Conversely, soils found in the European countries may be depleted of nutrients due to centuries of farming the land. Crop yields under organic management are typically 60-70% lower in Europe compared to the conventionally managed land (Mäder and others 2002). European soil under organic or biodynamic management systems is lower in nitrogen, phosphorus and potassium compared to the conventionally managed land (Mäder and others 2002).

Falling number and flour yield (%) did not differ ($p > 0.05$) between organic and conventionally grown wheat grain (Table 2-5) in this study. Poutala and others (1993) reported that falling number values were generally higher for wheat grown under an organic management system, while Gooding and others (1999) observed falling number values to be lower than required for breadmaking in organically grown UK wheat grain. Kihlberg and others (2006) observed that falling number of the wheat grain had an impact on the juiciness of the bread, suggesting that sensory quality is also affected by the quality of the grain components.

The particle size index was greater ($p \leq 0.05$) in the conventionally produced wheat. Particle size index is an indication of flour particle size and is used to determine kernel hardness of the grain. Ohm and Chung (1999) reported that there was a significant positive correlation between kernel hardness and gluten characteristics, suggesting that the quantity and quality of the gluten in the grain may be responsible for the variation seen in the hardness values. The physical structure of the grain will break down based on the arrangement of the gluten proteins and starch in the grain (Ohm and Chung 1999).

Harder wheat kernels also require more energy to break down into flour, increasing the amount of damaged starch granules (Mason and others 2006). Damaged starch particles increase water absorption capacity in the flour because they can absorb 3 times the amount of water than undamaged starch particles (Ohm and Chung 1999). Accordingly, Ohm and Chung (1999) also observed that the kernel hardness was correlated with the mixograph results for physiochemical properties of the flour.

In the present analysis, the mixing development time was greater ($p \leq 0.05$) for conventional flour (2.3 min) compared to organic flour (1.8 min) (Table 2-5). This suggests that the gluten network in the dough took longer to develop in conventional flour thereby producing a stronger dough for bread making (Bloksma and Bushuk 1988). Higher dough strength allows more air to be incorporated and held within the matrix of gluten proteins during baking (Bloksma and Bushuk 1988). This results in bread with a larger loaf volume and is consistent with the results observed here. Visual observation during our experiment revealed conventional bread had a consistently larger loaf volume than organic bread (Figure 2-1).

Organic flour had a greater ($p \leq 0.05$) value for total energy under the graph (Table 2-5). Higher total energy under the graph values indicate that more overall energy was needed to mix the dough. Organic and conventionally grown wheat ground into flour did not differ for energy to peak and bandwidth energy (Table 2-5). Increased levels of nitrogen fertilizer application on wheat grains were reported to increase mixograph characteristics of mixing development time, total energy under the graph and bandwidth energy (Ames and others 2003). It was suggested that the differences were associated with the increased levels of protein found in the grain, which lead to increased water absorption in the flour (Ames and others 2003).

Kihlberg and others (2004) postulated that organic wheat had higher bran to endosperm ratio than conventional wheat, thus cutting the gluten strands and preventing an increased loaf volume in spite of the higher protein content. Mason and others (2006) reported that mixograph results showed trends toward higher dough strength under organic management, but actual bread baking procedures were not conducted in their work.

Wheat grain grown under organic management for this experiment was seeded at later dates than the conventional grain to allow for tillage operation to kill weeds (as opposed to chemical spraying). Thus, organically produced wheat was harvested later, with the associated environmental constraints of greater weed pressure, lower yield potential and greater frost damage. This results in greater crop stress, which may alter the chemical composition of the grain (Ryan and others 2004; Mason and Spaner 2006).

2.3.2. Sensory evaluation

Analyses of variance results and mean ratings for the descriptive analysis evaluation collected from 9 panelists for the 3 bread samples are provided in Table 2-6. Panellist was highly significant ($p > 0.01$) for 13 of the 14 attributes evaluated, despite the fact that training is expected to reduce variation between panellists. The treatments differed ($P<0.05$) for 13 of the 14 attributes evaluated by the panelists. However, direct comparisons between sensory attributes of organic and conventional bread only differed for surface texture and density. The interaction of panelist and treatment was significant for 7 of the 14 attributes, indicating that there may have been some inconsistencies in the use of terms by the panelists for those attributes (Meilgaard and others 1991). Inconsistencies among panelists is common in sensory evaluation, and even upon recalculation the magnitude of these inconsistencies may be small compared to the magnitude of the differences between samples (Cliff and others 1996).

Crumb colour did not differ ($p > 0.05$) between treatments. For crust colour, organic bread had a darker crust ($p \leq 0.05$) than commercial, but conventional bread did not differ from organic bread or commercial bread ($p > 0.05$). Panelists reported differences in "surface texture" between organic, conventional and commercial bread samples. The size of the air cells in each slice was smaller (that is, more dense) ($p \leq 0.05$) in organic bread compared to conventional bread, and larger (that is, less dense) ($p \leq 0.05$) in commercial bread compared to conventional bread. Panelists were able to discriminate the differences in visual density between organic and conventional bread samples, which confirms our initial visual assessment of loaf volume and density (Figure 2-1).

Organic bread had stronger "overall wheat bread aroma" in the crumb compared to commercial bread, but conventional bread did not differ ($p > 0.05$) from either organic or commercial bread samples. Haglund and others (2004) observed that organic bread had a more intense aroma than conventional bread, but this was not observed in our results. Organic and conventional bread did not differ ($p > 0.05$) for "toasted aroma" of the crust, but they were higher ($p \leq 0.05$) in toasted aroma than commercial bread.

Panelists evaluated 4 textural attributes of whole wheat bread and found that organic and conventional bread differed from commercial bread for all attributes evaluated. Commercial bread was moister, more cohesive, less dense, and less grainy ($p \leq 0.05$) compared to organic and conventional bread samples. Within organic and conventional treatments, bread samples did not differ ($p > 0.05$) for "dryness", "cohesiveness of mass", and "graininess of mass". Organic and conventional bread differed only for the attribute of "denseness". Organic bread was more "dense" ($p \leq 0.05$) than conventional bread, and conventional bread was more "dense" ($p \leq 0.05$) than commercial bread. This result parallels the visual "surface texture" evaluation of the bread. Organic bread was characterized by a "denser" appearance and more compact crumb than conventional bread, upon evaluation by compression between the finger and thumb.

Our sensory panel thus confirmed differences observed in the physiochemical properties of the organic and conventional flour. Organic bread had a smaller loaf volume than conventional bread due to the differences in protein quality and dough properties. This resulted in a denser texture in organic bread that was identified by the panelists to be significantly different than conventional bread. Although protein content does not directly explain the final bread properties, the resulting mixograph parameters describe the variation in baking performance between organic and conventional wheat flour dough.

When comparing the textural attributes of 60% whole wheat bread baked with Canadian wheat grain to wheat bread in European studies, it is apparent that similarities exist between the wheat grain products. Kihlberg and others (2004 and 2006) reported that textural attributes of "compactness", and "deformability" were important sensory attributes during their 2004 evaluation, while "compressibility", "springiness" and "elasticity" were significantly different between organic and conventional bread samples during their 2006 evaluation.

For flavour attributes, panelists found no difference ($p > 0.05$) between organic and conventional for "wheaty", "sweet", or "salty" flavours in the crumb, as well as "toasted flavour" in the crust. Commercial bread samples differed from organic and conventional ($p \leq 0.05$) with a less "wheaty" flavour in the crumb, a higher "sweet" and "salty" flavour in the crumb, and lower "toasted flavour" in the crust. For "yeasty", organic had a higher intensity ($p \leq 0.05$) compared to commercial, but conventional did not differ from either organic or commercial samples.

The predominant sensory attributes of 60% whole wheat bread were revealed in the sensory profile developed through this research using a descriptive analysis panel. Overall, the intensities of flavour and aroma attributes did not differ between the organic and conventional bread when samples were prepared under identical conditions. The commercial sample differed from the organic and conventional bread for 13 of the 14 attributes evaluated. This confirms the necessity to make direct source comparisons for sensory analyses of this type. In addition, the results also confirm that considerable variation can occur with different bread formulations, due to varying ingredients used during production.

A review completed by "The Soil Association" reported that organically grown foods "tasted better" than conventionally grown foods (Heaton 2001). As we observed no difference in the intensity of any of the flavour or aroma attributes, we can not confirm a more flavourful product or what may be interpreted as "superior taste" qualities. The results of this research reveal that differences in the sensory profiles of organic and conventionally grown grain are limited to the textural attributes alone, evaluated visually or physically discernable by hand.

Consumer food choice is often based on more than sensory characteristics alone. The perceived sensory differences between organic and conventional bread may be due to the non-sensory factors, such as context of presentation, or consumer characteristics (Rozin and Tuorila 1993; Jaeger 2006). Thus, an assessment of consumer acceptance for organic and conventional 60% whole wheat bread has also been completed, and is reported in Chapter 3.

Future research on Canadian wheat baked into bread should include an evaluation of the milling technique as previous research (Kihlberg and others 2004) has found this an important variable in bread quality. Also, variation over season should be examined as environmental changes and crop stress from year to year can play a significant role in the partitioning of protein within the grain and thus the bread making quality of the flour.

2.4. Conclusion

Organic and conventional wheat grains were compared for their physiochemical properties, and then baked into bread to evaluate their sensory profiles using the sensory technique of descriptive analysis. Organically produced grain had more protein in the whole grain, but mixograph parameters indicated that conventional flour produced stronger dough. Conventionally produced wheat bread had a larger loaf volume. Fourteen sensory attributes where generated by the descriptive analysis panel. The sensory profiles indicate that attributes of denseness and visual surface texture were different between the organic and conventional whole wheat bread. Organic bread had greater density, and had smaller air cells in the crumb.

2.5. Tables

Table 1: Soil fertility analysis prior to planting on conventional and organic land used for experimental wheat production in Edmonton, AB in 2005.

Year	Site	Soil nutrient analysis (kg ha^{-1})				pH	Organic matter (%)
		N[a]	P	K	S[b]		
2005	Conventional	272	192	1462	>90	7.3	7.2
2005	Organic	199	260	1582	>90	6.1	10.3

[a] Nitrate-N only [b] Sulphate-S only

Table 2-2: Experimental bread formulation (organic and conventional)

Ingredients	**Amount, g**	**Percent, %**
60% Whole wheat flour	10230.0	54
Water	6802.5	36
Dried skim milk powder	594.6	3
Crisco all vegetable shortening (solid)	510.0	3
Sugar	424.7	2
Salt	212.4	1
Active dry yeast	212.4	1

Table 2-3: Sensory attributes, definitions, and endpoint labels used for the evaluation of 60% whole wheat bread on 15cm line scales (trained assessors, n=9)

Sensory attribute	Definition	Endpoint label
Appearance		
Colour intensity of crust	Intensity of the brown colour associated with *bread products*	Not at all intense to Very intense
Colour intensity of crumb	Intensity of the brown colour associated with *bread products*	Not at all intense to Very intense
Surface texture	The number and size of air cells present in the slice.	Not at all dense to Very dense
Aroma		
Overall intensity of wheat bread aroma	The degree of intensity associated with the overall aroma of the bread sample	Not at all intense to Very intense
Toasted (crust)	The aromatics associated with wheat grain that has been roasted/burnt	Not at all toasted to Very toasted
Texture		
Denseness	Compactness of the cross section (by hand)	Not at all dense to Very dense
Dryness	Degree of drying effect, amount of saliva absorbed by the sample	Not at all dry to Very dry
Cohesiveness of mass	Degree to which the chewed sample holds together	Not at all cohesive to Very cohesive
Graininess of mass	Amount of small particles in the chewed mass	Not at all grainy to Very grainy
Flavor		
Wheaty	The degree of perceived flavor aromatics associated with cooked wheat grains	Not at all wheaty to Very wheaty
Sweet	The degree of perceived sweet taste, as a basic taste	Not at all sweet to Very sweet
Salty	The degree of perceived salt taste, as a basic taste.	Not at all salty to Very salty
Yeasty	The flavor associated with natural yeast as a leavening agent.	Not at all yeasty to Very yeasty
Toasted (crust)	The aroma associated with roasted/burnt wheat products.	Not at all toasted to Very toasted

Table 2-4: Reference standards for sensory attributes and their placement on the 15cm line scale (0=low, 15=high).

Sensory attribute	Reference standard	Scale value (15cm)
Appearance		
Colour intensity of crust and crumb	1) Ivory Palace, 45YY 83/125 (Glidden, ICI Paints, Strongsville, OH, U.S.A.)	0cm
	2) Naturally Calm, 10YY 44/215 (Glidden, ICI Paints, Strongsville, OH, U.S.A.)	7.5cm
	3) Bronze Amulet, 70YR 08/186 (CIL, ICI Paints, Strongsville, OH, U.S.A.)	15cm
Surface texture	none	none
Aroma		
Overall intensity of wheat bread aroma	1) Whole wheat pasta, spaghetti, boil 8min in water (Catelli®, Ronzoni Foods Canada Corporation, Montreal, QC, Canada)	5.0cm
	2) Red River cereal, cooked, follow directions, 1 serving (Smuckers Foods of Canada Co., Markham, ON, Canada)	10.5cm
Toasted (crust)	Postum, instant cereal beverage, 1.0g in 250mL (Kraft Canada Inc., Don Mills, ON, Canada)	8.5cm
Texture		
Denseness	1) Angel food cake (Safeway Canada Ltd., Edmonton, AB, Canada)	0cm
	2) Plain bagel (Safeway Canada Ltd., Edmonton, AB, Canada)	15cm
Dryness	1) Bread stick dough (Pillsbury®, General Mills, Minneapolis, MN, U.S.A.)	0cm
	2) Unsalted, soda cracker (Loblaw Companies Ltd, Brampton, ON, Canada)	15cm
Cohesiveness of mass	1) Unsalted, soda cracker (Loblaw Companies Ltd, Brampton, ON, Canada)	0cm
	2) White baguettes, frozen partially baked bread (Dempster's Home Bakery, Canada Bread Company, Etobicoke, ON, Canada)	15cm
Graininess of mass	1) White bread (Safeway Canada Ltd., Edmonton, AB, Canada)	0cm
	2) 16 grain bread – sprouted grain bread (Silver Hills Bakery, Abbotsford, BC, Canada)	15cm
FLAVOR		
Wheaty	1) Cream of Wheat, 60g in 250mL of boiling water (Kraft Canada, Inc., Don Mills, ON, Canada)	5.0cm
	2) Whole wheat pasta, spaghetti, boil 8 min in water (Catelli, Ronzoni Foods Canada Corporation, Montreal, QC, Canada)	10.0cm
Sweet	2% sucrose, solution in water	4.5cm
Salty	Triscuit crackers, 50% less salt (Kraft Canada, Inc., Don Mills, ON, Canada)	5.0cm
Yeasty	Bread stick dough (Pillsbury®, General Mills, Minneapolis, MN, U.S.A.)	11.0cm
Toasted (crust)	Postum, instant cereal beverage, 0.5g in 250mL (Kraft Canada, Inc., Don Mills, ON, Canada)	9.0cm

Table 2-5: Mean values of cereal quality traits for organic and conventionally grown wheat grain samples (n=5)

	Farming system treatment			
	Organic	**Conventional**	**Standard error**	***p*-value**[1]
Wholemeal protein (%) (WPRO)	16.2	14.9	0.1	0.001
Falling number (FN)	539.8	509.4	36.6	ns
Particle size index (%) (PSI)	52.1	53.8	0.5	0.03
Flour yield (%) (FLY%)	74.6	75.1	0.4	ns
Mixing development time (min) (MDT)	1.8	2.3	0.1	0.01
Energy to peak (%)(ETP)	67.6	75.5	5.1	ns
Total energy under the graph (Nm) (TEG)	232.3	201.1	10.6	0.04
Band width energy (BWE)	90.0	87.7	4.7	ns

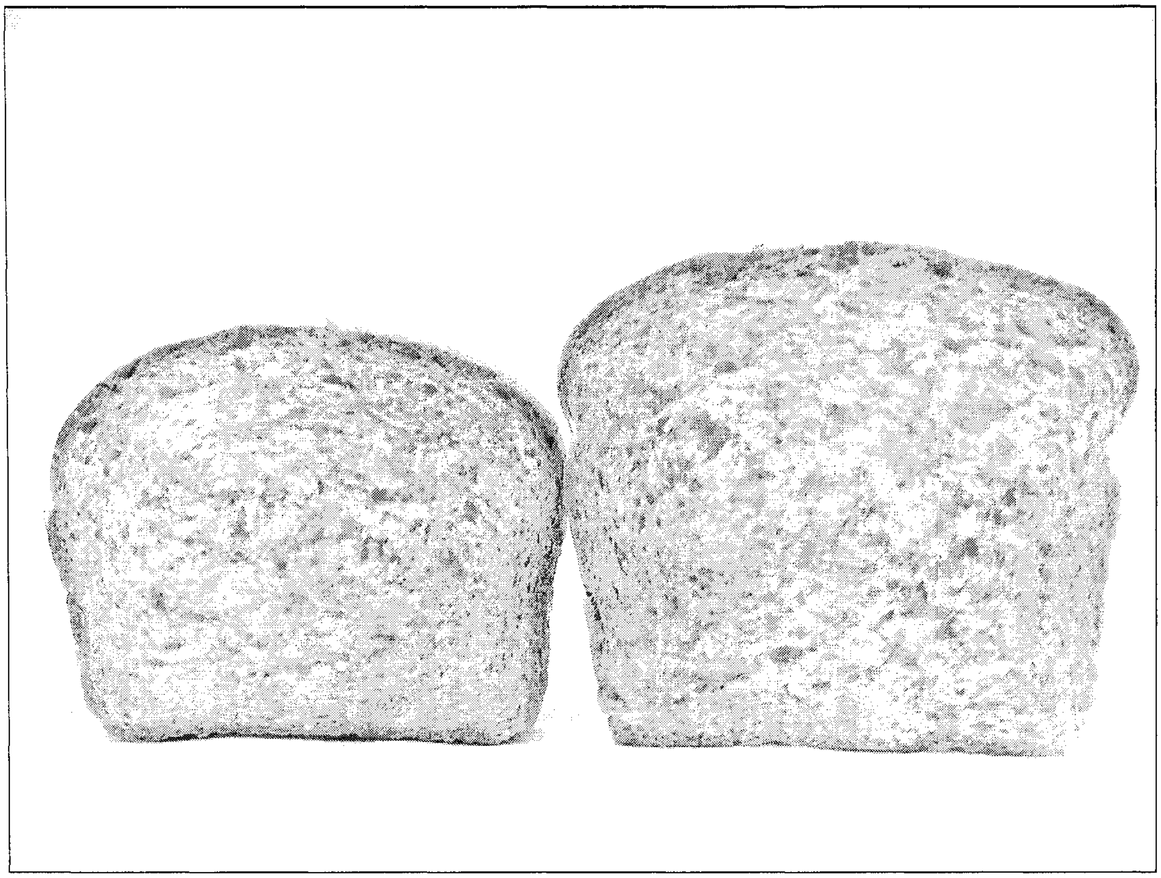
[1]Actual significance levels reported, ns = not significant at 0.05 level.

Table 2-6: Analysis of variance (ANOVA) and mean ratings for sensory attributes of organic and conventional wheat grain baked into 60% whole wheat bread (9 assessors; 3 replications) on a 15cm line scale.

	ANOVA[1]			Mean ratings[2]		
Sensory attribute	**Panelist**	**Treatment**	**Panelist*Trt**	**Organic (1)**	**Conventional (2)**	**Commercial (3)**
Appearance						
Colour intensity of crumb	***	ns	*	5.44a (0.17)	5.13a (0.18)	4.94a (0.18)
Colour intensity of crust	***	**	ns	11.72a (0.13)	11.43ab (0.13)	11.12b (0.13)
Surface texture	***	***	***	10.01a (0.13)	9.29b (0.13)	5.10c (0.12)
Aroma						
Overall intensity of wheat bread aroma	***	***	ns	9.96a (0.24)	9.48ab (0.24)	7.21b (0.25)
Toasted (crust)	***	***	ns	9.10a (0.08)	8.87a (0.08)	8.08b (0.08)
Texture						
Denseness	***	***	**	9.90a (0.14)	9.26b (0.13)	5.39c (0.14)
Dryness	**	***	ns	7.46a (0.29)	8.04a (0.26)	4.85b (0.26)
Cohesiveness of mass	ns	***	ns	7.69a (0.23)	7.78a (0.24)	9.94b (0.23)
Graininess of mass	***	***	*	8.32a (0.18)	8.26a (0.17)	6.12b (0.17)
Flavor						
Wheaty	***	***	**	9.44a (0.10)	9.33a (0.10)	6.44b (0.10)
Sweet	***	***	***	1.43a (0.08)	1.34a (0.09)	3.18b (0.08)
Salty	***	*	***	1.08a (0.10)	1.13a (0.09)	1.42b (0.09)
Yeasty	***	**	ns	4.71a (0.25)	4.23ab (0.25)	3.86b (0.25)
Toasted (crust)	***	***	ns	9.45a (0.09)	9.31a (0.09)	8.65b (0.09)

[1]Significance at *p =0.05, **p=0.01, and ***p =0.001. ns = not significant at 0.05 level.
[2]Means in each row not followed by the same letter are significantly different; numbers in parentheses are standard error of the mean

2.6. Figures



A B

Figure 2-1: Photographs of 60% whole wheat organic (A) and conventional (B) bread slices used in the sensory evaluation (1.4cm thickness)

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Chapter 3: Hedonic evaluation of organic and conventional wheat when baked into bread: Influence of health or environmental information on consumer choice.

3.1. Introduction

The demand for organic food has increased over the last decade in North America and other countries around the world. Worldwide sales of organic food and drink were valued at US$23 billion in the year 2002 (Sahota 2004), and according to Lockie and others (2004) this value is expected to increase to US$100 billion by the year 2010. In 2002, the main consumers of organic food and drink were in Western Europe and North America with sales of US$10.5 and US$11.75 billion, respectively (Sahota 2004). In light of this increasing demand and the marginal differences scientific research has found between organic and conventional products (Woese and others 1997), understanding consumers' motivations for choosing organic foods becomes ever more important.

Consumer perception of sensory quality is an important aspect of food choice. Previous studies have shown that in addition to sensory properties, food choice is also affected by the presentation context of the food as well as characteristics of the potential consumer (Shepherd 1989; Kähkönen and others 1997). Thus, the selection of organic food products may be influenced by more than sensory appeal alone (Lyman 1989; Kihlberg and others 2005).

Socio-demographic variables (Thompson 1998), ethics and values (Dreezens and others 2005) and attitudes and beliefs towards health or the environment (Magnusson and others 2003; Lockie and others 2004; Chryssohoidis and Krystallis 2005) can influence how and why consumers choose to purchase organic products. The motivation for choosing an organic product over a conventional one is often based on a set of credence attributes (Grunert and others 2000; van den Heuvel and others 2006); preference based on the belief that organic food products are produced in a manner that protects the environment, treats animals humanely, and may contain more nutrients. The presence or absence of these characteristics is not easily perceived by the consumer even after purchase or use of a product (Yiridoe and others 2005). However, beyond motivations determined by consumer characteristics, taste is still the most important product attribute that influences food choice (Wandel and Bugge 1997; Glanz and others 1998; Chryssohoidis and Krystallis 2005; Radder and le Roux 2005).

Most consumers evaluate the quality of a food product by its appearance, but the type of information received about the product is just as important (von Alvensleben and Meier 1990). Information can affect sensory perception, as well as final choice of a product. The extent of reception and understanding by the consumer may be determined by how information is presented; written or verbal. Soler and others (2002) presented information on organic farming through either written text or verbal explanation and investigated the effects on willingness to pay (WTP) for organic olive oil. Consumers were more likely to trust the information on organic farming when provided verbally, and thus were more willing to pay a premium for organic olive oil (Soler and others 2002). With respect to providing nutritional label information, Bower and others (2003) reported that consumers were not influenced by label information about fat content, but preferred the fat spread they evaluated based on sensory appeal alone. Mialon and others (2002) observed that information about the dietary fiber content of bread samples increased the acceptance ratings of fibre enriched breads, but decreased the acceptance ratings of white bread. Information on the origin of a food product (Stefani and others 2006), or the process by which it was made (Siret and Issanchou 2000; Caporale and others 2006), have also been examined in various consumer populations. As discussed by Kähkönen and others (1997), the receptiveness of each consumer to different types of information will vary. Individuals will only respond to the information they think is important for making their choice, and ignore the rest as unnecessary or redundant (Kähkönen and others 1997).

European studies have focused on the effects of health information on consumer perception of organic food, as previous researchers found the main motivation for choosing organic was individual health benefits (Ekelund 1989; Tregear and others 1994; Schifferstein and Oude Ophuis 1998; Baker and others 2004). However, information on environmental issues surrounding organic production is also important, as other researchers have reported that some consumers are motivated more by environmental concern (Wandel and Bugge 1997; Storstad and Bjørkhaug 2003). According to the classifications of Cunningham (2002), 'classic organic consumers' buy products out of concern for the environment; where as 'new organic consumers' are more concerned with the health and nutritional value of the food they purchase. Thus, health and environmental information may have very different effects on perceptions of organic products by consumers in western Canada.

The objectives of this research project were to:

1) Examine the impact of health and environmental information pertaining to organic production methods on consumer acceptance of organic and conventional 60% whole wheat bread, and
2) Assess the role of other non-sensory factors such as consumer characteristics on changes in consumer preference for 60% whole wheat bread made from organically grown wheat.

This research project furthers the understanding of how focused information on health or environmental issues can affect the liking of a food product. More specifically, the project examines how short paragraphs of targeted information on health or environmental aspects of organic production methods can influence liking of organic food products. The length and source of information provided to consumers was unique to this project. As discussed in Chapter 1, the main limitation of previous research comparing organically and conventionally produced food products is the inconsistent source of the samples. Thus, the samples used for this research project were selected to ensure paired samples of organically and conventionally grown wheat.

3.2. Materials and methods

3.2.1. Wheat grain

Wheat for this research project was grown under organic and conventional agricultural management systems, harvested, and cleaned as described in section *2.2.1.* of Chapter 2.

3.2.2. Flour milling and preparation of bread

The bread formulation for both organic and conventional samples (Table 3-1) was adapted from Food for Fifty (Molt 2000). Flour milling and preparation of bread were completed as described in section *2.2.3.* and *2.2.4.* of Chapter 2. All wheat conditioning, flour milling and bread manufacture were completed at the Leduc Food Processing Development Centre in Leduc, AB, Canada.

3.2.3. Sensory evaluation

3.2.3.1. Sample preparation

Bread loaves were removed from frozen storage and thawed at room temperature overnight. A manual bread slicer and serrated knife were used to cut thirteen 1.4cm thick slices from each 454g loaf. Samples were presented to consumers in separate self-sealing plastic sandwich size bags labelled with either randomized 3-digit codes (for Part A of questionnaire) or "organic" and "conventional" (for Part B of questionnaire) to represent each treatment. Filtered water was provided as a palate cleanser during evaluation.

3.2.3.2. Consumer acceptance testing

A consumer sensory evaluation panel was carried out in Edmonton, AB, Canada during October and November 2005 to evaluate organic and conventional whole wheat bread using acceptance testing. Potential participants were screened to select regular consumers of wheat bread products (Appendix 8). Testing was carried out at a local farmers' market, organic grocery stores, shopping centres and public venues in Edmonton and surrounding communities (Sherwood Park, St. Albert, and Red Deer), as well as the University of Alberta Campus in Edmonton, AB, Canada. These locations were selected to ensure a well-distributed sample of consumers of varying age, income and education levels who habitually purchase either organically or conventionally produced food products. Sensory acceptance of two samples of 60% whole wheat bread made with organic or conventional wheat grain was evaluated on the 9-point hedonic scale before and after information presentation. The verbal anchors on the 9-point hedonic scale ranged from 'dislike extremely' (1), to 'neither like nor dislike' (5) as a midpoint, to 'like extremely' (9). In all, 384 evaluations were completed. The sensory protocol was approved by the Faculty Research Ethics Board. Information and consent forms given to each panellist before evaluation can be found in Appendix 9.

3.2.4. Questionnaire construction

The consumer questionnaire was designed in two parts. In part A, evaluations of bread consumption (all whole wheat bread products), purchase habits for bread products, and demographics were collected. This was followed by a blind taste evaluation (9-point hedonic scale) and an evaluation of consumer attitudes towards health and environmental issues. In part B, short paragraphs of information on health or environmental aspects of organic production were presented, followed by a revealed taste evaluation (9-point hedonic scale), and willingness to pay (WTP) questions. In addition, part B also tabulated organic bread consumption (organic whole wheat bread products), purchase habits for organic food, and reasons that might prevent purchase of organic food.

The survey design of the 4 questionnaire formats is shown in Figure 3-1. Each questionnaire had one of two types of information (health (H) or environment (E)) and used one of two presentation orders for revealed sensory evaluation and willingness to pay (WTP) questions. Thus, there were a total of four questionnaire formats. Seven possible bid levels were used for WTP, with organic bread premiums ranging from \$0.25 to \$3.75 (in \$0.50 intervals) on top of the average price for a loaf of conventional bread at \$1.50. The combination of questionnaire format and willingness to pay bids gave 28 possible versions of the questionnaire. An example version of the questionnaire can be found in Appendix 10. Participants at all locations were given one version of the questionnaire according to a completely randomized design.

Information statements provided to consumers regarding organic production were short paragraphs of targeted information on health or environmental aspects of organic production methods (Appendix 10). The source of the information on Canadian regulations pertaining to organic production was the Canadian General Standards Board and the National Standards of Canada. Information on regulations was also sourced from European standards (UK Food Standards Agency). Other information provided on health issues was sourced from scientific research papers investigating the effects of antioxidants on human health.

Consumers' attitudes towards health and environmental issues were assessed using two attitude scales. The Health Attitudes scale was adapted from the Health Locus of control scale developed by Houts and Warland (1989). Five questions were asked regarding their level of concern for their own health with possible responses from Not very much (score of 1) to Very much (score of 5). The Environmental Attitudes scale was adapted from the Environmental concern attitudes scale developed by Clarke and others (2000). The original 15-question scale was reduced to 8 questions for ease of respondent completion. Possible responses ranged from strongly disagree (score of 1) to strongly agree (score of 5). Pre-testing of both attitude scales was completed with approximately 700 undergraduate students from the University of Alberta. Chronbach's alpha values confirmed the scale reliability of both health and environmental scale questions before they were used the final questionnaire.

3.2.5. Statistical analyses

Mean values for overall acceptance on the 9-point hedonic scale were obtained for organic (O) and conventional (C) 60% whole wheat bread under both blind (B) and labelled (L) conditions. Pairwise comparisons of means were completed using *t*-tests for paired means in SPSS (version 14.0, SPSS Inc., Chicago, IL, U.S.A.). Paired comparisons between samples of organic and conventional were analyzed before (OB, CB) and after (OL, CL) information was presented. Paired comparisons within organic (OB, OL) and conventional (CB, CL) samples were analyzed for shifts in liking scores. The mean values of OB, CB, OL, and CL were also used to create a preference change variable for both organic and conventional. Organic preference change (OrgPC) was generated by subtracting OL-OB and conventional preference change (ConvPC) was generated by subtracting CL-CB. The difference in preference change (DiffPC) was generated by subtracting OrgPC – ConvPC.

Ordinary least squares regression [OLS] analysis was used to examine the overall preference changes for organic bread (maintaining direction and magnitude, on the 9-point hedonic scale) as dependant variable. The hypothesized OLS equation used to analyze OrgPC and DiffPC models is shown below:

$$y_i = \alpha_0 + \beta_E X_i^E + \beta_R X_i^R + \varepsilon_i$$

Where:

- y_i = preference change for organic bread (OrgPC), or the difference in preference change for organic and conventional bread (DiffPC) for respondent *i*.
- α_0 = intercept term, and ε = error term.
- X_i^E refers to a vector of independent variables describing the information treatment (health or environment) and sequencing of the experimental work (sensory before or after WTP) presented to respondent *i*, while X_i^R represents a vector of independent variables associated with the demographic and other individual specific variables associated with each respondent.
- β_{EI} *and* β_R are vectors of estimated coefficients in the model that indicate the direction and magnitude of the effects of the independent variables on preference change

To analyze the probability of consumers increasing their preference for organic products, we chose to use binary response regression analysis instead; namely a probit model. Binary variables (1=event did occur, or 0 = event did not occur) are used as the dependent variable for a probit regression model where the marginal effects are the probability of the event occurring. This was used to examine the effect of consumer variables influencing the probability of a positive preference change for organic products (OrgPPC). The binary variable, OrgPPC, was determined as follows: If participants had a positive shift in their acceptance score for the bread samples due to label and information, they received a value of 1 for OrgPPC, while those who did not shift their acceptance, or had a negative shift in acceptance received a value of 0. Both the OLS and probit model regressions were performed using the econometric software SHAZAM Professional Edition v.9 (Northwest Econometrics, Ltd, Vancouver, BC, Canada).

3.3. Results

3.3.1. Characteristics of consumer population

The consumer population was stratified into three groups based on the location where consumers were recruited; 1) General Edmonton locations (GEL) (n=141) included consumers from Edmonton shopping malls, public venues and the University of Alberta campus, 2) organic market locations (OML) (n=146) included consumers from a farmer's market, and local organic grocery stores, and 3) surrounding community locations (SCL) (n=97) included consumers from smaller communities of Red Deer, Sherwood Park, and St. Albert.

At each of the three locations, approximately 65% of the participants were female and 35% were male (Table 3-2). The age range of consumers from GEL was lower than OML and SCL, as it included students recruited from the University of Alberta. The educational level was equally distributed among participants from GEL and OML, while participants from SCL tended to have less post secondary education. Income levels were higher for OML compared to GEL, which is consistent with past research (Thompson 1998). Compared to the other two locations, there were more than twice as many participants from OML who were members of an environmental group.

Purchase and consumption habits of a consumer population are important when examining food choice. Information was collected on bread consumption and purchase habits, as well as consumption of organic bread and purchase habits for all organic products (Table 3-3). Over 50% of participants at each location said they consumed 2-4 servings of bread or more each day. OML consumers purchased their bread at specialty bakeries (34%), organic grocery stores (28%), or farmer's markets (33%), while those from GEL and SCL purchased their bread at supermarkets (89%, and 90% respectively). Organic bread consumption was higher for OML with 40% consuming bread once a day or more, where as about 85% of GEL and SCL had less than 2 servings per week. Consumers from OML purchased organic products more frequently with 31% only buying or frequently buying organic. In contrast, about 25% of GEL and SCL rarely or never buy organic food products. Of the total population, 62% of consumers sometimes buy organic, confirming the observation that organic foods are becoming more mainstream in the consumer market (Lockie and others 2004).

With respect to the reasons that prevent the purchase of organic products, there was a distinct difference between consumer groups in perceived drawbacks to increased consumption of organic food. For GEL, 90% felt that organic foods were too expensive. While fewer consumers from OML perceived food to be too expensive (68%), they did believe that availability was limited (32%). The demographic and behavioural description of consumers from OML is consistent with the "organic foods consumer" as described by Grunert and Kristensen (1991), where low distribution and uncertainty of product quality were also issues of concern.

3.3.2. Impact of information on consumer preference

3.3.2.1. t-test analyses

The results of the *t*-tests of paired means of acceptance scores on the 9-point hedonic scale are provided in Table 3-4. Mean acceptance scores were also segmented by information type (health or environment) for analyses (Table 3-4). Organic bread (6.73) was liked significantly more than conventional bread (6.37) when identity was unknown in the blind conditions ($p = 0.0001$). After either type of information was presented and production system identity was revealed, organic bread (6.86) was still liked significantly more than conventional (6.34) ($p = 0.0001$). Although these results show statistical significance, there is little practical significance as they are both within "like slightly" (6.0) to "like moderately" (7.0) on the 9-point hedonic scale.

The results of the *t*-tests of paired means within samples of organic or conventional demonstrated a shift in response after either type of information was presented and production system identity was revealed. There was a significant increase in the liking of organic bread between blind (6.73) and labelled (6.86) conditions ($p = 0.041$); thus, organic bread was liked significantly more after information was presented. There was no significant change in the liking of conventional bread between blind (6.37) and labelled (6.34) conditions ($p = 0.666$). Paired comparison *t*-tests revealed a significant shift in liking scores for organic bread from blind to labelled evaluation, which indicates that consumers were affected by the label and information (health and environment) presented. Regression analysis can be used to explain what factors, other than label and information provided, play a significant role in preference changes.

3.3.2.2. Regression analyses

3.3.2.2.1. Organic preference change (OrgPC)

'Health information coupled with sensory evaluation', 'post secondary education', 'amount of bread consumed each day', and 'consumer knowledge of organic production' were significant variables in the OLS regression analyses for OrgPC (Table 3-5). When participants received health information and completed the sensory evaluation before WTP questions, they were more likely to increase their acceptance rating of the organic bread ($\beta = 0.29, p = 0.04$). By this means, participants were able to experience the sensory quality of organic bread samples immediately after receiving information on health benefits of organic food. This is the 'its good for you – and it tastes good' combination (Martins and others 1997), allowing taste to be coupled with information.

Conversely, we can postulate that if participants were given health information, but before evaluating the samples they were reminded that it costs more for organic products (through WTP questions), they were less likely to rate the bread more positively. This suggests that bringing 'market' effects into play can affect the hedonic evaluation of organic bread samples, reflecting the concern expressed by participants in the consumer survey that organic foods are "too expensive".

If the participant had 'post secondary education' (that is, an undergraduate degree or higher), they were more likely to rate the bread higher after information was given ($\beta = 0.33, p = 0.01$). Consumers with post secondary education are more familiar with the integrity of "scientific research" and thereby may be more likely to trust the source of the information.

For participants who 'consumed more than 2-4 servings of organic bread per day', they were more likely to rate the organic bread higher after information was given and sample identity was revealed ($\beta = 0.90, p = 0.0001$). Consumers who currently choose organic products may rely more heavily on label information instead of their actual hedonic evaluation of the product. Acceptance scores of these consumers are reflective of their trust placed in the credence attributes of a product.

Participants who had 'limited knowledge' of organic products were obtaining new information about organic production from the information given, and thus were more likely to rate the organic bread more positively after sample identity was revealed ($\beta = 0.33, p = 0.03$). Consumers who do not buy organic products regularly might lack knowledge about organic production methods, but may increase their preference for organic products if they received positive information about organic production.

Variables for gender and income were not included in the OrgPC OLS regression model as they were found to be insignificant in previous OrgPC models.

3.3.2.2.2 Difference in preference change for organic and conventional (DiffPC)

There were four significant variables in the OLS regression analyses of DiffPC (Table 3-5). The model suggests that gender was significant, with a larger preference change for organic bread than conventional expected in male participants ($\beta = 0.38, p = 0.06$). For a one-unit increase in household income, there was a significant effect on DiffPC ($\beta = 0.66 \times 10^{-5}, p = 0.02$) with a larger preference change for organic compared to conventional.

If the participant consumed more that 2-4 servings of organic bread per day, a significantly larger preference change was suggested for organic bread compared to conventional (β= 1.51, p= 0.001), with a full 1.51 point difference on the 9-point hedonic scale. And finally, if the participant had limited knowledge of organic production the model suggests an increase in preference for organic bread greater than the change in preference for conventional bread (β= 0.41, p= 0.09).

The information treatment (health or environment) and sequencing effect (sensory before or after WTP) were not significant in this model indicating that there was no effect of information on consumers' difference in preference change between organic and conventional bread.

3.3.2.2.3. Positive preference change for organic (OrgPPC)

The probit regression model for OrgPPC incorporated 14 variables encompassing information type (health or environment), hedonic evaluation, attitudes towards health and environmental issues, consumer characteristics, and survey location (Table 3-6). Seven of the 14 variables were significant ($p \leq 0.10$) for an increase in the probability of a positive preference change. In other words, this model predicted the probability that a participant would increase or decrease their acceptance rating of organic bread after information and label were presented. In the case of each variable, marginal effects only hold true when all other significant factors are held constant.

Positive signs on 5 of the 7 significant variables in OrgPPC indicated an increase in the probability a consumer would have a positive preference change for organic bread. If they had a high average score (> 4.14 out of 5) on the environmental attitude questionnaire, there was an 8% increase in the probability (p = 0.05), and if they consumed more then 2-4 servings of bread per day, there was an 8.6% increase in the probability (p = 0.09). Although these two variables are significant, the propensity to increase organic preference was still relatively small in size compared to the other variables.

The 3 other significant factors with positive signs were 'reversal of conventional acceptance', 'limited knowledge' and 'general Edmonton location (GEL)'. There was a 15% increase in the probability (p = 0.007) of a positive preference change towards organic bread, if the consumer had reversed preference for the conventional bread after information and label were presented (that is, gave the bread a lower score after knowing it was conventional and having read the organic information). If they indicated that their limited knowledge of organic production methods prevented them from purchasing organic products, there was an 11% increase in the probability (p = 0.07). And lastly, if consumers were recruited from GEL, there was a 13%

increase in the probability ($p = 0.06$) that they would have a positive preference change for organic bread. Participants who were not recruited from organic market locations were more likely to increase their preference for organic compared to consumers from OML or SCL.

Negative signs on 2 of the 7 significant variables in OrgPPC indicated a decrease in the probability of a positive preference change for organic bread. There was a 16% decrease in the probability ($p < 0.0001$) if the consumer had previously rated the organic bread high (>6.73) on the hedonic scale during the blind evaluation (before information and label effects). It is important to remember that the food product used in this experiment was a plain slice of bread, with no added butter or jam as people would normally consume the product at home. So as much as organic bread can be liked on an overall acceptance scale, even after the presentation of information, it was still a plain piece of bread.

Trust in the source of organic products was also an issue for consumers. There was a 20% decrease in the probability ($p = 0.01$) that they would have a positive preference change for organic bread if they did not trust the source of organic products. So creating a trustworthy source or label may help change this perception in the consumer population.

3.4. Discussion

3.4.1. Impact of information

The first objective of this research project was to assess the impact of health and environmental information on the sensory evaluation of organic bread using a blend of consumer and sensory science methodology. Sensory evaluation revealed that consumers' liking scores were higher for organic bread than conventional bread, both before and after information was presented. Previous research completed by Kihlberg and others (2005) revealed that liking scores were higher for organic bread when labeled with the organic flour's origin. But it should be noted that blind sensory evaluations of bread samples were not performed by Kihlberg and others (2005) and thus changes in preference could not be evaluated.

"The Soil Association" from the UK reviewed sensory comparison studies investigating differences between organic and conventional food products reported that organic foods had "superior" taste qualities compared to conventional foods (Heaton 2001). In Chapter 2 we investigated the sensory profiles of paired samples of organic and conventionally grown wheat when baked into 60% whole wheat bread, and reported no difference ($p > 0.05$) between organic and conventional bread for flavor and aroma attributes. Therefore, we suggested that increased preference for organic bread may be attributable to the context of presentation or characteristics of the consumer.

Results presented here demonstrate that positive information on organic production methods, whether focused on health or environmental issues had a positive impact on sensory evaluation of organic bread. Consumers displayed a significant increase in their liking of organic bread after information, while there was no significant change in liking for conventional bread.

Short paragraphs of targeted information on health or environmental aspects of organic production methods were provided to consumers during the evaluation. The length of the information was approximately 150 words, which is longer than consumer information typically provided during sensory evaluations. Researchers examining the effects of health information on product acceptance most often provide one or two sentences of information to consumers about nutritional content of a product (Mialon and others 2002; Bower and others 2003; Goerlitz and Delwiche 2004) or a short health claim on the label (van Kleef and others 2005).

Results from OLS models indicated that limited knowledge was a significant factor for increased liking of organic bread (OrgPC), as well as increasing the difference between organic and conventional preference changes (DiffPC). In addition, the probit model also found limited knowledge to be a significant predictor of the probability for positive preference shift towards organic bread (OrgPPC). The provision of additional information about organic production methods may have educated consumers, who before the evaluation knew little about the positive health or environmental aspects of organic production.

The source of the information, whether from a government organization, producer, or consumer group, plays a role in the amount of trust that consumers put in the quality of their food product (Torjusen and others 2004). Information for this research was obtained from the National Standards of Canada and recently published scientific literature. Our results demonstrate that consumers who do not trust the source of organic products were very unlikely to increase their preference for organic bread, even after information was provided (OrgPPC). According to Grunert and others (2000), consumers must trust the source of the label information communicating the nutritional content or process of production; otherwise the product may not satisfy the need they are looking to fill.

Differences in culture and the role of food in society often determine which organizations can be trusted (Torjusen and others 2004). In a Canada-wide survey of consumers, West and others (2002) investigated who consumers trust for their information on food safety. They reported that consumers were more confident in the information provided by consumer and / or environmental groups rather than from government or food manufacturers. According to West and others (2002), the credibility problem facing government organizations and food manufacturers could be overcome by seeking the help of professional nutritionists, doctors, and health specialists who are the most likely to provide truthful information. Consumer and Environmental groups often provide negative information to increase consumer scepticism, but are also the most likely to provide false information to the consumer (West and others 2002). It is important for research on the effects of information to consider the source and the possible implications it will have on perceptions of the consumer population of interest.

3.4.2. Role of non-sensory factors on consumer acceptance

The second objective of this research project was to assess the role of other non-sensory factors on consumer preference for organic bread. Characteristics of the consumer such as socio-demographics, values and attitudes have been postulated to have a significant effect on consumer behaviour and thus food choice. The OLS regression models revealed socio-demographic factors that can influence overall preference changes, while the probit model revealed both socio-demographics and attitudes towards the environment as factors that could influence the probability of a positive change in preference towards organic products in the consumer population.

Post secondary education was found to increase the liking of organic bread after information and label (OrgPC), suggesting a higher level of trust might have been placed in the information. In a review of research studies completed in the U.S.A., Thompson (1998) reported that evidence from national studies suggests a positive correlation between education and organic purchasing. However, when undergraduate education was set apart from graduate studies, there was a lower probability of buying organic with higher graduate education, as well as decreased WTP more for organic (Thompson 1998). One could postulate that graduate students no longer live at home and thus may not have the income purchase more expensive foods. Lockie and others (2004) also observed that age and education had a significant effect on organic food consumption in Australia, with older and more educated consumers less likely to consume organic food products. Graduate level education was not separated from undergraduate level education during our analyses, but completing this type of segmentation may lead to a better understanding of the consumer. In addition, the type of degree received might play a more significant role in predicting organic preferences; arts and social science graduates may well have very different perceptions of organic than those graduates from health and natural sciences.

Consumers recruited from general Edmonton locations (GEL), were more likely to increase their liking of organic after information and label (OrgPPC). These consumers were from non-specialty locations, the university campus, or other regular consumer venues in Edmonton. According to Thompson (1998), the choice of shopping location influenced which factors affected consumers' propensity to purchase organic foods. There was a significant effect of consumer characteristics in upscale shops that was not found in the discount stores (Thompson 1998).

Gender influenced the difference in preference change (DiffPC), where males were more likely to increase their rating of organic bread over that of conventional bread after information was presented. A review of previous research reveals limited evidence of the effects of gender and marital status on organic preferences (Thompson 1998). Researchers suggest that individually these characteristics may have little influence on organic purchase, but that together they might explain more variation (Thompson 1998). Wandel and Bugge (1990) found that consideration for environmental aspects of food products were dependant on socio-demographic characteristics of the consumer, with women and those in the highest education group were more likely to put environmental aspects as a priority. As well, young consumers valued environmental and animal welfare, while those in the oldest age group placed the most importance on health aspects.

Income was also a significant factor for the difference in preference change (DiffPC), with an increase in the preference for organic bread over that of conventional bread with increased income. According to Thompson (1998), higher income levels were generally linked to increased purchase of organic foods.

Consumption habits were an important factor in all three regression models (OrgPC, DiffPC and OrgPPC). Individual consumers who ate more than 2-4 servings of *organic* bread per day were more likely to increase their preference for organic bread (OrgPC). There was also a substantial increase in the difference of liking (DiffPC) between organic and conventional bread (1.5 points on the 9 point Hedonic scale) for consumers who ate more than 2-4 servings of *organic* bread per day. It can be inferred from this that the organic consumers were very aware of the label, which may allow credence attributes to overrule hedonic evaluation.

Consumption habits revealed that whole-grain products were important to many consumers. Botonaki and others (2006) reported that the main motivation for consumers in Greece to purchase organic foods was the fact they were considered 'healthier than conventional'. Consequently, health conscious consumers were also willing to pay more for organic foods (Botonaki and others 2006). Huang (1996) also observed that consumers who were nutritionally conscious were more likely to prefer organically grown produce.

Attitudes towards health and environmental issues can affect consumers' food choice by altering decisions made during purchase. Probit model results revealed that consumers with pro-environmental attitudes had a greater propensity for rating organic bread more positively on the liking scale after information and label (OrgPPC). This result revealed potential differences between consumers in western Canada and those in European countries.

Chryssohoidis and Krystallis (2005) used the list of values (LOV) scale to understand the specific values motivating consumers to choose organic food. "Self respect" and "enjoyment of life" internal values (corresponding to healthiness and better taste of organic foods) are main motivators behind purchasing organic food, while the external value "belonging" (relating to environmental protection through organic cultivation) was less important.

Baker and others (2004) observed that the connection between organic food and the environment was absent for a group of UK consumers, while German consumers were remarkably aware of environmental issues. Norwegian consumers who perceived more benefits than risks associated with the use of pesticides had less positive attitudes towards organic foods (Saba and Messina 2003).

Australian consumers who were concerned about "natural foods" as well as the "sensory and emotional appeal" of food had the propensity to consume greater amounts of organic food compared to those who were concerned with the "convenience" of purchasing and preparing their food (Lockie and others 2004). Lockie and others (2004) also observed that "healthy food values" had no impact on increasing consumption of organic food, a result that was unexpected.

Sensory acceptance of organic bread was affected by information about organic production, but there were non-sensory factors such as socio-demographic variables, and attitudes towards environmental issues that had a significant impact on liking of organic bread. Consumers' WTP for organic bread was also collected in the survey questionnaire. The results are not reported here, but an extensive analysis of the effects of information on WTP for organic bread can be found in Muralidharan and others (2006).

Future research coupling sensory and consumer testing should include a middle step where only the label is revealed prior to presenting information to consumers. Caporale and Monteleone (2004) and Stefani and others (2006) have completed sensory evaluation of food products under blind, expected, and labelled information conditions. This creates experimental separation between the label effects from the information effects.

Additional assessments of attitudes and values related to health and environmental issues may also provide further insight, with more extensive questions directed at specific values. The source of the information could also be varied during the evaluation to understand who consumers trust for their information on organic production methods. In addition, unfamiliar products, either well-liked, or not well-liked, should be used to examine the effects of information with novel food products.

3.5. Conclusion

Sensory acceptance data revealed that organic bread was liked more than conventional bread under both blind and labelled conditions. Although this data was statistically significant, there is little practical significance as they are both within "like slightly" (6.0) to "like moderately" (7.0) on the 9-point hedonic scale. Further evaluation of the consumer data revealed that consumer characteristics played a significant role in preference changes for organic bread. OLS regression models identified socio-demographic characteristics, such as post secondary education, income and bread consumption habits, as important determinants of preference for organic bread. Health information was only important for organic preference changes when coupled with sensory evaluation. The binary response (probit) regression model effectively evaluated non-sensory factors, such as socio-demographic characteristics and attitudes towards environmental issues, as key factors in predicting the propensity for a positive preference change for organic bread. Thus, a combination of sensory and consumer science techniques strengthens the evaluation of consumer food choice.

3.6. Tables

Table 3-1: Experimental bread formulation (organic and conventional)

Ingredients	Amount, g	Percent, %
60% Whole wheat flour	8866.0	54
Water	5895.5	36
Dried skim milk powder	515.3	3
Crisco all vegetable shortening (solid)	442.0	3
Sugar	368.1	2
Salt	184.1	1
Active dry yeast	184.1	1

Table 3-2: Distribution of sample demographic characteristics as a percentage of the total surveyed population and each location segmented consumer group.

	Total surveyed (n=384)	GEL[1] Consumers (n=141)	OML[2] Consumers (n=146)	SCL[3] Consumers (n=97)
Gender				
Male	36	35	34	39
Female	64	65	66	61
Age				
18-24	27	45	24	12
25-34	28	34	25	24
35-44	13	8	11	20
45-54	13	5	16	18
55-64	12	6	18	11
65-74	5	1	5	8
75+	3	1	1	7
Education				
Some high school	6	2	3	13
High school graduate	9	6	7	14
Some university or college	26	37	21	21
College diploma/degree	18	13	14	27
University undergraduate degree	21	16	30	18
Some post graduate university study	9	12	11	5
Post graduate university degree	10	14	13	2
Income[4]				
Less than $36,600	35	52	29	23
$36,601- $71,000	28	24	34	27
$71,001 - $115,000	24	16	27	27
More than $115,001	9	6	5	14
Member of Environmental Group				
Yes	11	6	19	6
No	89	94	81	94

[1]General Edmonton locations (GEL) = Consumers from Edmonton shopping malls, public venues and the University of Alberta Campus; [2]Organic market locations (OML) = Consumers from a farmer's market, and local organic grocery stores; [3]Surrounding community locations (SCL) = Consumers from smaller communities of Red Deer, Sherwood Park, and St. Albert; [4]Sixteen people did not respond

Note: Percentages may not add up to 100% due to rounding.

Table 3-3: Purchase and consumption habits as a percentage of the total surveyed population and each location segmented consumer group.

	Total surveyed (n=384)	GEL[1] Consumers (n=141)	OML[2] Consumers (n=146)	SCL[3] Consumers (n=97)
Average bread consumption				
More than 2-4 servings per day	55	57	49	60
One serving per day or 2-6 per week	31	26	36	30
Less than 2 servings per week	15	17	15	10
Where purchase bread				
Supermarket	85	89	77	90
Supermarket's organic or natural section	27	19	31	31
Specialty food stores or bakeries	24	20	34	15
Organic grocery store	16	7	28	9
Farmer's market	21	13	33	12
Wholesaler	23	26	21	22
Homebaked or other	9	8	9	11
Type of bread most often purchased				
National brand	46	54	38	44
Store brand	40	38	37	48
Specialty bakery	13	7	23	6
Organic bread consumption				
More than 2-4 servings per day	13	8	18	12
One serving per day or 2-6 per week	12	6	22	7
Less than 2 servings per week	75	87	60	80
Frequency of organic purchase				
Only or frequent	19	9	31	15
Sometimes	62	67	60	58
Rarely or never	18	23	8	27
Type of organic food purchased				
Milk or dairy products	18	15	23	15
Vegetables	57	45	72	49
Fruit	53	47	60	49
Meat, fish, or meat products	23	14	29	25
Bread or bread products	31	16	47	30
Pre-prepared products (eg. canned soup)	16	13	22	11
Other	12	8	14	13
Reasons that prevent purchase of organic				
Too expensive	78	90	68	74
Availability limited	23	16	32	22
Poor quality	13	12	15	10
Limited knowledge about organics	22	26	17	24
Do not trust the source of organics	15	13	16	18
Other	13	18	10	8

[1]General Edmonton locations (GEL) = Consumers from Edmonton shopping malls, public venues and the University of Alberta Campus; [2]Organic market locations (OML) = Consumers from a farmer's market, and local organic grocery stores; [3]Surrounding community locations (SCL) = Consumers from smaller communities of Red Deer, Sherwood Park, and St. Albert; Note: Percentages may not add up to 100% due to rounding.

Table 3-4: Mean values for overall acceptance (9-point hedonic scale) of 60% whole wheat bread under blind and labelled conditions by information type (n=384)

	Conventional bread			**Organic bread**		
	Blind	Labelled	ConvPC[1]	Blind	Labelled	OrgPC[1]
			All participants (n=384)			
Mean	6.37[x,a]	6.34[x,m]	-0.03	6.73[x,b]	6.86[y,n]	0.14
Standard Deviation	1.6	1.5	1.3	1.5	1.3	1.3
			Health information (n=192)			
Mean	6.31[x,a]	6.34[x,m]	0.03	6.61[x,b]	6.78[y,n]	0.17
Standard Deviation	1.6	1.5	1.3	1.6	1.4	1.3
			Environmental information (n=192)			
Mean	6.42 [x,a]	6.33 [x,m]	-0.09	6.85 [x,b]	6.95 [x,n]	0.10
Standard Deviation	1.6	1.5	1.3	1.4	1.3	1.3

[1]Preference change [PC] = labelled – blind

[x,y] – Blind and labelled values within information type and bread type not followed by the same letter are significantly different ($p \leq 0.05$).

[a,b] – Organic and conventional bread compared under BLIND conditions within information type not followed by the same letter are significantly different ($p \leq 0.05$).

[m,n] – Organic and conventional bread compared under LABELLED conditions within information type not followed by the same letter are significantly different ($p \leq 0.05$).

Table 3-5: OLS regression analysis results for organic preference change (OrgPC) and difference in preference change (DiffPC) (n=384)

	ORGPC[1]		DIFFPC[2]	
Variable name	Coefficient (std error)	*p*-value	Coefficient (std error)	*p*-value
Health information – sensory before WTP	0.30 (0.15)	0.04	0.18 (0.27)	ns
Health information – sensory after WTP			-0.20 (0.27)	ns
Environmental information – sensory before WTP			-0.13 (0.27)	ns
Male			0.38 (0.20)	0.06
Post secondary education	0.33 (0.13)	0.01	0.12 (0.20)	ns
Household income ($Canadian)			0.66 E-05 (0.28 E-05)	0.02
Consumes more than 2-4 servings of organic bread per day	0.90 (0.19)	0.00	1.51 (0.27)	0.00
Limited knowledge of organic products	0.33 (0.16)	0.03	0.41 (0.24)	0.09
CONSTANT	-0.33 (0.12)	0.01	-0.64 (0.28)	0.02

Note: Base case for information variable was "Environmental info – sensory after WTP"
[1]ORGPC = labelled - blind
[2]DIFFPC = orgPC – convPC

Table 3-6: Probit regression analysis results for binary variable: Positive preference change for organic bread (OrgPPC[1]) (n=384)

Variable name	**Coefficient (std error)**	***p*-value**	**Marginal effects**
Health information – sensory before WTP	0.09 (0.22)	ns	
Health information – sensory after WTP	-0.05 (0.23)	ns	
Environmental information – sensory before WTP	0.10 (0.22)	ns	
Blind hedonic evaluation organic bread	-0.50 (0.06)	<0.0001	-0.16
Decrease in hedonic evaluation of conventional bread after information	0.46 (0.17)	0.007	0.15
Average health attitude	0.16 (0.15)	ns	
Average environmental attitude	0.25 (0.13)	0.05	0.08
Consumes more than 2-4 servings of bread per day	0.27 (0.16)	0.09	0.08
Frequently purchases organic food	0.09 (0.22)	ns	
Does not purchase organic due to high price	-0.21 (0.19)	ns	
Limited knowledge of organic products	0.34 (0.19)	0.07	0.11
Does not trust the source of organic products	-0.62 (0.24)	0.01	-0.20
Organic market location (OML)	0.22 (0.22)	ns	
General Edmonton location (GEL)	0.40 (0.21)	0.06	0.13
CONSTANT	0.64 (0.73)	ns	

Note: Base case for information variable was "Environmental info – sensory after WTP"
[1][OrgPPC] = Positive preference change for organic bread.

3.7. Figures

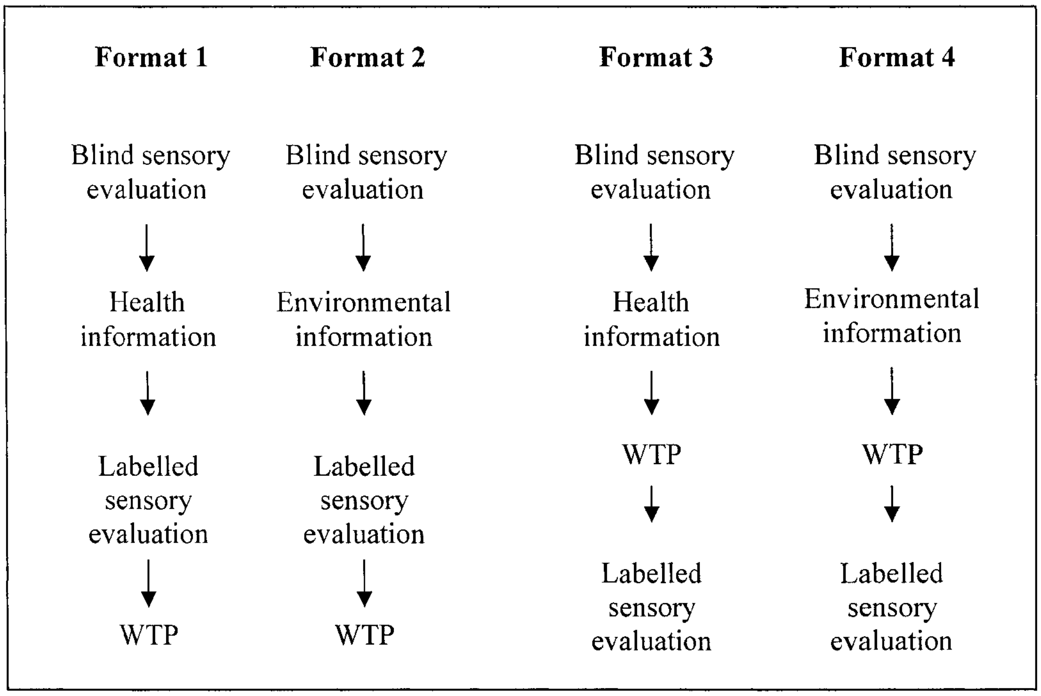

Figure 3-1: Questionnaire format with information, sensory evaluation, and willingness to pay questions (WTP)

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Chapter 4: Summaries, conclusions and future recommendations

4.1. Summaries

In Canada and worldwide, the organic food and beverage market is expanding due to increased consumer demand (Sahota 2004). The increased demand seems to have arisen from consumers concern over health and environmental issues associated with agricultural and food production systems (Williams 2002). Organic agriculture attempts to promote ecosystem health through the prohibition of external inputs such as synthetic pesticides and fertilizers, growth regulators, and genetically modified organisms (Sydness 1991). In addition, processed organic food products restrict the use of some preservatives and artificial additives in an effort to benefit human health. Investigating the chemical composition and sensory qualities of organic and conventional food products can lead to greater insight about how they differ, as well as an understanding of why consumers are motivated to choose organic food products.

The unique approach to the present research is the direct comparison of bread formulated from paired samples of organic and conventionally grown wheat grain. The hard red spring wheat cultivar 'Park' was grown in 2005 at the Edmonton Research Station in Edmonton, AB, Canada on both conventionally and organically managed land, situated less than one km apart.

4.1.1. Chapter 2

Grain quality analyses were used to compare the physiochemical properties of organic and conventionally grown wheat and flour. The wholemeal protein content was greater ($p \leq 0.05$) in the organic than the conventional wheat grain, but both were excellent quality grains for making yeast-leavened bread with protein contents greater than 14% (Halverson and Zeleny 1988). Mixograph parameters indicated that conventional flour produced stronger dough, and visual observation during our experiment revealed conventional bread had a consistently larger loaf volume than organic bread (Figure 2-1).

The sensory evaluation technique of descriptive analysis was used to compare the colour, texture, taste, and aroma attributes of bread baked from organically and conventionally produced wheat. The panellists evaluated 3 treatments of 60% whole wheat bread: Organic, conventional, and commercial. The sensory profiles indicated that attributes of denseness and visual surface texture differed ($p \leq 0.05$) between the organic and conventional whole wheat bread. Organic bread had greater density, and had smaller air cells in the crumb, confirming the differences observed in physiochemical properties of the flour. The intensities of flavour and aroma attributes did not differ between the organic and conventional bread which does not confirm the claim to "superior taste" qualities of organic food that have been reported by the Soil Association (Heaton 2001). Thus, we have suggested that the perceived sensory differences between organic and conventional bread may be due to the non-sensory factors, such as context of presentation, or consumer characteristics (Rozin and Tuorila 1993; Jaeger 2006).

4.1.2. Chapter 3

A consumer sensory evaluation panel was carried out to examine the impact of health and environmental information pertaining to organic production methods on consumers' acceptance of 60% whole wheat bread baked from organically and conventionally grown wheat. Sensory evaluation revealed that consumers' liking scores were higher ($p \leq 0.05$) for organic bread than conventional bread, both before and after information was presented. However, there is little practical significance as they are both within "like slightly" (6.0) to "like moderately" (7.0) on the 9-point hedonic scale.

Regression analyses were performed on the consumer panel data to assess the role of consumer characteristics and attitudes on changes in preference for 60% whole wheat bread made from organically grown wheat. The OLS regression models revealed socio-demographic factors that can influence overall preference changes, while the probit model revealed both socio-demographics and attitudes towards the environment as factors that could influence the probability of a positive change in preference towards organic products in the consumer population. Post secondary education, income and bread consumption habits were important determinants of preference for organic bread. Health information was only important for organic preference changes when coupled with sensory evaluation. Consumers with pro-environmental attitudes had a higher propensity for rating organic bread more positively on the liking scale after information and label (OrgPPC).

4.2. Conclusions and future recommendations

Future research on Canadian grown wheat grain managed under organic and conventional methods could evaluate the milling technique used to produce the flour as this can have a significant effect on the dough properties and thus bread quality (Kihlberg and others 2004). Variation over season should also be examined as environmental changes and crop stress from year to year can play a significant role in the quality of the wheat protein (Mason and others 2006). The descriptive analysis results revealed that differences in the sensory profiles of organic and conventionally grown grain were limited to the textural attributes alone, evaluated visually or physically by hand.

In light of the increasing consumer demand for organically produced food products and the marginal differences found between organic and conventional flour and bread, it was important to assess consumers liking and the factors that influence choice of organic food products. Focused information on health or environmental issues furthered the understanding of information effects on the liking of organic food products, with the length and source of information provided to consumers unique to this project.

Future research coupling sensory and consumer testing should include a middle step where only the label is revealed prior to presenting information to consumers. Sensory evaluation of food products under blind, expected, and labelled information conditions creates experimental separation between the label effects from the information effects.

As well, additional assessments of attitudes and values related to health and environmental issues may also provide further insight about motivations for food choice. The source of the information could be varied to understand who consumers trust for their information. In addition, novel food products could be used to examine the reliability of the blended techniques.

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Appendix 1: Detailed methods of bread production

Bread Manufacture

Each batch of organic and conventional 60% whole wheat bread was formulated as follows: 8866.0g of 60% whole wheat flour (organic or conventional) (53.9%), 5895.5g of water (35.8%), 515.3g of dried skim milk powder (3.1%), 442.0g of Crisco all vegetable shortening (solid) (2.7%), 368.1g of sugar (2.2%), 184.1g of salt (1.1%), and 184.1g of yeast (1.1%).

First, 975g of water at 34°C and 5g of sugar was added to the yeast and allowed to soften for 10 min. The dried skim milk powder, salt, and remaining sugar were combined. The shortening was melted in 30-second intervals for at total of 1.5 minutes using a 900Watt microwave.

A Blakeslee Mixer (Blakeslee DB-80 QT Mixer, Blakeslee USA, Chicago, IL) with a maximum capacity of 35kg was used for mixing. Melted shortening was added to the mixing bowl first to prevent the flour from sticking to the surface of the bowl. The dry ingredients and water were added along with 50% of the flour. The softened yeast mixture was added next, followed by the remaining 50% of the flour. The ingredients were mixed for one minute at speed 1 (low) to ensure sufficient blending.

The dough was then mixed at speed 2 (medium) for 10 minutes to develop the gluten network and knead the dough. The strength of the dough was examined during each batch to ensure consistency. The dough was proofed at 27°C and 80% relative humidity for 1 hour and 5 minutes using a Plantinous Sterling Series Temperature and Humidity Chamber (with SCP-220 instrumentation, Espec North America, Hudsonville, MI, U.S.A.). This was followed by a punch down in the mixing bowl and a second proof for 40 minutes again at 27°C and 80% relative humidity.

The dough was divided in to 510g portions (range 510-515g) and formed into loaves using a Bloemhof Moulder (model 860-1, Bloemhof Inc., Edmonton, AB). This step was completed to ensure 1 pound loaves after baking. Thirty loaf pans (1-pound size) were sprayed with Pam non-stick cooking spray before loaves were added. The formed loaves were then proofed for 25 minutes at 35°C and 90% relative humidity.

Loaves were baked at 190°C for 30 minutes until an internal temperature of 91.6°C was reached, using a Baxter Oven (Advantage Rotating Rack oven, model V16-340-1, Orting, Washington, USA). Bread loaves were allowed to cool for 30 minutes in loaf pans, followed by 25 minutes on parchment paper. Bread loaves were packed into polyethylene bags and placed in a commercial freezer at –18°C within 2 hours of baking and were stored there until required for sensory evaluation. Bread manufacture for organic and conventional whole wheat bread was completed at the Leduc Food Processing Development Centre in Leduc, AB, Canada.

Appendix 2: Basic taste scorecard used to train potential trained panellists

Basic Taste Identification Scorecard

Name: ____________________ Date: ___________

On the tray there are five water solutions; four each of the basic tastes plus one of water.

Please taste the samples in the order indicated. **DO NOT SWALLOW THE SAMPLES.** "Swish" the samples around the mouth, then expectorate into the large coloured cup provided. Identify the taste you experience. Rinse your mouth with water between samples and wait one minute before proceeding to the next sample. Continue testing in the same manner until all samples have been tasted. Record your initial reaction and **DO NOT** go back to re-taste or change your answer.

Sample Code	***Identity***
468	
251	
983	
575	
832	

Thank you!

Appendix 3: Sweetness intensity scorecard used to train potential trained panellists

Ranking of Sweetness Intensity

Name: ___________________ Date: __________

Please evaluate and rank the five samples of sweet solutions in water according to their intensity of sweetness. Rank the samples from least sweet to most sweet. Write in the sample three-digit codes in the spaces provided.

_______________ Least sweet

____

____

____

_______________ Most sweet

Thank you!

Appendix 4: Odour identification scorecard used to train potential trained panellists

Odour Identification Scorecard

Name: ____________________ Date: ___________

On the tray there are six bottles containing samples of food or non-food items.

Open each container and sniff the odour. Immediately close the container. Try to identify the odour, or to describe the odour if you do not recognize it.

Re-open the container and re-sniff as often as you wish, but do not fatigue your olfactory system by sniffing too long or too often. If you fatigue your system take a short break by leaving the lab for a couple of minutes. Fresh outdoor air will provide the best rest for your olfactory system.

Sample Code	***Identity***
117	
698	
832	
983	
499	

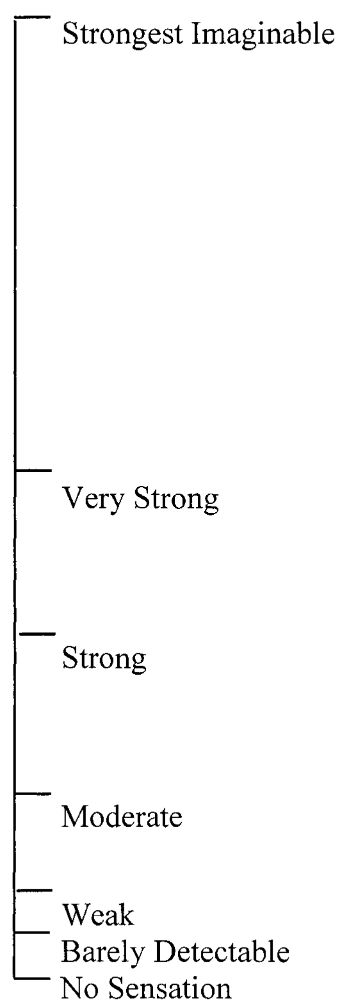
Appendix 5: PROP test scorecard used to train potential trained panellists

PROP Test Sensation

Name: ____________________ Date: _____________

Instructions:

1. Cleanse your palate with a sip of water
2. Place the PROP solution provided in your mouth. **DO NOT SWALLOW THE SOLUTION.**
3. Swish it around in your mouth for ***10*** seconds, ***spit out the solution into the cup provided***, then rate the taste of the solution somewhere between no taste at all ***(no sensation)*** and taste which is the strongest sensation that you could imagine having in your mouth ***(strongest imaginable***).



Thank you! Please return to room 2-35 for your candy treat.

Appendix 6: Screening questionnaire given to potential trained panellists

Trained Panelist Screening Questionnaire

Contact information:

Name: ______________________________

Phone number (lab/office): ______________________________

Email: ______________________________

Availability:

1. Are there any weekdays or times (Tuesday to Friday) that you will not be available during January 17th and February 10th?

____

____

2. Which time of day would work best in your day to day routine? (circle one)

- 11:00 am to 12:00 pm
-
- 2:00 pm to 3:00 pm
-
- other time:______________

Health:

1. Do you have any of the following?

Dentures	________
Diabetes	________
Oral or gum disease	________
Hypoglycemia	________
Food allergies	________
Hypertension	________
Thyroid condition	________
Pregnant	________

2. Do you take any medications which affect your senses, especially taste and smell?

____

____

3. Do you currently smoke? Have you in the past? Please Explain.

____

____

Food Habits:

1. Are you currently on a restricted diet? If yes, please explain.

____

2. What is (are) your favorite foods? ___________________________

3. What is (are) your least favorite foods?________________________

4. What foods do you <u>not</u> eat because of sensitivities, intolerances, allergies or dislikes?

Sensitivities:_________ ______________________________
Intolerances: ____________________________________
Allergies: _______________________________________

5. How would you rate your ability to distinguish smells and tastes?

	Smell	Taste
Better than average	______	______
Average	______	______
Worse than average	______	______

6. Does anyone in your immediate family work for a food company?_______________

____

_

7. Does anyone in your immediate family work for an advertising company or a marketing research agency?

   ____

____

__

8. Members of the trained panel should not use heavy perfumes/colognes on evaluations days. They should also not smoke an hour before the panel meets. Would you be willing to do the above if you are chosen as a panelist?

   ____

Flavour Quiz:

1. What would you say is the difference between flavour and aroma? __________

____
____
____

2. What would you say is the difference between flavour and texture? ____________
____
____
____

Ice Cream Sundae Evaluation

- Imagine you are given unlimited ingredients to make your very own ice cream sundae. Indicate what type of toppings would be on your sundae and what distinctive characteristics you would experience when eating your creation?

- Sundae toppings:

- Important characteristics of the sundae:

Whole Wheat Bread Evaluation

Please evaluate and describe the bread samples in front of you.

Flavor:

Texture:

Aroma:

Appendix 7: Compusense® ballot and colour evaluation scales for trained panel

WELCOME to the
Sensory and Consumer Science
LAB

Whole Wheat Bread Panel

February 2006

Please evaluate each of the following three samples one at a time.

Evaluate the crumb for all attributes unless specified 'crust'.

You have been provided with all of the reference standards for AROMA, and FLAVOR. You have also been provided with selected references for TEXTURE. Remember, these were decided as the anchors on the line scale.

Please refer to your attribute definition sheet for the description of each attribute as well as how it is evaluated. It is important that you are consistent each time you evaluate a sample.

Finally, Colour intensity for each sample will be evaluated in the LAB when you are finished.

Good Luck!

And remember, if you have any questions...please ask me.

APPEARANCE

Sample _____

Surface Texture

Not at all Dense		Very Dense

AROMA

Sample _____

Overall Intensity of Wheat Bread Aroma

Not at all Intense	R1 Whole Wheat Pasta	R2 Red River Cereal	Very Intense

Toasted Aroma (crust)

Not at all Toasted	R Postum (weak)	Very Toasted

TEXTURE

Sample _____

Denseness (by finger)

Not at all Dense — Very Dense

Dryness (by mouthfeel)

Not at all Dry — Very Dry

Cohesiveness of Mass (by mouthfeel)

Not at all Cohesive — Very Cohesive

Grainy (by mouthfeel)

Not at all Grainy — Very Grainy

Please rinse your mouth with a sip of water before beginning the flavor evaluation.

Remember to rinse your mouth with water between reference standards - this will reduce carry over flavors.

--WAIT 10 seconds

THANK YOU.
Please return to the Sensory Discussion Room
We will evaluate colour intensity of each sample in the LAB.

Appendix 8: Verbal and email recruitment text for potential Whole Wheat Bread consumer panel participants

E-mail subject line: Consumer Sensory Panel on Whole wheat bread

"Are you interested in participating in a consumer panel to evaluate Whole Wheat Bread?"

We are looking for individuals who

- like and consume whole wheat bread
- would be willing to taste four wheat bread samples and tell us how much they like each, and complete a questionnaire regarding consumer wheat bread consumption, purchase habits and opinions of wheat grain production practices.

Participation in the consumer panel will take approximately 15-20 minutes. The panel will take place between 10:00 am and 2:00 pm in the sensory room (2-35) in the Agriculture and Forestry Centre on ***November 8th, 2005.***

We cannot pay you for the taste testing, however you will receive a $2.00 Tim Horton's Gift Certificate at the end of the session and you can take your bread samples with you to eat at your leisure.

Would you like to participate? Do you have questions about the project? Below is an email address where you can get a hold of us, as well as a phone number. If you are interested, we can send a project information sheet that outlines the project in greater detail. Thanks for your time and we hope to hear from you!

Lisa Annett
Email: lisa.annett@ualberta.ca
Phone #: 492-3833

Appendix 9: Consumer survey information and consent forms

Project Information Sheet: Consumer Panel Sensory Evaluation of Wheat Bread

Purpose: The purpose of this project is to evaluate consumer liking of four samples of whole wheat bread and gather information about consumer wheat bread consumption, purchase habits and opinions of wheat grain production practices.

Consumer Panel Methods: You are being asked to participate in a consumer sensory panel to taste four samples of 60% whole wheat bread. There are two parts to this evaluation; Part A of the questionnaire with two samples of bread to evaluate followed by Part B of the questionnaire with two more samples of bread to evaluate. The session takes about 15-20 minutes.

Confidentiality: You are not asked to provide your name on any of the questionnaires. Your questionnaires will be given a participant number. Only the research team will have access to your data. The contact information you provide on the consent form will be used only to inform you of the outcome of the study if you have requested this information.

Benefits: The results of this study may not have any direct benefits for you. No payment is offered, however you will receive a $2.00 Tim Horton's gift certificate at the end of the session. The results from this study will be valuable to the wheat farmers of Alberta.

Risks: The risks of participating are no different from the normal risks associated with the consumption of wheat bread and water. The ingredients in the wheat bread are as follows:

- Whole wheat flour
- Yeast
- Non-fat dried milk
- All-Vegetable Shortening
- Salt
- Sugar

If you have any allergies, intolerances or sensitivities to these ingredients you should not participate.

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

Use of Your Information: This study is being done by researchers in the Departments of Agricultural, Food and Nutritional Science and Rural Economy. Your consumer panel data will be averaged with those of the other participants and these mean values will be used to generate overall preferences for the wheat bread. The data will be used for a Master's Thesis and journal publication entailing the research study and results. If you want, a summary of the research results will be e-mailed or post-mailed to you.

For further information about the study, you can contact the research team:

Wendy Wismer	Lisa Annett	Peter Boxall	Sean Cash
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For information about how this project is carried out you may contact:

Georgie Jarvis
Research Ethics Board Administrator
2-14 Ag/For Centre, University of Alberta
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Consent Form for Consumer Panel Sensory Evaluation of Wheat Bread

Consent: Please circle your answers:

Do you have any allergies, sensitivities or intolerances to the wheat bread ingredients:	Yes	No

- **Whole wheat flour**
- **Yeast**
- **Non-fat dried milk**
- **All-Vegetable Shortening**
- **Sugar**
- **Salt**

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

I understand the true nature of this research study along with the benefits and risks associated with being a part of it. I have read and received the copy of the attached information sheet and have been assured of the confidentiality with respect to the information I provide.	Yes	No
I have had the opportunity to ask questions, and I know who will have access to the data and what the information will be used for. I also understand that I am free to quit taking part in the study at any time while completing the questionnaire. Therefore, I give consent to use the data obtained in this experiment for the purpose of the study outlined in the project information sheet.	Yes	No

This study was explained to me by: ______________________________

I agree to take part in this study.

______________________	______________________	____/____/ 2005
Signature of Research Participant	Printed Name	Date (dd/mm/yyyy)

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

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Signature of Investigator or Designee

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

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

E-mail OR Postal Address: ______________________________

Appendix 10: Consumer Panel Questionnaire

PART A: Information about yourself

Please answer the following questions about yourself by placing a check mark (√) in the box that best represents you:

1. On average, how often do you eat **whole wheat** bread (60%, 80% or 100% whole wheat) or **whole wheat** bread products (*e.g.* bagels, buns)?
   - ☐ 5 or more servings a day
   - ☐ 2-4 servings a day
   - ☐ One serving a day
   - ☐ 2-6 servings a week
   - ☐ Less then 2 servings a week
   - ☐ Never consume whole wheat bread or bread products

One serving =
1 slice bread or ½ bagel

2. Where do you normally purchase your **bread and bread products**?

Please circle the number (1-4) that best represents your purchase of bread at the following stores.

	Most Often	Sometimes	Rarely	Not at all
Supermarkets (e.g. Safeway, Sobeys, Superstore)	1	2	3	4
Organic or Natural section in Supermarket (e.g. Safeway, Sobeys, Superstore)	1	2	3	4
Specialty Food Stores or Bakeries (e.g. Bee Bell Bakery, Sunterra Markets)	1	2	3	4
Organic Grocery Stores	1	2	3	4
Farmer's Markets	1	2	3	4
Wholesalers (e.g.Costco)	1	2	3	4
Other: (Please specify)__________	1	2	3	4

3. I most often purchase bread that is a: (please check one)
   - ☐ **National Brand** (*e.g.* Dempster's, Wonderbread, Ovenjoy, Olafson, Healthy Way, etc)
   - ☐ **Store Brand** (*e.g.* Safeway, IGA, President's choice, Western Family, etc)
   - ☐ **Produced at a Specialty Bakery** (*e.g.* Bee-Bell, Buns&Roses, BonTon, Kinnikinnick Foods)

4. Please indicate your gender:
   - ☐ Female
   - ☐ Male

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

- ☐ 18-24 years
- ☐ 25-34 years
- ☐ 35-44 years
- ☐ 45-54 years
- ☐ 55-64 years
- ☐ 65-74 years
- ☐ 75 plus years

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

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

7. Please indicate the range that represents your household income level in the year 2004, before taxes:

- ☐ Less than $36,600
- ☐ $36,601- $71,000
- ☐ $71,001 - $115,000
- ☐ More than $115,001

8. Are you a member, or do you participate in, an environmental organization?(such as Ducks Unlimited, ECOS, Green Communities Edmonton Association, Environmental Direct Action Network, Friends of Elk Island Society etc.)

- ☐ Yes
- ☐ No

Part A: Taste Evaluation of Wheat Bread

Please take a sip of water to rinse before beginning the evaluation.

Please evaluate the two bread samples.

1. Look at the appearance of the bread sample.
2. Open the bag and take the sample out of the bag
3. Smell the aroma of the bread sample
4. Taste the bread sample

For each sample, rate your **overall opinion** on the scales below by placing a check mark (√) in the box that best represents your opinion.

Sample: 762

Please rate your overall opinion.

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

Please add any comments you may have about bread sample **762**:

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Please take a sip of water to rinse your mouth before evaluating the second sample.

Sample: 185

Please rate your overall opinion.

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

Please add any comments you may have about bread sample **185**:

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Part A: Your Opinions on Food and Related issues

Please answer the following questions about your views on health. Please circle the number (1-5) that best represents your opinion.

		Not At All	Not Very Much	Somewhat	Very Much	A Lot
1	How much of an effect do you feel what you eat will have on your future health?	1	2	3	4	5
2	To what extent do you feel your health depends on how you take care of yourself	1	2	3	4	5
3	Some people feel that if they are going to be sick, they will be. How much do you feel it is possible to prevent sickness?	1	2	3	4	5
4	If qualified health professionals recommend eating certain foods, how likely are you to try them?	1	2	3	4	5
5	How much more are you concerned about what you eat then you used to be?	1	2	3	4	5

Please answer the following questions about your views on the environment. Please circle the number (1-5) that best represents your opinion.

		Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
1	It makes me sad to see natural environments destroyed	1	2	3	4	5
2	Unique environments should be protected at all costs.	1	2	3	4	5
3	One of the most important reasons to conserve is to preserve wild areas	1	2	3	4	5
4	Wild plants and animals have a right to live unmolested by humans	1	2	3	4	5
5	We must prevent any type of animal from becoming extinct, even if it means sacrificing some things for ourselves.	1	2	3	4	5
6	I am willing to make personal sacrifices for the sake of slowing down pollution even though the immediate results may not seem significant	1	2	3	4	5
7	Natural ecosystems have a right to exist for their own sake, regardless of human concerns and uses.	1	2	3	4	5

Thank you for completing the first part of the consumer questionnaire.
Please let us know when you are ready for the second part.

PART B: Consumer Information

Please read the following information about organic farming practices.

Health Information: (H1 and H2)

Fruits, vegetables and grains grown under organic farming practices tend to contain higher levels of antioxidants compared to their conventional counterparts. According to recent research, a high antioxidant intake has been associated with a lower incidence of heart disease and some cancers.

Antioxidants are naturally made by a plant when it is attacked by insects. The National Standards of Canada for Organic Agriculture prohibit the use of most synthetic pesticides and fertilizers on crops and soil. Since pesticides are not allowed, the plants produce more antioxidants to discourage insects. This also results in fewer synthetic chemical residues in food.

Organic food products may also contain fewer food additives. For example, in the United Kingdom, the UK Food Standards Agency restricts certain ingredients and additives in processed organic foods such as:

- artificial colorings and artificial sweeteners
- MSG (monosodium glutamate)
- Hydrogenated fats

In each case their use has been restricted because of evidence that they may be damaging to health.

PART B: Consumer Information

Please read the following information about organic farming practices.

Environmental Information: (E1 and E2)

The basic idea of organic food production is to ensure that the organic farm is sustainable and operates in a manner harmonious with the environment. Voluntary guidelines for organic agriculture have been set up by the Canadian General Standards Board. They recommend that organic farmers:

- Protect the environment
- Minimize soil degradation and erosion
- Decrease pollution
- Optimize biological productivity
- Promote a sound state of human, animal and environmental health
- Recycle materials and resources when possible
- Maintain the integrity of organic foods and processed products from initial handling to point of sale

The National Standards of Canada for Organic Agriculture prohibit the use of most synthetic pesticides and fertilizers on crops and soil. This results in less harm to the environment. Organic farmers must use other management methods and selected varieties to prevent diseases and resist pests.

Part B: Taste Evaluation of Wheat Bread

Please take a sip of water to rinse before beginning the evaluation.

Please evaluate the two bread samples.

1. Look at the appearance of the bread sample.
2. Open the bag and take the sample out of the bag
3. Smell the aroma of the bread sample
4. Taste the bread sample

For each sample, rate your **overall opinion** on the scales below by placing a check mark (√) in the box that best represents your opinion.

"Organic" Sample: Bread made with flour from organically grown wheat.

Please rate your overall opinion.

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

Please add any comments you may have about the bread made from organically grown wheat:

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Please take a sip of water to rinse before evaluating the second sample.

"Conventional" Sample: Bread made with flour from conventionally grown wheat

Please rate your overall opinion.

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

Please add any comments you may have about the bread made from conventionally grown wheat:

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Part B: Purchasing Organic Bread Products

Please answer the following questions about yourself by placing a check mark (√) in the box that best represents you:

1. Recall that the information provided earlier suggested that organic farming practices do not involve the use of synthetic fertilizers or pesticides. Due to lower yielding crops and more weeds, there are greater labour inputs per unit of output required for organic production. For these reasons, organic products can be more expensive.

We are about to ask you if you would purchase an organic product at a certain price. Previous surveys of this nature find that the amount of money people SAY they are willing to pay is sometimes higher than the amount they would ACTUALLY pay for this product. For this reason, as you read the following question, please imagine that you would ACTUALLY have to pay this amount keeping in mind what you normally pay for groceries for you and your family.

Assume that the cost of conventional bread on average is $1.50/loaf at the store where you usually shop. On your next shopping trip assume you need to buy one loaf of bread. If organic bread were available for purchase, would you purchase this organic bread if it cost range ($0.25 to $3.25)/ loaf more than the conventional product, in other words if the total price of the organic bread was range ($1.75 to $4.75)/ loaf?

Yes ☐ No ☐

2. If you answered "yes" to the question above, how certain are you of your answer?

Very Certain	Somewhat Certain	Unsure	Somewhat Uncertain	Very Uncertain
☐	☐	☐	☐	☐

If you answered "NO" to question 1, would you buy this loaf of organic bread if the price was the same as the average price of conventional bread?

Yes ☐ No ☐

3. On average, how often do you eat **ORGANIC whole wheat bread** (60%, 80% or 100% whole wheat) or **ORGANIC whole wheat bread** products (e.g. bagels, buns etc)?
   - ☐ 5 or more servings a day
   - ☐ 2-4 servings a day
   - ☐ One serving a day
   - ☐ 2-6 servings a week
   - ☐ Less then 2 servings a week
   - ☐ Never consume organic whole wheat bread or bread products

One serving =
1 slice bread or ½ bagel

4. How often do you purchase **organic foods**?
   - ☐ I only buy organic foods
   - ☐ I frequently buy organic foods
   - ☐ I sometimes buy organic foods
   - ☐ I rarely buy organic foods
   - ☐ I never buy organic foods

5. If you do purchase organic foods, **what types of organic foods** do you buy? (check all that apply)
   - ☐ Milk or dairy products
   - ☐ Vegetables
   - ☐ Fruit
   - ☐ Meat, fish, or meat products
   - ☐ Bread or bread products
   - ☐ Pre-prepared products (eg. Canned soup)
   - ☐ Other: (Please specify)____________________________

6. What are some reasons that may **prevent you** from purchasing **organic foods**? (check all that apply)
   - ☐ Organic foods are too expensive
   - ☐ Organic foods are not available where I shop
   - ☐ The quality of organic foods is poor
   - ☐ I have limited knowledge about organic products
   - ☐ I do not trust the source of organic products
   - ☐ Other (please specify) ____________________________________

Thank you for completing the second part of the consumer questionnaire.
Please let us know when you are finished.