Formulating a Pasta Sauce with Added Health Benefits for the Aging Baby Boomer Population

by

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ABSTRACT

Background: Baby boomers are placing a demand on the food industry for products that promote longevity, well-being, and contain functional ingredients for enhanced nutritional and health benefits. **Objectives:** Develop a pasta sauce with increased health benefits; conduct sensory and shelf-life testing; and conduct consumer acceptability tests. **Methods:** Study was conducted in four phases. Three sources of fibre were investigated (oat fibre, pea fibre and red lentils). Sensory analysis conducted to identify ideal level of red lentils in the pasta sauce followed by a shelf-life study. Chemical, physical and microbiological analyses were performed. Consumer acceptability testing conducted with one hundred and twenty-three baby boomers. **Results:** Red lentils at a concentration of 15% were identified as ideal source and amount showing no significant differences in analyses compared to other fibres, other concentrations and over 12 week storage. Participants were in favour of the color, flavour, odour and texture of the pasta sauce and willing to pay $0.34 more for a 750 ml jar compared to average commercial price. **Conclusions:** The pasta sauce may aid baby boomers in attaining daily recommendations of fibre and an alternative to commercial pasta sauces in offering lower sodium content.

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LIST OF ABBREVIATIONS

a*	red-green (scale +/-)
Amnt	Amount
ASTM	American Society for Testing and Materials
b*	yellow-blue (scale +/-)
BMI	Body Mass Index
C	Chroma
°C	Celsius
Ca	Calcium
CFIA	Canadian Food Inspection Agency
CHO	Carbohydrate
cP	Centipoise
DRI	Dietary Reference Intake
DV	Daily Value
FDA	Food and Drug Administration
G	grams
h	Hue angle
HACCP	Hazard Analysis and Critical Control Points
HPLC	High Performance Liquid Chromatography
In	Inulin
IU	International Unit
L	Litre
L*	lightness (scale 0-100)
Lb	pound
LDL	low-density lipoprotein
LTW	Leading the Way
mg	milligram
ml	millilitre
NHP	Natural Health Product
PEF	Pulse Electric Field
PF	Pea Fibre
PSF	Pasta Sauce Final
PSP	Pasta Sauce Prototype
OF	Oat Fibre
RDI	Recommended Dietary Intake
RL	Red Lentils
rpm	Rotations per minute
s	second
SD	Standard Deviation
TCS	Tomato Catsup Score
TJS	Tomato Juice Score
TPS	Tomato Paste and Puree Score
TSS	Tomato Sauce Score
µg	microgram

USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
Wk	Week

CHAPTER 1
INTRODUCTION

Overview

In Canada, baby boomers (individuals born between 1946 - 1965) represent nearly one-third of the population and this number is increasing rapidly (Statistics Canada, 2006b). With the increasing number of baby boomers reaching their sixties, food processors and developers must now re-evaluate their foci on product development and marketing strategies. Baby boomers, unlike older adults (65 years and older), have been exposed to a wide range of ethnic foods, have diverse palates, and are considered to have the most disposable income. Food processors and developers are now left with the task of catering to the nutritional demands of this generation.

Nutrition is considered one of the determinants of successful aging and eating contributes to quality of life (American Dietetic Association, 2005). With age, optimal nutrition plays a crucial role in a healthy lifestyle. Dietary changes, caused by decreased appetite, decreased flavour acuity and increased early satiety, are associated with physiological changes, health conditions, the social situation, and the environment which may lead to a decrease in consumption of energy and nutrients (American Dietetic Association, 2005). As a result, many older adults are at risk for nutritional deficiencies such as protein, calcium, vitamin D, and fibre.

Baby boomers would greatly benefit from the use of functional foods (food products with physiological benefits beyond basic nutritional function) which are increasing in popularity among all age groups. Consumption of functional foods may enhance nutrient intake, promote health, prevent complications associated with chronic

diseases which may lead to decreased health care costs and increased quality of life among aging consumers. The development of functional foods would significantly benefit baby boomers by promoting health and preventing diseases or related complications.

The baby boomer generation is aging and they are placing a demand on the food industry for healthy and tasty food products that not only promote longevity and quality of life, but contain functional food properties. Published research is limited on the nutritional perceptions of baby boomers. In Manitoba the most common chronic illnesses are cardiovascular disease, diabetes, cancer, chronic obstructive pulmonary disease, asthma and mental illness (i.e., depression, stress and anxiety). The first three chronic illnesses are estimated to cost the Canadian economy $55 billion every year (Government of Manitoba, 2009a). Of the research that has been conducted, none focus on developing functional food products for this group of consumers using raw materials from Manitoba for commercialization. This project will utilize Manitoba grown crops and work within Manitoba research infrastructure and cluster to develop and commercialize food products for this growing consumer market.

The present study (Phase II) is an extension of the focus group study (Phase I) conducted by Lengyel and Utioh (2009). The objectives of Phase I were: 1) to determine healthy eating perceptions and practices of functional food usage of baby boomers; 2) to review and identify products that are commonly consumed by baby boomers as important vehicles for the delivery of specific nutrients; and 3) to identify gaps in new food product development for baby boomers. Phase II of the study consists of developing four food

products based on information from Phase I. For the purpose of this project, a pasta sauce was formulated and evaluated.

The development of the pasta sauce includes commercial ingredient sourcing, product formulation, sensory evaluation, optimizing trials, shelf-life study and consumer acceptability. The ingredients utilized were locally grown Manitoba and some Saskatchewan raw materials such as red lentils, vegetables and canola oil. Manitoba has the resources and the environment for production, development, and commercialization of value-added functional food products that would benefit the food industry and promote healthy living for the growing number of baby boomers and older adult consumers.

The development of functional foods, namely a pasta sauce, would significantly benefit baby boomers living in rural and urban Manitoba communities to promote health and prevent diseases or related complications. In the long-term, the availability and consumption of functional foods may assist in reducing health care costs and improving the quality of life of aging adults.

Research Questions

The research questions of the study were:

1. What locally grown ingredients and quantities should be used in the newly developed pasta sauce?
2. What is the acceptable level of fibre in the pasta sauce?
3. Are there any chemical, physical and sensory changes to the pasta sauce over time?
4. Does the newly developed pasta sauce meet consumer acceptability standards?

Objectives

The objectives of the study were:

1. To develop a pasta sauce with increased health benefits.
2. To conduct sensory and shelf-life testing of the new pasta sauce.
3. To conduct consumer acceptability tests on the new pasta sauce.

Summary

The study's objectives were conducted in four phases: (1) Product development and fibre identification; (2) Sensory evaluation; (3) Shelf-life study; and (4) Consumer acceptability. Figure 1.1 is a flow diagram depicting the four phases of the research study. The research is structured as a paper-based manuscript and includes the following:

Chapter 2 presents a critical review of literature pertaining to the baby boomer population and the food industry. Topics include: functional foods, nutraceuticals, natural health products, regulations, food trends, local food industry (Manitoba and Saskatchewan), and characteristics of tomato products.

Chapter 3 presents the pasta sauce development steps and fibre identification.

Chapter 4 presents the sensory evaluation of red lentils concentrations in a pasta sauce and a shelf-life study of the selected pasta sauce formulation.

Chapter 5 presents consumer acceptability of the scaled up pasta sauce of the shelf-life study in Chapter 4.

Chapter 6 provides a general discussion of the research and examines linkages between the four phases.

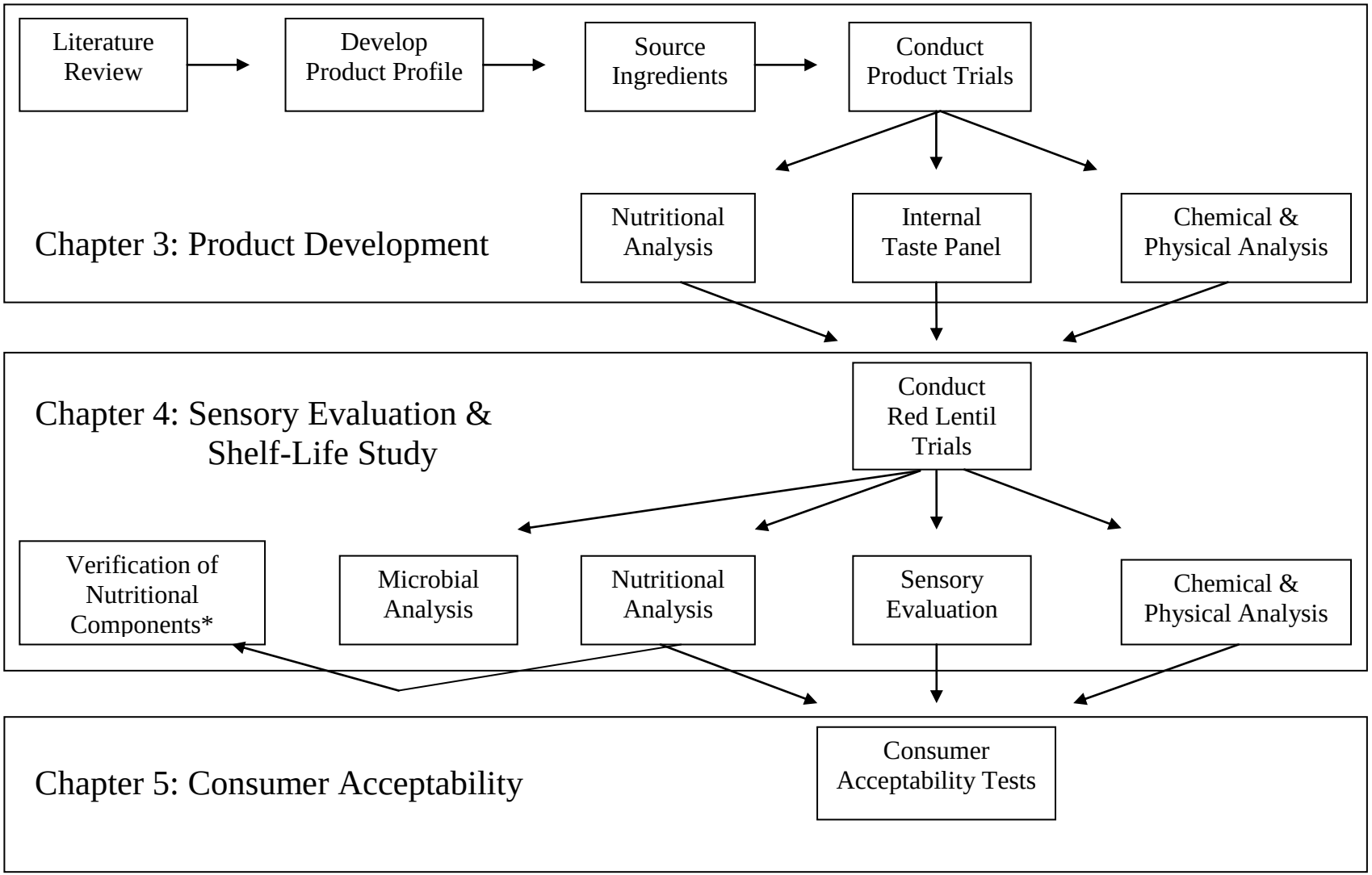


Figure 1.1. Product Development Flow Diagram
*Outsourced Laboratory Testing

CHAPTER 2

LITERATURE REVIEW

Demographics

Baby boomers, individuals born between 1946 and 1965, represent a third of the Canadian population (Statistics Canada, 2006b). Presently, there are 4.2 million older adults (individuals >65 years of age) in Canada and this number is expected to increase to 9.8 million between 2005 and 2036, from 13.2% to 24.5% of the Canadian population. In Manitoba, the older adult population is expected to increase from 13.5% to 19.9% between 2005 and 2026. In 2031 the number of baby boomers, who will be 65 to 74 years of age, is expected to reach 4.8 million representing 12.4% of the Canadian population (Statistics Canada, 2006a).

Market Segmentation

Market segmentation is the process of dividing consumers into groups with similar characteristics such as demographics (Payne-Palacio & Theis, 2005). Target marketing is a strategic marketing tactic to identify a select segment of consumers with specific needs and wants and to develop specific products for that segment (Payne-Palacio & Theis, 2005). Baby boomers are driven, determined, independent, and health conscious individuals. According to a consumer segmentation report, baby boomers are clustered into one predominant segment: the "leading the way" (LTW) segment (The Futures Company, 2009). See Table 2.1 for segmentation comparison. The median age of consumers in the "leading the way" segment is 49 years of age and the annual income is $72,000 (highest of all other segments). Common health behaviours of LTW are taking daily vitamins (74%), exercising 3 days/week (60%), and reading nutritional labels (68%). Their motivators for the

aforementioned behaviours are to feel healthier, to have more energy and to avoid ill-health and heart disease. LTW consumers associate the following characteristics with healthy foods: whole grain, high fibre, trans fat free, low sodium, fresh, heart health and low fat. Major drivers to their food purchasing behaviour are health benefits, taste, price and freshness. The most important characteristic that will influence LTW consumers to purchase a food product is locally grown (55%) and locally produced. (The Futures Company, 2009; Yankelovich Inc., 2008)

Table 2.1. Consumer Segmentation

Segment	%	Description
Leading the Way	*10*	Taking control of their health, value health & wellness, focused on long term health & have the power to keep themselves healthy.
In It For Fun	*21*	Very healthy and work hard to maintain their current weight, enjoy exercise –stress reliever.
Values Independence	*15*	Believe good health should come from within –it just happens, less reliant on traditional medicine as a health partner.
I Need a Plan	*17*	Have turned their health over to health professionals, place great trust in modern medicine, and exercise because doctor told them.
Not Right Now	*23*	Show little interest in health and wellness –because they are young with no health problems.
Get Through the Day	*15*	Are poor in health and feel there is nothing they can do, have chronic health conditions, hoping for new drugs for remedy.

(The Futures Company, 2009; Yankelovich Inc., 2008)

Health and Illness

Murray et al. (2003) explored how baby boomers define health and illness in regards to their own personal responsibility to their health and well being. Baby boomers have defined health through the following six categories:

1. Health as Lifestyle: is not automatic and something that an individual continuously thrives to achieve. Baby boomers also found that lifestyle promoting messages do, to a certain degree, have an effect on their everyday behaviours;
2. Health as Attitude: even though an individual may be suffering from an illness they may still be healthy. However, this does depend on the individual's personal attitudes. If they believe they are healthy, in spite of their health condition, they may feel and perceive to be healthier;
3. Health as Social Engagement: relates to family and community relationships. It is believed that with stronger relationships one will have better overall health;
4. Health as Reserve: some people were just born to be healthy and always feel healthy while others are not as fortunate;
5. Health as Functionality: a major issue for baby boomers. Individuals who continue to have functionality in their lives, are able to do daily activities without struggle or pain, report better overall health. As baby boomers age, many expect to continue having full function regardless of any underlying illness; and
6. Health as a Vacuum: defined by individuals as 'the absence of sickness' or the 'absence of illness'. This may indicate that true health may only be achieved if one is free of any illness or sickness.

Baby boomers characterise illness in three broad categories (Murray et al., 2003):

1. Causes of Illness: pertain to the development of an illness. An individual's lifestyle and self-care have been found to be the primary cause of illness. Baby boomers also felt that nature and modern life stressors were causes of illness.
2. Character of Illness: how an individual deals with the illness after its diagnosis. Many felt that initially an illness was destructive to one's life; a feeling of loss of control. Others felt an ongoing struggle with their illness in overcoming the limitations of their illness and reintegrating into society. Some baby boomers defined that character of illness as a liberator.
3. Prevention of Illness: lifestyle choices may be a cause for illness. Altering an individual's lifestyle may inevitably prevent certain illnesses from occurring. Adopting healthy lifestyle habits could improve their chances of developing an illness. Self-care is also highly recognized as an essential component in disease prevention. It is important to note that self-care and lifestyle can be direct causes of illness as well as direct preventions of illness.

To summarize, baby boomers do recognize that their actions and lifestyle choices influences their overall health. Moreover, they have the ability to manage their own health in order to prevent or manage illness or sickness.

Health Status

It is assumed with the advances in medical technology, numerous programs on health promotion, disease prevention and active living, baby boomers would have better health than older cohorts. However, recent trends indicate that there is an increased incidence of cardiovascular disease, obesity, diabetes and lung disease among baby boomers (Martin et al., 2009). Similar results were reported by Rice et al. (2010), where English baby boomers

reported no improvement in self-rated health, greater numbers of chronic diseases, increased BMI (body mass index) and increased incidents of diabetes, hypertension and mental illnesses. In 2000/2001, there was a 19 % relative increase in the number of baby boomers who report suffering from a chronic illness compared to the same age group in 1978/1979 (Wister, 2005). In 2000/20001 younger baby boomers (35-44 years of age) reported a chronic illness rate of 60.1%, this rose from 46.6% in 1978/1979, a 29% rise (Wister, 2005). Within the same period, older baby boomers (45-54 years of age) reported a chronic illness rate of 66.8% in 2000/2001, compared to 60% in 1978/1979, a slight increase of 11.3% (Wister, 2005). Contradictory research shows that over a 20 year period (1978/1979 – 1998/1999) there was a decline in the prevalence of arthritis, high blood pressure, heart disease, and bronchitis among Canadians aged 45 to 64 (Statistics Canada, 1999). Although the prevalence of these common chronic illnesses has decreased, the prevalence of diabetes has increased within the same period (Statistics Canada, 1999). Diabetes, if not managed properly, may lead to future complications such as heart disease, stroke, kidney problems, eye problems and mobility issues (Statistics Canada, 1999).

Baby boomers thrive to stay young, healthy and active as much and long as possible. On average, 50% of Canadians aged 45 to 64 reported their health as either excellent or very good (Statistics Canada, 2005a). Over 90% of baby boomers in the recent study by Lengyel and Utioh (2009) reported their health as either excellent or good. Adoption of healthy eating habits early in life is known to be a good predictor of health later in life. Unhealthy eating habits during early- and middle-aged years may not have an immediate impact on health but they tend to catch up in later years (Statistics Canada, 2005b). In an eight year study, people who adopted healthy behaviours in early life continued to report good health through older

age (Statistics Canada, 2005c). This further emphasizes that health behaviours, even if adoption is in the middle-aged years may still influence the development of positive outcomes later on in life.

Baby boomers recognize that adopting functional foods into their diets may have beneficial outcomes in later years. When asked what health issues could be improved by their food intake, baby boomers mentioned the following: heart-related diseases (high cholesterol, hypertension), weight, diabetes, osteoporosis, food allergies/intolerances, ulcerative colitis, eyesight, bone and joint problems (Lengyel & Utioh, 2009). Consequently, baby boomers may be more receptive to functional foods targeting these specific chronic illnesses and willing to adopt these foods into their present diet. Unfortunately, research shows that many consumers adopt new eating habits only after a diet-related illness has been diagnosed (Landström et al., 2007). Nonetheless, many do turn to the use of functional foods to improve overall health status.

Baby boomers are not only concerned with developing chronic illnesses, they are also concerned about consuming enough nutrients. Healthy eating and good eating habits are part of a healthy balanced diet. According to Lengyel and Utioh (2009) baby boomers were concerned their diets were lacking in the following nutrients: calcium, vitamin D, vitamin B_{12}, phosphorous, conjugated linoleic acid, fibre, B complex, lutein, vitamin C, omega-3, -6 and -9, antioxidants and iron. Consumption of calcium and vitamin D in older adults has been reported to be below the dietary reference intakes (DRI). Adults between the ages of 51-70 years (men = 908 mg, women = 1063 mg) and >70 years (men = 884 mg, women = 1035 mg; Polliquin et al., 2009) all consumed less than the DRI levels of 1200 mg of calcium (Institute of Medicine, 1997). Adequate consumption of both vitamin D and calcium

throughout life is crucial for bone health but also to prevent osteoporosis in later years. Synthesis of vitamin D within the skin decreases as individual's age, adding to the increased risk of inadequate intake. Baby boomers are also at risk for vitamin B_{12} deficiency as the body has the decreased ability to absorb the vitamin. Results from provincial nutrition surveys conducted in the 1990s indicate that inadequate fibre intake is a nutritional concern for all Canadian adults (18-84 years of age) (Dolega-Cieszkowski, et al., 2006). Reduced consumption of fibre not only negatively affects the digestive system but other systems as well. Adequate intake of fibre has been shown to be beneficial in cardiovascular disease, bowel function, weight control, diabetes, and various cancers (American Dietetic Association, 2008). Fibre is also used in therapeutic diets for those suffering from diverticulitis and irritable bowel syndrome (American Dietetic Association, 2008). For that reason baby boomers may be more willing to consume products with probiotics and high fibre foods (Urala & Lähteenmäki, 2005) to relieve symptoms and /or manage symptoms from the aforementioned disease states. The benefits of consuming foods with high sources of certain antioxidants, such as vitamin C, vitamin E, β-carotene and polyphenols, are well known in reducing oxidative stress (Gallagher, 2004). Increased oxidative stress is related to the development of many chronic illnesses. Common food sources of antioxidants are fruit and vegetables.

On the other hand, respondents were also concerned they were consuming excessive amounts of sodium and fat in their diet (Lengyel & Utioh, 2009). Consumers were more willing to consume products with low-salt and low-fat benefits for general health interests than functional foods (Urala & Lähtennmäki, 2004).

Functional Foods and Nutraceuticals

Health Canada (1998) defines *functional foods* as "similar in appearance to, or may be, a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions". Examples of functional foods are probiotic bacteria added to yogurt, vitamin D and calcium added to yogurt and milk, omega-3 enriched eggs and antioxidants added to juice. Functional foods have functionality which creates a novelty aspect on the food without necessarily changing sensory aspects of the food product itself (Urala & Lähtennmäki, 2004). This indicates that certain foods inherently have functionality without needing to add functionality to them.

Nutraceuticals are defined as "a product isolated or purified from foods which is generally sold in medicinal forms not usually associated with foods and is demonstrated to have physiological benefit or provide protection against chronic illnesses" (Health Canada, 1998). Examples of nutraceuticals are omega-3 fatty acids, conjugated linoleic acid, lycopene, beta-glucan, tannins, flavonones and plant sterols.

The functional food and nutraceutical market is a growing industry in Canada even though it is a young market compared to the United States and Europe. Canadian sales of functional foods reached $2.9 billion in 2004 (Statistics Canada, 2007) and the market is continuously growing. In 2004 there were 9,715 functional foods and nutraceuticals in the Canadian market (Statistics Canada, 2007). The major targeted health aspects of these products were:

- cardiovascular disease (47%)
- diabetes (13%)
- cancer (17%)
- energy (34%)
- mental ability (7%)
- gut health (23%)
- immune system (19%)
- sports performance (11%)
- bone health, (19%)
- eye health (10%)
- weight control (21%)
- general nutrition (57%)

The main sources of functional ingredients within these products were oil seeds, grains and cereals, pulses/legumes, fruits and vegetables (Statistics Canada, 2007). All of these are locally grown in Manitoba.

There is limited research on the functional food perceptions of baby boomers. Of the research that is conducted on functional foods, researchers explored acceptability, knowledge, willingness to try or buy, taste, trust, carrier (i.e., the product that is 'carrying' the said health claim or health benefit), and health claims of functional foods. Research is lacking in the development of functional foods based on nutritional concerns, needs and wants of the population, not only baby boomers.

In Canada, the majority of consumers of functional foods with health promoting and disease prevention characteristics are characterized as being over the age of 55 years, reside in rural areas (Herath et al, 2008) and have a high disposable income[1]. These individuals reported to be most concerned with the following illnesses: arthritis, aging or Alzheimer's

[1] Individuals in rural areas are predominantly older consumers whereas as individuals in urban centres are predominantly younger consumers. As such, older consumers are more interested in consuming functional foods with disease prevention characteristics as compared to younger consumers who are more interested in consuming functional foods with energy enhancing benefits. (Herath et al., 2008)

disease, menopausal symptoms, diabetes, digestion/intestinal health, eye disease/vision deterioration, heart problems, mental performance, prostate cancer, urinary tract infections, osteoporosis, and colon cancer (Herath et al., 2008). Canadians believe that food choices have an impact on the likelihood of eventually developing a chronic illness (West et al, 2002). Canadians are sceptic about genetically modified functional foods (West et al., 2002; Larue et al., 2004) and instead may consume either conventional or organic functional foods. Perceived reward from consuming a functional food was a stronger predictor to willingness to try a functional food in older consumers (Urala & Lähtennmäki, 2005). Factors having most influence on the intention to try a functional food are attractiveness, uniqueness and credibility (van Kleef et al., 2005; Williams et al., 2008). There is ample research to show that consumers have distrust in food companies and thus finding uniqueness of a food product to be less credible (van Kleef et al., 2005).

Functional foods are ideal food products to aid in the prevention of chronic illnesses among the aging Canadian population. Baby boomers want to be more involved in the management of their health. As such, consuming foods with beneficial health-related properties is a step in the right direction. The challenge now is to develop functional foods that baby boomers will want to adopt in their diet to assist in the management of their health.

Natural Health Products

Natural health products (NHPs) are naturally occurring substances, often made from plants but can also be made from animals, microorganisms and marine sources, which are used by consumers to restore or maintain good health (Health Canada, 2010). NHPs are also commonly referred to as ‘complementary’ or ‘alternative’ medicines by consumers (Health Canada, 2010). The definition of NHPs has two components: function and substance. The

function of NHPs refers to its use in 'the diagnosis, treatment, mitigation or prevention of a disease, disorder or abnormal physical state or its symptoms in humans, restoring or correcting organic functions in humans, or modifying organic functions in humans, such as modifying those functions in a manner that maintains or promotes health' (Health Canada, 2003, p.4). The substance component of the NHP definition refers to the medicinal ingredient in a natural health product (Health Canada, 2003, p. 4). Recent research shows that 71% of Canadians use some form of NHPs such as vitamins and minerals, herbal remedies, homeopathic medicines, traditional medicines (i.e., Chinese medicines), probiotics, and other products such as amino acids and essential fatty acids (Health Canada, 2005).

Unlike functional foods and nutraceuticals, NHPs are regulated by Health Canada. Health Canada has developed specific requirements for NHPs with strict regulations for manufacturing, packaging, labelling, storing, importing for sale, distributing and selling NHPs, and clinical trials involving humans (Health Canada, 2003).

Health Claims

Health Canada regulates the use of health claims which can be used on food products. In Canada there are five allowed health claims (Health Canada, 2007b). These health claims and their relationship with disease risks are as follows:

1. A healthy diet low in sodium and high in potassium and reduced risk of high blood pressure;
2. A healthy diet with adequate calcium and vitamin D and reduced risk of osteoporosis;
3. A healthy diet low in saturated and trans fat and reduced risk of heart disease;
4. A healthy diet rich in vegetables and fruits and reduced risk of some types of cancers;

5. Non-fermentable carbohydrates in gums and hard candies and reduction of dental caries.

Clearly, four of the aforementioned health claims have been linked with reduction of four key health concerns of baby boomers; high blood pressure, osteoporosis, heart disease and cancers. As such, for the purpose of this project, a prospective objective may be to attach a health claim to the potentially produced food products.

Canadian Food Inspection Agency

The Canadian Food Inspection Agency (CFIA) is a Canadian government regulatory body who is 'dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy' (CFIA, 2010). It is the CFIA which regulates all food labelling guidelines for food products and their ingredients. The agency provides a list of labelling requirements such as bilingual requirements, common names, list of ingredients, nutritional facts table, and standard container sizes for numerous products (CFIA, 2010). The CFIA provides the guidelines for producing a product with potential nutrient content claims.

Nutrient Content Claims

Nutrient content claims are 'statements or expressions which describe, directly or indirectly, the level of a nutrient in a food or a group of foods' (CFIA, 2010). The following nutrient content claims are a reflection of nutritional concerns of baby boomers (Lengyel & Utioh, 2009): *(Further explanation of the content claims will be discussed in a later section.)*

- Fat Claims
- Saturated Fatty Acid Claims
- Trans Fatty Acid Claims
- Sodium (Salt) Claims
- Dietary Fat Claims

Dietary Fibre Claims –Novel Fibres

Dietary fibres are "the endogenous components of plant material in the diet which are resistant to digestion by enzymes produced by humans" (CFIA, 2010). There are two categories. The first is soluble fibres which dissolve in water. These include gums, mucilages, pectins and some hemicelluloses which can be found in peas and beans such as lentils, splits peas, pinto beans, black beans and garbanzo beans as well as oats, barley and some fruits and vegetables like apples, oranges and carrots. The second category are insoluble fibres with do not dissolve in water. These include cellulose, lignin, and the rest of the hemicelluloses. Examples are whole grains, wheat and corn fibre, many vegetables such as cauliflower, green beans and whole potatoes, the skin of fruits and vegetables and wheat bran (CFIA, 2010; Guo, 2009).

A novel fibre according to the CFIA (2010) is a food that has been manufactured to be a source of dietary fibre, and:

1. has not traditionally been used for human consumption to any significant extent;
2. has been chemically processed (e.g., oxidized) or physically processed (e.g., very finely ground) so as to modify the properties of the fibre;
3. has been highly concentrated from its plant source.

In addition, novel fibres cannot be identified as the primary source of fibre or used to produce a fibre claim if it has not been approved by Health Canada in that food category. Table 2.2 is a summary of sources and acceptability of dietary fibre. The majority of the fibres in Table 2.2 are applied to bakery products, cereals, and bars. A literature review on application of the dietary fibre ingredients in pasta sauces produced no results. Investigation

Table 2.2. Dietary Fibre –Sources and Acceptability

Fibre	Ingredient	Traditional Source	Novel Source	Acceptable
Barley Beta Glucan	Barley meal	✓		Yes
Standard inulin from chicory root	Inulin from Chicory root	✓		Yes
Inulin from Jerusalem artichoke tuber	Inulin from Jerusalem artichoke tuber	✓		Yes
Oat hulls	Oat hull fibre		✓	Yes
Pea Hull Fibres	Ground pea hull fibre		✓	Yes
Whole foods: fruits, vegetables, traditionally-milled cereals	quinoa, legumes, nuts, seeds	✓		Yes

Adapted from CFIA, 2010

into the possible application of the dietary fibres in pasta sauce, such as inulin, whole foods (lentils), pea and oat fibres, warrants further analysis.

Added Sources of Fibre

Possible added sources of fibre to pasta sauce could be Oat Fibre (OF; Canadian Harvest® 300-58), Pea Fibre (PF; Centara®) and Inulin (In; Beneo Orafti® GR). Table 2.3 illustrates the product characteristics of the fibres. Oat fibre is derived from the hull of the oat grain (SunOpta™ Ingredients Group, 2009). Pea fibre are derived from the hull of yellow peas (NutriPea Ltd., 2005). Inulin is derived from chicory but is also found in artichokes, asparagus, leeks, onions and garlic (Beneo Orafti®, 2008). It is important to note that OF and PF are novel fibres and will need special approval from Health Canada. Nonetheless it would be beneficial to investigate the possible inclusion of OF, PF as well as inulin in pasta sauce which may generate future research in all three sources in their applications other than those stated in Table 2.3.

Table 2.3. Product Characteristics of Oat Fibre, Pea Fibre and Inulin

	Oat Fibre	Pea Fibre	Inulin
Reason for application	• Increase fibre • Enhance texture	• Increase fiber • Used for color sensitive applications	• Fat replacement • Carbohydrate replacement • Improve mouthfeel • Increase fiber
Description	• Best for high fibre & low calorie products • Standard all purpose fibre • Light cream fine powder	• White in color • Minor alteration in color, flavor or odor of product	• White, odourless, soluble powder • prebiotic
Fibre content	Total: 90% Soluble: <5%		Total: 92%
Flavour	Bland	Bland	Slightly sweet, no aftertaste
Applications/Uses	Breads, Baked Goods, Fried Products, Meat Products, Pasta, Bars, Dry Beverages	Nutritional Bars, White Breads, Bagels, Tortillas, Pasta, Vegetarian Applications, Cookies and Crackers	Bakery Goods, Meat Products, Dairy Products, Pasta, Fruit Spreads, Cereals

(SunOpta™ Ingredients Group, 2009)
(NutriPea Ltd., 2005)
(Beneo Orafti®, 2008)

Trends in the Food Industry

Baby boomers are looking for foods to promote health and disease prevention. Consequently, food developers need to focus on the consumer's needs to be successful. Baby boomers and older adults, in general, specifically seek out food products with disease prevention benefits rather than energy enhancing benefits (Krystallis et al., 2008). Middle-aged adults (including young baby boomers) tend to seek out food products with the following attributes: "l*ow cholesterol level*", "*contribution to digestion improvement*", "*reduced cardiovascular risk*" and "*low saturated fatty acid content*" (Krystallis et al., 2008).

Functional Food Ingredients

The top functional food ingredients reflect the needs and wants of aging baby boomers. Aging adults find that overall reduced disease risk-framed health claims have the greatest effect on their intention to purchase such products (van Kleef et al., 2005). Table 2.4 is a summary of the functions and concerns of five key functional food ingredients: vitamin K, vitamin D and calcium, fibre and soy (Anthony, 2008).

Table 2.4. Functional Ingredients

Ingredient	Function and Concerns
Vitamin K	Is believed to reduce calcification of the arteries and improve bone mass (Anthony, 2008). Vitamin K's role within the body is blood clotting.
Vitamin D & Calcium	Both are major nutrients of concern for aging baby boomers as well as the older adult population. Vitamin D and calcium are important in bone health throughout life as well as for prevention of osteoporosis in later years. van Kleef et al. (2005) demonstrated that health claims regarding prevention of osteoporosis resulted in high intention to purchase by consumers. Consumers showed highest willingness to purchase functional yogurt with physiological benefits over chocolate with the same benefits (Siegrist et al., 2008). These results may indicate that caution needs to be taken when adding ingredients, such as vitamin D and calcium, to products as consumers regard yogurt as healthy food and chocolate as a luxury food. Allowable fortification of calcium and vitamin D in certain food products (Newmark et al., 2004): • Enriched vegetable products: may contain 500-625 mg Ca/lb and 250-1000 IU vitamin D/lb • Enriched noodle products: may contain 500-625 mg Ca/lb and 250-1000 IU vitamin D/lb Permitted vitamin and mineral claims are as follows (CFIA, 2010): • A source of...: the food provides ≥ 5% of the RDI • A good source of...: the food provides ≥ 15% of the RDI • A very high source of...: the food provides ≥25% of the RDI Weighted recommended nutrient intake (CFIA, 2010; Institute of Medicine, 1997): • Vitamin D 5.0 μg • Calcium 1100 mg
Fibre	Fibre is important for gut health and gut motility in order to prevent many diseases such as gastrointestinal diseases, cardiovascular diseases, weight management and diabetes (American Dietetic Association, 2008) as well as daily inconveniences such as diarrhea and constipation. Adults (19-

Continued ...

	50 year) recommendations are to consume 38 g/day (males) and 25 g/day (females) and older adults (>51 years) recommendations are to consume 30 g/day (males) and 21 g/day (females) (Institute of Medicine, 2002); however, many do not consume nearly enough. Research shows that consumers are familiar with fibre (Arès et al., 2008). Arès et al. (2009) also found that by adding fibre to milk desserts consumers were more willing to purchase the dessert attributing additional healthiness to the product. Permitted fibre claims are as follows (CFIA, 2010): • A source of fibre: 2 g or more of fibre per reference amount • A high source of fibre: 4 g or more of fibre per reference amount • A very high source of fibre: 6 g or more of fibre per reference amount Examples of approved sources of fibre (CFIA, 2010): • Inulin from chicory root • Inulin from Jerusalum artichoke root • Pea hull fibre • Whole foods, fruit & legumes
Soy	Soy is a source of isoflavones; an antioxidant. Arès et al., (2008; 2009) showed that consumers attribute increased healthiness to products with added antioxidants. Consumers are aware of soy as a food product, however many are cautious in adding it to their diet as they are not familiar with its function. Consumers who have the knowledge about the function of soy are highly likely to purchase soy products as well as soy-fortified meats and soy dishes in restaurants (Wansink et al., 2005).

Health and Wellness

Baby boomers are not only looking for specific ingredients to increase overall health and prevent diseases, they are also looking at general well-being and lifestyle changes. Research has shown that women are more health conscious and more likely to purchase functional foods than men (Arès et al, 2009; 2008 & Landström et al., 2007). However, many recent studies show that there is no statistical significance between gender and willingness to purchase (Peng et al., 2006; Siegrist et al., 2008 & Niva, 2006) or attitudes (Urala & Lähteenmäki, 2005; Terattanavat & Hooker, 2006) towards functional foods. Nonetheless, men are now beginning to show increasing interest in preventative health (Shelke, 2008). Henson et al. (2008) examined the propensity of men to use lycopene to offset the risk of prostate cancer. Henson et al. (2008) initially discovered that in order for men to consider using lycopene containing foods there first needs to be predisposing factors. These predisposing factors are as follows: the perceived '*fear*' of the disease, the '*severity*' of prostate cancer and three vulnerability variables: (1) one's own health status, (2) one's relative risk, and (3) one's vulnerability of a close other person (vulnerability due to family history or experience from friends; Henson et al., 2008). Results showed that being over the age of 45 was the single most predictor of propensity to purchase tomato juice with lycopene and the pill form of lycopene but not for a snack food with lycopene. This reinforces that it is not necessarily the ingredient that influences intention to purchase, but rather the carrier (food product which contains the ingredient or which the claim is connected to).

Food companies are looking towards developing products catering to the older population (Shelke, 2008). Developers are realizing that the aging baby boomer population wants familiar foods with added benefits that taste the same (Messina et al. (2008).

Increased familiarity with foods and ingredients may increase willingness to try and purchase functional foods (Arès et al., 2008). Baby boomers want foods with preventative health benefits and specifically look for these types of food products when grocery shopping. Verbeke (2006) has reported that 23.3% of adults greater than 50 years are willing to compromise taste for the benefits of functional foods, however, it is not conclusive to generalize these findings to all individuals. Overall, individuals are not willing to compromise taste for health and that 'good taste and healthiness are not necessarily to be traded-off against each other' (Verbeke, 2006, p.130). Finally, consumers are becoming more adamant about eco-friendly packaging, farming and manufacturing practices (Shelke, 2008).

Consumer Needs

In the end, it is the consumer's demand that will drive product development. Consumer control tops the charts in food purchasing (Toops, 2009). Consumers know what they want and they know how to show it. We can only assume that baby boomers will choose food products based on their health concerns. Consumers are more willing to purchase foods whose health claims relate to a personal relevant illness as it makes them more attractive and convincing than health claims which have no relevance (van Kleef et al., 2005). As a result, food developers may need to cater to consumer demands to prosper and profit. Food developers may need to segment the population for similar health and nutrition attitudes which would allow them to target specific products to each segment (Arès et al., 2008). Another emerging trend among consumers is the need for simplicity and purity in food products (Toops, 2009). Consumers continue to demand convenience and strategies to make home cooked meals as quick and easy as possible. Moreover, consumers also want complete transparency with the products they purchase. Krystallis et al. (2008) found that consumers

placed high importance on information regarding quality-related attributes such as the product being "*pure*", "*safe*", "*healthy*", and of high "*quality*". Moreover, consumers also placed high importance on information regarding attributes such as the "*best before*" and "*packaging*" dates, and the type of "*health/functionality claims*", "*quality assurance*" and "*nutritional value*" (Krystallis et al., 2008).

A major concern for many consumers regarding the food industry as a whole is trust (Toops, 2009). Today's consumers have high levels of distrust in food companies. Research has shown that consumer's trust greatly affect willingness to purchase foods (Siegrist et al., 2008). Consumers do not trust product and ingredient information provided by food companies (Urala & Lähteenmäki, 2004). In general, women have demonstrated complete distrust in manufacturers' products, labels and information on packaging, supermarkets' brochures, farmers and farming organisations, and manufacturers' ads (Korzen-Bohr & Jensen, 2006). As a result, food companies must now rebuild this trust to regain consumer loyalty. Finally, financial circumstances are also a forefront in consumer's willingness to purchase food products (Toops, 2009). In the present economy, consumers are more financially conscious and aware of their spending habits. Although baby boomers have the highest disposable income, caution may need to be taken in this economic downturn. When it comes to purchasing functional foods many consumers are not as reluctant to 'splurge'. As baby boomers near retirement, many anticipate purchasing fewer luxuries in order to purchase more fresh produce and less convenience foods; making meals from scratch and possibly grow a garden (Hunter & Worsley, 2009). Even more, baby boomers indicated they would need to decrease the quantity of groceries or buying in bulk when on sale and decrease their portion sizes (Hunter & Worsley, 2009). Overall, it is those individuals with higher

incomes and higher education levels who are more likely to purchase functional foods (Niva & Mäkelä, 2007; Terattanavat & Hooker, 2006).

Consumers are beginning to purchase food products to prevent chronic illnesses, improve overall well-being, improve active living, and for general health interest. Food companies realize that the aging baby boomer population is an under-marketed segment of the population and more research and product development will need to be done to better cater to their specific needs.

Manitoba Grown Crops

Vegetable Market

Manitoba has a small vegetable market but is technologically advanced in vegetable storage (Peak of the Market, 2010). In spite of this, it is widely renowned on account of businesses such as Peak of the Market (a grower-owned 'not for profit' vegetable supplier) and McCain Foods (potato production). In view of our geographical location, vegetable production is limited in growing selected year-round vegetables. However, with improved storage facilities, vegetable production has improved drastically over the past decade in Manitoba. Peak of the Market produces the following elective vegetables for pasta sauce formulation: carrots, green peppers, onions, and summer squash (zucchini; Peak of the Market, 2010).

Canola Industry

Canola is an integral crop to the province of Manitoba. In 2008 alone, Manitoba farmers seeded 3.1 million acres of canola which equals to 113.6 million bushels producing 20% of Canada's total canola crop production (Government of Manitoba, 2010b). The economic benefit of the production of canola is estimated to be $2.3 billion in Manitoba

alone (Canola Council of Canada, 2010a). Canola oil is also processed locally in Manitoba; there are three local processing plants (Bunge Ltd, Viterra and Pacific Coast Canola). Canola oil is known for its balanced lipid profile compared to other oils. It is the lowest in saturated fat, contains a good ratio of omega-6 to omega-3, it is high in monounsaturated fat, and free of cholesterol and trans-fat (Canola Council of Canada, 2010b). Canola oil is a functional oil with applications in baking, frying, deep-frying, and cooking and it is used to produce shortenings, margarines and salad oils (Canola Council of Canada, 2010c).

Pulse Industry

Canada is a world leader in pulse production accounting for 35% of pulse trade in the world (Pulse Canada, 2010c). Within the last 20 years pulse productions has increased fivefold from one million tonnes in the early 1990s to 5.6 million tonnes in 2009 (Pulse Canada, 2010c). Manitoba produces white and coloured beans, in addition to peas and lentils (Pulse Canada, 2010d). Pulses, the seed of legumes, include dry beans, dry peas, lentils and chickpeas. Pulses are staple foods in vegetarian diets, the Americas, (not including Canada and the United States) and in the Middle East. Pulses are very nutritious and are a source of complex carbohydrates, dietary fibre, protein (incomplete source), vitamins and minerals (folate, potassium and iron), minimal fat, mostly mono- and poly-unsaturated fats (Wang & Daun, 2004) and no saturated fat or cholesterol (1 g/ 100 g dry red lentils) (Pulse Canada, 2010b; Pulse Canada, 2010e). Research shows a link between pulse consumption and the prevention of chronic diseases. Health benefits identified in clinical trials were cardiovascular health, weight management, diabetes, and gut health (Pulse Canada, 2010e). Applications of pulses include soups, stews, baking goods, casseroles, salads, dips and many more.

Red lentil production in Manitoba is not as predominant, nonetheless, their functionality and application are noteworthy. The province of Saskatchewan produces 95% of the lentils (green and red) in Canada (AAFC, 2010). Production of red lentils increased to about 60% of the lentil area seeded up from 32% seeded in 2007 (AAFC, 2007). Red lentils cook quickly with no soaking needed and are readily used in soups and tomato sauces (Pulse Canada, 2010a). Application of red lentils in commercial pasta sauces has not been identified however potential for application is worth investigating. A review on pasta sauce recipes generated a small number of recipes containing red lentils in the formulation.

Grain Industry

Manitoba is a major producer of grains in Canada and worldwide. Manitoba produces 15% of Canada's wheat production, one quarter of the oats production and 10% of the barley production (Government of Manitoba, 2010a). Located at the center of the grain trade industry, Manitoba is the headquarters for major grain companies such as James Richardson and Sons, Cargill Limited, the Canadian Wheat Board and the location of ICE Futures Canada (Government of Manitoba, 2010a). Areas of nutritional interest in the grains industry are oat and barley and their beta-glucans. Beta-glucans have been linked to reducing cholesterol, blood glucose and insulin levels (Wood, 2010). Common applications of grain products are baked goods, pasta and cereal bars.

Potential Food Products

The development of food products for the study was based on the focus group discussions conducted in Phase I. According to responses, baby boomers presently consume soy milk, fortified orange juice, spinach, fish and their bones, yogurt, supplements/multivitamins, more fruits and vegetables, whole grains, cereals and pasta, bran

and granola, ground flax, oat bran, and almonds to increase their daily nutrient intake (Lengyel & Utioh, 2009). Baby boomers are aware of some benefits from functional foods and try to incorporate them into their daily diets. However, most are sceptic about the credibility (van Kleef et al., 2005) of these products and would rather see more locally produced functional foods (Lengyel & Utioh, 2009) in order to put a familiar face to the food product (Arès et al., 2008; Messina et al., 2008). Moreover, the respondents noted that they would consider purchasing cereal (breakfast food), fish, flax, and consume more fruits and vegetables to increase nutrient intake (Lengyel & Utioh, 2009).

Respondents also expressed concern over the kind of products they were presently consuming. Suggestions were made on how products may be improved to better suit their needs. These improvements are portion control, individual servings, foods higher in fibre, less processed foods, locally produced foods, better food labelling system, and healthy convenient food choices (Lengyel & Utioh, 2009). Key nutritional features of the food prototypes were to decrease sodium and fat and increase fibre, probiotics/prebiotics, and vitamins and minerals. In regards to packaging, key features were easy to open and use, portion sizes and portion control. Convenience, fast and easy to prepare, and familiarity and nostalgia were other important features to keep in mind when developing functional foods for the aging baby boomer population (Lengyel & Utioh, 2009).

Food Products

Four food product concepts were generated from the respondents' comments with the help of food development consultants at the Food Development Centre, Portage la Prairie, Manitoba. The four food products were: beverage shot, pasta sauce, functional pasta, and cookie dough. For the purpose of this project, the focus will be on the development of one

food product; the pasta sauce. The other three products were also developed as separate projects but not covered in this report. Pasta sauce is a product which is widely consumed not only by baby boomers, but all age groups. The pasta sauce is a product which contains many nutritious vegetables, some of which are locally produced in Manitoba and the neighbouring province of Saskatchewan.

Characteristics of Tomato Products

Tomato products are widely consumed food products. Pasta sauce is by definition characterized as 'value-added tomato-based pasta sauces, including seasoning and/or meat' (p. 30, Food For Thought, 2010). In Canada, the estimated total sale for pasta sauces in 2008 was $273 million and this is expected to increase annually to an estimated $326.4 million in 2011. The pasta sauce market share is growing from 6.7 % in 2003 to an estimated 11.6% in 2011 (Food for Thought, 2010, p. 30). The top nine food companies in 2010 to hold total market shares by value in Canada are illustrated in Table 2.5. Brand name pasta sauces make up 85% of the total market shares and the distributors' own label only 15% of total market shares. There are no unbranded pasta sauces and no artisanal pasta sauces sold on the Canadian market. (Food For Thought, 2010)

There is a wide range of pasta sauces found on grocery store shelves. The majority are name brands or store brands, a smaller number are private companies, however none are locally produced in Manitoba. There are also countless varieties promoting chunkiness, various flavour attributes, some are marketed as more nutritious than others however there are very few.

Table 2.5. Pasta Sauce Companies

Holding Company	Key Subsidiary	Major Brands	% Share
1. Heinz	Heinz	Bravo, Catelli, Classico	31.0
2. Unilever	Unilever	Five Brothers, Lipton Ragu	15.0
3. Mars	Effem	Uncle Ben's	13.5
4. Pastene	Pastene	Pastene	12.2
5. Imperial Capital	E.D. Smith	E. D. Smith	7.5
6. ConAgra	Hunt Wesson	Gourmet Mediterranea, Hunt's	6.5
7. Maple Leaf	Olivieri Foods	Olivieri Foods	5.7
8. Ebro Puleva	New World Pasta	Ronzoni, Saclá	5.0
9. International Gourmet	International Gourmet	Internaltional Gourmet	2.0

(Food For Thought, 2010, p. 31-32)

Pasta Sauces on Manitoba Grocery Store Shelves

In order to have a comprehensive overview of pasta sauces on grocery store shelves Table 2.6 lists the sampled pasta sauces. Table 2.7 provides an overview of ingredients from the sampled commercial pasta sauces from grocery stores in Manitoba. All of the sampled pasta sauces (A, B, D, E, F, and K) follow a general base formulation with minor modification with the exception of product C which is marketed as a healthier choice and contains additional modifiers such as soy lecithin, flavour, tomato fibre, glucose-fructose, and corn syrup.

Table 2.6. Legend of Commercial Pasta Sauces

Code	Name of Pasta Sauce	Holding Company
A	Catelli® Garden Select diced tomatoes & basil - thick & chunky	Heinz®
B	Eating Right® Tomato Basil Pasta Sauce	Lucerne® Foods
C	Healthy Choice® Traditional Pasta Sauce	ConAgra Foods®
D	Ragu® Original Mushroom	Unilever
E	Safeway Select™ Verdi Marinara Pasta Sauce	Safeway™
F	Newman's Own® Marinara Pasta Sauce	Newman's Own®
K	President's Choice® Tomato Basil	Loblaw's®

Table 2.7. Commercial Pasta Sauce Ingredient Profiles

Product	Tomato[a]	Tomato Puree[b]	Tomato Paste[b]	Oil	Water	Salt	Garlic	Vegetables[g]	Spices[h]	Modifiers	Other
A	√	√		Soybean	√	√	√[d]	carrots, celery, dehydrated onions, green peppers	basil, parsley, spices	sugar, citric acid, calcium chloride	
B	√		√	Olive, Fish	√	√	√[d]	dehydrated onions	basil, spices	Vinegar	
C		√				√	√[e]	dehydrated onions, tomato fibre	spices, parsley	sugar, glucose-fructose, corn syrup, flavour, soy lecithin	
D	√		√	Soybean	√	√		dried vegetables (mushrooms, onions)	spices, parsley	sugar, modified corn starch, citric acid, sulphites	
E	√		√	Soybean, Olive	√	√	√[d]	dehydrated onions, celery, mushroom	spices	sugar, vinegar	red wine, romano cheese
F	√		√	Soybean, Olive	√	√	√[f]	dried onions	spices	Sugar	
K	√		√	Olive	√	√[c]	√[g]	Onions	basil, spices	citric acid	

[a] Not identified as canned or fresh.
[b] Canned Products
[c] Sea Salt
[d] Dehydrated garlic
[e] Garlic Powder
[f] Dried garlic
[g] Not identified as fresh or dehydrated unless stated otherwise.
[h] Basil and spices not identified as fresh or dehydrated.

Table 2.8 outlines the key nutritional points of the same sampled commercial pasta sauces found on Manitoba grocery store shelves. Recommendations for fat intake are to consume no more than 2-3 tablespoons of unsaturated fats including a balanced ratio of omega-6 to omega-3, to saturated fat, trans fat and cholesterol (Health Canada, 2007a). According to a new sodium policy, supported by many health organizations, the goal is to limit daily consumption of sodium to less than 2300 mg by 2020 (Hypertension Canada, 2010). The average Canadian consumes 3500 mg of sodium per day which increases their risks of death from strokes, coronary heart disease, and hypertension. To illustrate, there is 500 mg of sodium in just 1.25 g of salt or in one teaspoon of salt there are 2300 mg of sodium, the daily maximum intake (Hypertension Canada, 2010). Ideal intake for consumers is between 1200–1500 mg of sodium per day (Heart & Stroke Foundation, 2011). Consumers are encouraged to choose foods with a % Daily Value (DV) of 5% or less of sodium and to avoid or limit foods with a % DV of 20% and higher as these are considered high in sodium (Heart & Stroke Foundation, 2011). Finally, none of the pasta sauces are either 'high sources' or 'very high sources' of fibre. All the pasta sauces provide less than 3 g of fibre per serving. Health Canada recommends males to consume 38 g of fibre per day and for women to consume 25 g of fibre per day (Health Canada, 2006).

Table 2.8. Commercial Pasta Sauce Nutritional Profiles[1]

	Guidelines		A	B	C	D	E	F	K
Calories	-	-	70	50	60	50	60	70	60
Fat (g)	low in fat	<3	1	1.5	0	0.5	2	2	1.5
Saturated (g)	free of saturated fat	<0.2	0.2	0.5	0	0	0.4	0	0.3
Trans (g)	free of trans fat	<0.2	0	0	0	0	0	0	0
Polyunsaturated	-	-		√					
Monounsaturated	-	-		√					
Sodium (mg)[2]			330	430	400	670	630	510	250
Potassium (mg)									440
Fibre (g)	source of fibre	>2	3	2	3	2	2	1	3
	high source	>4							
	very high source	>6							

(CFIA, 2010)

[1] per serving size of 125 ml (CFIA, 2010)

[2] Sodium guidelines on the Nutritional Facts Table: no salt (<5 mg), low in sodium (<140 mg) per serving.

Research on Tomato Products/Pasta Sauces

Research on pasta sauce development and the food industry is extremely limited and not easily accessible. The majority of reports and documents related to pasta sauce development are patented and thus not available. There are no explicit Canadian or American governmental regulations for pasta sauces. According to an American Commodity Report for canned vegetables, meatless spaghetti sauces should have a 'bright, typical red-orange tomato color', and 'the ingredients may include water, tomato product, sugar, olive oil, corn oil, soybean and/or cottonseed oil, onion powder, citric acid, natural flavouring, starches, and other ingredients' (p. 12-13, USDA, 2009). Note that these specifications are for canned meatless spaghetti sauces only and not jarred. Other USDA reports on tomato products include grading manual for tomato sauces (USDA, 1994), standards for grades of canned tomatoes (USDA, 1990), standards for grades of canned tomato paste (USDA, 1977), standards for grades of canned tomato puree (USDA, 1978) and standards for grades of tomato catsup (USDA, 1992). As a result, a review of pasta sauce recipes was undertaken in order to evaluate various formulations.

Nearly all research articles found focused on tomatoes (fresh or canned), tomato sauces/purées, ketchup (catsup), tomato paste and tomato juice and touched on topics such as flavour characteristics (Hongsoongnern & Chambers, 2008), color (Intelmann et al., 2005), viscosity (Kaur et al., 2007), other chemical, physical, rheological and sensory attributes (Apaiah et al., 2001; Krebbers et al., 2003; Jiménez et al., 1989) and storage/shelf life studies (Landy et al., 2002; Min et al., 2003). The few articles on pasta sauces investigated color (Claybon & Barringer, 2002a), viscosity (Claybon & Barringer,

2002b), comparison of flavonoids, carotenoids and vitamin C content (Koh et al., 2008), a shelf-life study (Armstrong and McIlveen, 2000) and flavour profiling (Hongsoongneri & Chambers, 2008; Moskowitz, 1996; Chambers et al., 2004).

Sensory Characteristics

Color

One of the key descriptors in the quality of tomato products is color. The red color of a tomato is due to the presence of lycopene, a carotenoid, which also makes up a large portion of the carotenoid content of a tomato (>90 %) with the highest concentration found in the skin (Shi & Le Maguer, 2000). Lycopene is an antioxidant and has been linked to the prevention of cardiovascular diseases, osteoporosis and cancers such as prostate, breast, ovarian and cervical (Rao & Rao, 2007). As a result of this association, levels of lycopene are commonly tested in tomato and tomato products. The average lycopene content found in raw tomatoes is 4.7 mg/100 g (Krebbers et al., 2003) however higher concentrations of 12 mg/100 g (Alda et al., 2009) have also been reported. Lycopene has been shown to be safe for consumption at intake levels up to 36 mg/day (USDHHS, 2009a). In supplements, for lycopene to be effective, supplementation needs to be over 15 mg (USDHHS, 2009b). Moreover, the Food and Drug Administration (FDA) limits the amount of lycopene added to foods or for medical use to not exceed 3 mg per 100 kilocalorie or no more than 36 mg per day (USDHHS, 2010). Nonetheless, the FDA only approved a qualified health claim for cancer risk for tomatoes and/or tomato sauce and prostate, ovarian, gastric, and pancreatic cancers as there was not sufficient research linking lycopene and the aforementioned cancers (FDA, 2011). A qualified health claim is a ‘claim authorized by the US FDA that must be supported by

credible scientific evidence regarding a relationship between a substance (specific food or food component) and a disease or health-related condition'(emedicinehealth,2011).

In commercial pasta sauces the amount of lycopene reported ranges from 4.3–13.17 mg/100 g (Koh et al., 2008) to a higher amount of 16 mg/100 g in commercial pasta sauces (Alda et al., 2009). According to the USDA, carotenoid database the average lycopene content of raw tomatoes and pasta sauce are 3.02 mg/100 g and 15.99 mg/100 g, respectively (USDA, 1998). Lycopene content in tomato products may vary depending on the variety, growing conditions and stage of ripeness of the tomato. There are conflicting reports on the effect of heat/processing treatment on lycopene in tomato products. Literature suggests that heat processing increases the bioavailability of lycopene, which is increased even more when the tomato product is processed with oil (Dewanto et al., 2002; Kaur et al.,2007; Shi & Le Maguer, 2000). Research also illustrates ranges of lycopene content of tomato products processed using various heat treatments. Table 2.9 is a summary of lycopene content of tomato and tomato products. Reports indicate increase in lycopene content through thermal processing (Dewanto et al., 2002) however levels of lycopene content vary by thermal treatment (Yildiz & Baysal, 2007; Apaiah et al., 2001). This indicates that there may be more promising heat treatments (e.g., electroplasmolysis) for processing tomato products in the food industry however current practices (e.g.,. pasteurization) continue to be just as effective in maintaining favourable lycopene content.

Table 2.9. Lycopene Content of Tomato Products

Researcher	Heat Treatment	Lycopene Content in mg/100 g
Yildiz & Baysal, 2007	Injection of Steam	18.6
Tomato Purée	Electroplasmolysis	18.69
	Steam & Electroplasmolysis	27.39
Kaur et al., 2007	Control	5
Tomato Juice	Different Processed Juices	4.46 - 5.06
Apaiah et al., 2001	Commercial Fresh Pack	26.9
Tomato Sauce	Commercial Remanufactured	24.5
	Laboratory Fresh Pack 1	22.2
	Laboratory Fresh Pack 2	22.3
	Laboratory Remanufactured 1	24.7
	Laboratory Remanufactured 2	21.8
Alda et al., 2009	Fresh Tomatoes	12
	Commercial Tomato Paste	16
	Commercial Tomato Sauce	4
	Commercial Tomato Ketchup	17
	Commercial Spaghetti Sauce	16
Koh et al., 2008	Commercial Pasta Sauces *average*	4.3 – 13.17
	Organic Commercial Pasta Sauces	4.3 – 11.72
	Conventional Commercial Pasta Sauces	6.14 – 13.17
Akanbi & Oludemi, 2004	Whole Fresh Roma VF	5.59
Tomato	Pulp Roma VF	5.85
	Whole Fresh Ib. Local tomato cultivar	4.76
	Pulp Ib. Local tomato cultivar	4.59
Sánchez-Moreno et al.,	Raw	9.93
2006	High-Pressure	14.76
Tomato Purée	Low Pasteurisation	8.62
	High Pasteurisation	9.47
	Freezing	7.95
	High Pasteurisation + Freezing	8.21

Color is also the primary identifier in the ripeness of tomatoes. The color spectrum of tomatoes goes from green, orange-red, to red. The stage of ripeness (Wahem, 1988) and the color of raw tomatoes (Barrett & Anthon, 2008) used in canned tomato products may have an impact on the end product. According to Wahem (1988), firm tomatoes were found to be superior in flavour, texture and overall quality, but inferior in color resulting in improved canned tomato product quality compared to soft tomatoes. Thus, a firm tomato, orange-red in color appears to produce overall better products than a riper, soft tomato with a deep-red color (Wahem, 1988). Color of tomato and tomato products is commonly measured using the Hunter scale L*, a*, and b*. The USDA has developed formulas in order to provide scores, based on the color scales, to compare tomato quality with tomato color. The formulas were established to 'correlate visual scoring of tomato product quality to instrumental color measurements' (Barrett & Anthon, 2008, p. 133). Formulas were developed for tomato paste and puree (TPS), tomato sauce (TSS), tomato catsup (TCS) and tomato juice (TJS) (Barrett & Anthon, 2008), but not for pasta sauce. Results are often calculated to measure color intensity, chroma (C) = $\sqrt{(a)^2 + (b)^2}$, color appreciation = (b* x L*)/a* and hue angle (h) = arctangent of b*/a* x 57.296. "The lower the hue angle, the redder the tomato sauce (product), while the higher the hue angle, the more yellow the tomato sauce (product)" (Apaiah & Barringer, 2001, p. 241). Table 2.10 is a summary of color measurements of tomato and tomato products. Only one research article reported color analysis (hue angle) of commercial and prototypical pasta sauces followed by consumer acceptability of the color. Results indicated that prototypical (Caucasian) consumers showed the widest range of color acceptability, 20.9–35.8, wherein the commercial pasta sauces available ranged

from 29.8–32.7 (Claybon & Barringer, 2002a). Thus, consumers appear to have a greater range of color acceptability for pasta sauces than what is commercially available. This may indicate, according to Claybon and Barringer (2002a), that consumers have a 'wide range of expectations' of pasta sauces as they are easy to make at home and widely available at restaurants (p. 494). Consumers found sauces (including pasta sauces) that were too red or too brown as unacceptable; it is the middle range of the two that is preferred by consumers. Consumers are accepting of pasta sauces that are reddish-brown, orange-red and bright red. Ultimately, for pasta sauces, it may be the overall eating experience that influences the color acceptability for consumers.

Table 2.10. Color Analysis of Tomato Products

Researcher	Tomato Product	L*	a*	b*	C	h
Krebber et al., 2003	Raw Tomato Purée	42.1 ± 1.4	9.0 ± 1.2	8.3 ± 1.2	12.3	-
Claybon & Barringer, 2002a	Barbecue Sauce	-	-	-	-	28.5 – 40.9
	Tomato Sauce	-	-	-	-	26.5 – 32.1
	Spaghetti Sauce	-	-	-	-	29.8 – 32.7
	Pizza Sauce	-	-	-	-	29.7 – 31.8
	Ketchup	-	-	-	-	26.3 – 29.3
	Salsa	-	-	-	-	30.4 – 38.4
Intelmann et al., 2005	Catsup	30.7 – 35.8	-	-	18.7 – 30.1	32.0 – 39.0
Yildiz & Baysal, 2007	Raw Tomato Purée	34.77	17.48	8.68	-	-
	Tomato Purée by Steam Injection	35.47	22.50	13.31	-	30.75
	Tomato Purée by Steam Injection and Electroplasmolysis	35.45	22.19	12.96	-	30.32
	Tomato Purée by Electroplasmolysis	34.68	23.52	11.73	-	26.48
Apaiah et al., 2001	Commercial Fresh Pack Tomato Sauce	30.16	16.44	8.34	-	26.98
	Remanufactured Tomato Sauce	29.59	15.78	7.87	-	26.49

Sensory Profile

Sensory profile is another key component of tomatoes and tomato products. Unlike product development and color, research on pasta sauce sensory profiling generated favourable outcomes. Sensory characteristics are dependent on the purpose and objectives of the study and thus not all attributes mentioned in Table 2.11 are beneficial for all studies. Nonetheless, recurrent sensory attributes are viscosity, texture, and flavour (tomato, spices, sweet and salty). Identification of the attributes in Table 2.11 (excluding Rapp et al., 2007) was generated from expert sensory panellists. The methodology for measuring the attributes was either the 15-point intensity scale (Hongsoongnern & Chambers, 2008; Chambers et al., 2004) or an anchored 9-point scale (Moskowitz, 1996). Methods to measure sensory attributes are dependent on the purpose of the study; however intensity scales are the preferred tool in attribute description. Attribute names and degree of specificity vary moderately by study. Again, this may be due to the purpose of the study or panellist consensus. Hongsoongnern & Chambers (2008) discussed inclusion criteria for certain attributes indicating that further to panellists discussion certain attributes were not included if they were not integral to 'tomato' flavour but rather to tomato products in a specific container. Moreover, attributes to describe tomato flavour such as '*tomato*', '*fresh tomato*', '*cooked tomato*', '*cooked*' and '*tomato ID*' varied by study. Identification of tomato flavour attributes is specific to tomatoes products and specific to panellists' consensus. Likewise, Hongsoongnern & Chambers' (2008) lexicon for fresh and processed tomatoes focused solely on tomato flavour and not other flavour complexes within the product. Whereas Chambers et al. (2004) and Moskowitz (2006)

identified attributes for all flavour complexes within the pasta sauce (tomato, oil, herbs/spices, vegetables and aftertaste).

The effect of training on panellists' performance with descriptive scales for pasta sauces identified that with short-term training (4 hours) panellists were able to observe texture and some flavour attributes. As training increased to 60 hours and 120 hours panellists' ability to differentiate between products attributes increased. Thus, short-term training appears to be adequate in order to discriminate between products where general attributes are required. Increased training (up to 120 hours) is suggested for description of more complex attributes such as the complete flavour profile and viscosity (Hongsoongnern & Chambers, 2008). In a study of consumer acceptability of viscosity of pasta sauce, Claybon & Barringer (2002b) detected that consumers were not able to differentiate between slight differences in viscosity only marked differences. What is more, consumers preferred pasta sauces that were thicker than what is commercially available. Claybon & Barringer (2002b) speculate that this is so because consumers may want a thicker pasta sauce that will adhere to the pasta whereas a thinner pasta sauce may not. They recommend that manufacturers invest in producing thicker pasta sauces as the additional cost of doing so may be worthwhile as it is what consumers prefer.

Research on the addition of fibre to pasta sauce or tomato products was not available or did not seem to exist. One article on the addition of soy protein in tomato sauce was located. Thakur et al. (1996) measured the effect of added soy protein to the quality of tomato sauce at 0.25-3.00% concentrations. The study showed that soy protein at concentration between 0.25 and 1.00% exhibited increased consistency, reduced serum separation and enhanced nutritional value. Sensory analysis revealed that the sauce was

Table 2.11. Flavour Profile of Tomatoes and Tomato Products

Researcher	Product	Flavour Attributes
Chambers et al., 2004	3 Pasta Sauces: Marinara Sauce Three Cheese Pasta Sauce Roasted Garlic and Onion Pasta Sauce	Viscosity, pulp amount, residual oily mouthcoat, cooked tomato, fresh tomato, cheese complex, herb complex, basil, oregano, onion/garlic, sweet, salty, sour, bitter and overall aftertaste
Moskowitz, 1996	Various sauces/gravies to put on pasta	*Appearance:* Flecks, amount of tomato pieces, size of tomato pieces, size of vegetable pieces & brown *Flavour:* Sour, black pepper, aftertaste, flavour, green pepper, tomato, onion, mushroom, garlic, aroma, meat, sweet, oily, vegetable, salty, & cheese *Texture:* Crispy vegetable, thickness, & oily mouthfeel
Rapp et al., 2007	Tomato sauce – restaurant style	*Aroma & Flavour:* Tomato, garlic, & butter Taste: Acidulous *Texture:* Viscosity
Hongsoongneri & Chambers, 2008	40 tomato products: Raw, canned, concentrated & dried ketchup, simple pasta sauce, etc...	*Aroma (5 attributes):* Tomato ID, browned, cardboard, decaying vegetation, & green-viney *Texture (8 attributes):* Fiber awareness, juiciness, mealiness, pulp amount, skin awareness, seed awareness, thickness, & viscosity *Flavour (10 attributes):* Tomato ID, browned, cardboard, fermented, fruity, green-viney, musty/earthy, ripeness, cooked, & umami *Basic Tastes (6 attributes):* Bitter, chemical, overall sweet, salty, sour, & sweet *Mouthfeel (3 attributes):* Astringent, chemical, & metallic

acceptable (color, flavour, texture and overall acceptability) up to concentrations of 1.00%. With increased soy protein concentration acceptability decreased as the sauce became lighter in colour –values 'L' (lightness) and 'b' (yellowness) increases where as value 'a' (redness) decreased. Possible similar outcomes may occur with the addition of sources of fibre to pasta sauce, although the product matrix is much more complex than tomato sauce.

Shelf-Life Study

Shelf-life studies are carried out in order to identify changes in a food product over a period of time. Changes may occur in sensory, microbiological, chemical or physical characteristics as a result of added fibre. Research shows that lycopene, pH, °Brix and viscosity do not change over time for both commercial scaled pulsed electric field (PEF) processing and thermal processing of tomato juice stored at 4 ◦C for 112 days (Min et al., 2003). Similar results were found by García-Alonso et al. (2009) where overall lycopene, total phenolic and flanonoids remained stable during storage for 12 months regardless of storage temperature (8, 22 and 37 °C) and packaging material (glass jar and Tetra pack).

Sensory changes during storage vary among tomato products. Armstrong and McIlveen (2000) measured the effect of prolonged storage on sous vide meat-based pasta sauces for 40 days stored at 1.5 °C. Results indicated no significant differences perceived by a trained panel for the meat-based pasta sauce over the 40 day period. Color of the meat-based pasta sauce was acceptable to panellists until day 20. Thereafter the pasta sauce became bright red, less viscous with increased clumping of meat particles however the product was still moderately acceptable. Conversely, Min et al. (2003) identified

significant sensory differences between thermal processing and PEF treatments of tomato juice over 112 days. Overall acceptability indicated that panellists preferred PEF tomato juice over thermally processed tomato juice as it had a fresher tomato flavour. The author insinuates this may be a result of higher lipoxygenase activity in PEF tomato juice which forms 'hexanal, cis-3-hexenal, trans-2-hexenal, hexanol, trans-2-hexenol, and cis-3-hexenol, that are responsible for the fresh flavour of tomato juice' (p. 3343). Similar findings were reported in storage of tomato sauce made from tomato paste or canned tomatoes stored at 25 °C for 18 months and 40 °C for 16 weeks (Landy et al., 2002). Sensory changes occurred at both temperatures but at different time points however similar results ensued. Landy et al. (2002) attributed the sensory changes of the tomato sauces to key odorants (acetaldehyde, methylpropanal, 3-methylbutanal, oct-1-en-3-one, 3-methylbutanoic acid, deca-2,4-dienal, 2-methoxyphenol, and *â*-damascenone). Results indicate that storage changes in tomato products may be associated to processing techniques, specific ingredients, or biological changes.

CHAPTER 3

DEVELOPMENT OF A PASTA SAUCE WITH ADDED HEALTH BENEFITS MADE WITH LOCALLY GROWN PRODUCTS FOR BABY BOOMERS

Introduction

Baby boomers, individuals born between 1946 and 1965, represent a third of the Canadian population (Statistics Canada, 2006b). Due to the aging baby boomer population, there will be an expected increase in the older adults' (individuals > 65 years of age) population in the years to come. In 2031 the number of baby boomers, who will be 65 to 74 years of age, is expected to be at 4.8 million representing 12.4% of the Canadian population (Statistics Canada, 2006a). In 2000/2001, there was a 19 % increase in the number of baby boomers who report suffering from a chronic illness compared to the same age group in 1978/1979 (Wister, 2005). Accordingly, baby boomers are not as healthy as previously assumed and they are now placing a demand on the food industry for healthy, tasty products that not only promote longevity and quality of life, but contain functional food properties. Baby boomers are driven, determined, independent, and health conscious individual (The Futures Company, 2009). They want foods with preventative health benefits related to their disease condition(s) (heart disease, cholesterol, cancer, osteoporosis, and gastrointestinal diseases) and specifically look for these types of products when grocery shopping (Van kleef et al., 2005; Larue et al., 2004; Siegrist et al., 2008). Baby boomers are concerned about portion control, individual servings, foods higher in fibre, less processed foods, locally produced foods, better food labelling systems, and healthy convenient food choices (Lengyel & Utioh, 2009).

Food companies are developing products catering to the aging population (Shelke, 2008) to better meet their needs. Consumers of functional foods with health promoting and disease prevention attributes are characterized as being over the age of 55 years, reside in rural areas (Herath et al, 2008) and having a high disposable income. Food developers are realizing that the aging population wants familiar foods with added health benefits that taste the same (Messina et al. (2008). Increased familiarity with foods and ingredients, attractiveness, uniqueness and credibility (van Kleef et al., 2005; Williams et al., 2008) may increase willingness to try and purchase functional foods (Arès et al., 2008). Perceived reward from consuming a functional food was a stronger predictor to willingness to try a functional food with the aging population (Urala & Lähtennmäki, 2005).

Food companies may target specific health claims and/or nutrient content claims during product development. In Canada there are five allowable health claims: (1) A healthy diet low in sodium and high in potassium and reduced risk of high blood pressure; (2) A healthy diet with adequate calcium and vitamin D and reduced risk of osteoporosis; (3) A healthy diet low in saturated and trans fat and reduced risk of heart disease; (4) A healthy diet rich in vegetables and fruits and reduced risk of some types of cancers; and (5) Non-fermentable carbohydrates in gums and hard candies and reduction of dental caries (Health Canada, 2007b). Nutrient content claims are regulated by the Canadian Food Inspection Agency (CFIA). The allowable nutrient content claims are presented in Table 3.1.

Table 3.1. Nutrient Content Claim Guidelines

Nutrient Content Claims	Guidelines[1]
Fat Claim	
Low in fat	< 3 g
Free of saturated fats	< 0.2 g
Free of trans fat:	< 0.2 g
Sodium Claim	
No salt	< 5 mg
Low sodium	< 140 mg
Fibre Claim	
Source of fibre	> 2 g
High source of fibre	> 4 g
Very high source of fibre	> 6 g

(CFIA, 2010)

[1] per reference amount of 125 ml for a pasta sauce

Pasta sauce is a product which is widely consumed not only by baby boomers but all age groups. In Canada the estimated total sale for pasta sauces in 2008 was $273 million and this is expected to increase annually to an estimated $326.4 million by 2011. The pasta sauce market share is continuously growing from 6.7% in 2003 to almost double at 11.6% (est.) by 2011 (Food for Thought, 2010, p. 30).

Nearly all of the research articles found focused on tomatoes (fresh or canned), tomato sauces/purées, ketchup, tomato paste, and tomato juice rather than pasta sauce. Research article topics discussed were flavor characteristics (Hongsoongnern & Chambers, 2008), color (Interlmann et al., 2005), viscosity (Kaur et al., 2007), chemical, physical, rheological and sensory attributes (Apaiah et el., 2001; Krebbers et al., 2003; Jiménez et al., 1989) and storage/shelf life studies (Landy et al., 2002; Min et al., 2003). The few research articles on pasta sauces investigated color (Claybon & Barringer, 2002a), viscosity (Claybon & Barringer, 2002b), shelf-life study (Armstrong and McIlveen, 2000) and comparisons of flavonoids, carotenoids and vitamin C (Koh et al., 2008).

The development of the pasta sauce included commercial ingredient sourcing from Manitoba and neighbouring province Saskatchewan, where possible, as Manitoba has the resource for producing value added ingredients. A pasta sauce is a tomato based product which contains lycopene, an antioxidant, that has been linked to the prevention of cardiovascular diseases, osteoporosis and cancers such as prostate, breast, ovarian and cervical (Rao & Rao, 2007). Pasta sauce can also contain other vegetables which also provide beneficial nutrients. Manitoba has relatively small vegetable production however it produces the following elective vegetables which can be used in the pasta sauce

formulation: carrots, green peppers, onions, and summer squash (zucchini) (Peak of the Market, 2010). Lycopene is fat soluble and thus requires fat for absorption. Canola oil is also produced locally in Manitoba; it is known for its balanced lipid profile compared to other oil. It is the lowest in saturated fat, contains a good ratio of omega-6 to omega-3, it is high in monounsaturated fat and is cholesterol and trans-fat free (Canola Council of Canada, 2010b) and thus an ideal product to incorporate in the development of a pasta sauce. Canola is an integral crop to the province of Manitoba.

Fibre is important in gastrointestinal health. Excellent sources of fibre are legumes (pea, beans and lentils) and oats. Manitoba produces peas, beans and lentils (Pulse Canada, 2010d) and one quarter of the Canadian oat production (Government of Manitoba, 2010a). The province of Saskatchewan produces 95% of the lentils (green and red) in Canada (AAFC, 2010). Legumes are very nutritious and are a source of complex carbohydrates, dietary fibre, protein (incomplete source), vitamins and minerals (folate, potassium and iron), minimal fat, mostly mono- and poly-unsaturated fats (Wang & Daun, 2004) and no saturated fat or cholesterol (1 g/ 100 g dry red lentils; Pulse Canada, 2010b; Pulse Canada, 2010e). Research indicates a link between pulse consumption and the prevention of chronic diseases. Health benefits identified in clinical trials were cardiovascular health, weight management, diabetes, and gut health (Pulse Canada, 2010e). Areas of nutritional interest in the grains industry is oat and its beta-glucans. Beta-glucans have been linked to reducing cholesterol, blood glucose and insulin levels (Wood, 2010). Applications of pulses and oats in commercial products do not include pasta sauces. As a result further investigation is warranted.

The objective of this work was to develop a pasta sauce prototype (PSP) with increased health benefits by using locally grown ingredients when available.

Methods

Review of Pasta Sauce Recipes

A review of pasta sauce recipes was undertaken when no scientific literature was found on pasta sauce formulations. A web-based search, using Google, Heart and Stroke Foundation, and All Recipes, was used to locate pasta sauce recipes. The following keywords were used in combination with "*pasta sauce*": "*healthy*", "*high fibre*", "*lentils*", "*peas*", "*legumes*", "*zucchini*", "*butternut squash*", and "*squash*". Investigation into the composition and proportion of the base ingredients of a pasta sauce was conducted from the recipes in order to develop a pasta sauce formulation. In addition, the composition of six popular commercial pasta sauces from local Winnipeg grocery stores were evaluated for chemical, physical, and nutritional analysis. Although exact proportion of ingredients could not be identified on product labels, the ingredient list was a useful tool in identifying key ingredients.

Internal Taste Panel

In the initial product development stages of the PSP, trials were conducted to investigate the ideal base formulation; the combination of fresh and canned tomatoes, tomato sauce, tomato paste, spices and vegetables. Formulation specifications and ingredient selections were conducted with an internal taste panel comprised of four product development consultants at the Food Development Centre, Portage la Prairie, Manitoba. Sessions were held once a week at the end of the day. At the sessions the panellists tasted the PSP formulation produced that day. Panellists also tasted the PSP on

the day of production and one week after production in order to identify changes or improvements to the PSP flavour profile. The product development consultants were familiar with the steps, ingredients and objectives of the pasta sauce development providing professional and constructive feedback on the formulation and ingredient selection. Pasta sauce development was undertaken to represent homemade-type pasta sauce.

Ingredient Inclusion Criteria

Throughout the product development process, key product criteria were set to produce a nutritious and healthy product for baby boomers. Nutrient content claims guidelines from (CFIA, 2010) were considered in identifying and selecting ingredients. Finally, guidelines for selection of ingredients were as follows: (1) to select local food products when available and feasible, (2) to select fresh products when feasible, (3) to select canned products with less or no added salt and (4) to select products with the least processing.

Tomato Products

Roma tomatoes were supplied from the food supplier Sysco™ Canada. The tomato sauces investigated in initial development trials were (1) homemade, (2) Heinz® (Sobeys Inc., Canada), and (3) Hunt's® (Safeway™, Canada). The tomato paste used was Heinz® brand (Sysco™, Canada). In the developmental trials sun-ripened dried tomatoes from Mezzetta® were purchased from Sobeys Inc. Canada.

Fibre Sources

Possible sources of fibre for addition were evaluated. Red lentils (RL) were locally supplied by Harvest® (Manitoba, Canada). The Inulin (In) Beneo Orafti® GR

was supplied by Quadra Chemicals Ltd. (Burlington, Ontario, Canada). The Oat Fibre (OF) Canadian Harvest® 300-58 was supplied by Nealanders International Inc. (Mississauga, Ontario, Canada). The Centara™ Pea Fibre (PF) was supplied by NutriPea Ltd. (Portage la Prairie, Manitoba, Canada).

Other Ingredients

Canola oil was supplied by Canola Harvest® (Richardson Oilseed Ltd., Winnipeg, Manitoba). The carrots were supplied by Peak of the Market (Manitoba, Canada) and all other vegetables (onions, zucchini, celery, and red and green peppers) were purchased from Sobeys Inc. Canada.

Prototype Formulation

Once a base formulation was identified for the PSP, investigation of adding fibre was conducted. Table 3.2 outlines the prototype base formulation (without added fibres) and procedures. Amounts of ingredients are represented in percentages (%) of the total amount in the recipe. Three sources of fibre were analyzed to provide Health Canada's '*high source of fibre*' and '*very high source of fibre*' claims within the PSP formulation. Inulin was also added in the third formulation of each trial. Three formulations were analyzed per fibre source and compared to a control PSP with no added fibre (Table 3.3).

Pasta Sauce Prototype Preparation

Ten PSPs, one control (no added fibre) and nine formulations with added fibre were prepared in the food laboratory at the Food Development Centre. The RL were incorporated into the PSP-RL as a RL purée. Procedures for the RL purée at found in table 3.4. Samples were cooked for 45 minutes at 85 °C and hot filled in sanitized jars. The jars were labelled with three digit codes and stored at room temperature (22 °C).

Analysis was conducted the following day in order to allow the flavours of the pasta sauce time to develop.

Table 3.2. Pasta Sauce Prototype Base Formulations and Procedures

Ingredients	Control	with OF or PF Amnt (%)	15 % RL Amnt (%)	20 % RL Amnt (%)	15% RL + In Amnt (%)	Procedures
Tomato Base						
Tomato sauce	62	60	48	44	46	- Weight out ingredients.
Tomato paste	4	4	4	4	4	- Add ingredients to the pot.
Canola oil	0.5	0.5	0.5	0.5	0.5	
Vegetables						
Yellow onion	1.4	1.4	1.4	1.4	1.4	- Clean and weight out vegetables.
Zuchinni	1.1	1.1	1.1	1.1	1.1	- Cut vegetables in pieces.
Carrots	1.1	1.1	1.1	1.1	1.1	- Chop vegetables in food processor.
Celery	0.9	0.9	0.9	0.9	0.9	- Add vegetables to pot.
Red peppers	0.5	0.5	0.5	0.5	0.5	
Green peppers	0.5	0.5	0.5	0.5	0.5	
Roma tomatoes	25	25	25	25	25	
Spices/Herbs						
Brown sugar	1.1	1.1	1.1	1.1	1.1	- Weight out every ingredient and place in a bowl.
Citric acid	1.1	0.1	0.1	0.1	0.1	- Stir ingredients so the inulin is dispersed evenly
Onion powder	0.1	0.9	0.9	0.9	0.9	throughout the mixture.
Garlic powder	0.9	0.4	0.4	0.4	0.4	- Add the mixture to the pot.
Roasted garlic powder	0.4	0.2	0.2	0.2	0.2	
Oregano leaves	0.2	0.1	0.1	0.1	0.1	
Basil leaves	0.1	0.2	0.2	0.2	0.2	- With all ingredients in the pot, stir and cook to a
Thyme leaves	0.2	0.04	0.04	0.04	0.04	boil –minimum temperature of 85°C for 45 minutes
Bay leaves	0.04	0.02	0.02	0.02	0.02	- Cover and stir occasionally
Black pepper	0.02	0.01	0.01	0.01	0.01	- Before canning, check pH of product –must be
Cayenne pepper	0.01	0.01	0.01	0.01	0.01	below a pH 4.5
Crushed red pepper flakes	0.01	0.02	0.02	0.02	0.02	

Table 3.3. Pasta Sauce Prototype Fibre Formulations

Formulation	4 g of Fibre	6 g of Fibre	6 g of Fibre w/ Inulin
Control	-	-	-
Red Lentils[1]	15%[2]	20%	15% RL 1.4% In
Pea Fibre	1.4%	2.3%	1.4% PF 1.4% In
Oat Fibre	1.4%	2.3%	1.4% OF 1.4% In

[1] RL purée was substituted for the tomato sauce. To reach the 6 g claim would have required over 40% of the formulation thus the addition of red lentils was capped at the 20% level.
[2] Percentages represent the concentration of the product in the total pasta sauce formulation. The red lentils made up 15% of the pasta sauce formulation for the 4 g of fibre trial.

Table 3.4. Red Lentils Purée Procedures

Ingredients	Amnt (%)	Procedures
Raw red lentils Water	22 78	- Weight out the raw red lentils an water. - Put ingredients in a pot and cook for 15 minutes at a boil, covered –until red lentils are cooked. - Purée the red lentils using a hand mixer

Physical and Chemical Analysis

Physical and chemical tests were performed to measure the affect of added fibre on all ten PSP formulations. All tests were conducted at room temperature (22 $^{\circ}$C). Samples were tested in replicates of three (n = 3). The Abbe Refractometer Model #10450 (Reichert Mark II Plus) was used to determine the °Brix calibrated with distilled water. The pH Meter (Accumet XL50) was used to determine the pH level and was calibrated with pH 4, 7 and 10 buffers

Apparent Viscosity

Apparent viscosity was measured in 500 ml samples with a model RVDVII + viscometer (Brookfield). Spindle #5 was selected at 50 and 100 rotations per minute (rpm). Reading was done after 15 s of starting the motor. Apparent viscosity was expressed in centipoises (cP).

Colour Measurement

The color of the samples was measured using the Chroma Meter CR-400/410 (Konica Minolta Inc., 2002) calibrated with a white standard tile (Y= 94.0, x= .3129, y=.3190). The color of the PSPs was analyzed in Petri dishes using the Hunter color scale L* (lightness), a* (red-green) and b* (yellow-blue). Samples were measured three times each, averaged and recorded. Results were expressed in L*C*h color scale where saturation (or chroma) $C= (a^2 + b^2)^{½}$ and Hue angle (h) = arctangent of b*/a* x 57.296.

Data Analysis

Nutritional

Nutritional analysis for each PSP formulation was conducted using the Genesis SQL® R&D (Version 9.6; 2010) by ESHA Research (Salem, Oregon 97306). Nutritional fact tables were developed by Genesis SQL® R&D.

Statistical

Data was analyzed using SPSS® software version 18.0.0 (IBM® Corporation, Somer, NY, USA). Analysis of variance was used to evaluate statistical differences within the data. Tukeys test was used to evaluate where statistical differences were between samples. Statistical significance was considered at $p < 0.05$.

Results

Review of the literature on scientific databases generated articles on pasta sauces however the articles were not accessible. Patented reports are accessible through Google™ patent, however only scientific databases were searched. Twenty two recipes were generated from the web-based search.

Analysis of Commercial Pasta Sauces

Table 3.5 presents the physical/chemical characteristics of the commercial pasta sauces selected from Winnipeg grocery stores. The pH of the commercial pasta sauces ranged from 3.95 to 4.32 with an average of 4.15. Soluble solids content ranged from 8.9 to 14.9 °Brix with an average of 11.9. The color of the pasta sauces varied by brand. The L* values were significantly different between samples where sample C (28.89 ± .19) was significantly darker and sample B (33.70 ± .79) was significantly lighter than all other samples. Mean L* value of the sampled commercial pasta sauce was 31.35 ± 1.74.

Table 3.5. Characteristics of Sampled Commercial Pasta Sauces

	Score ± SD						
						Viscosity (cP/s)	
	pH	◦Brix	L*	C	H	50 rpm	100 rpm
A	4.29	12.3	30.39 ± 0.8b	25.91 ± 0.7b	30.54 ± 0.3b	285	164
B	3.95	8.9	33.70 ± 0.8d	28.35 ± 0.2d	37.85 ± 1.1e	196	136
C	4.01	14.9	28.89 ± 0.2a	24.85 ± 0.1a	26.21 ± 0.6a	410	-[1]
D	4.32	10.9	30.12 ± 0.2b	26.96 ±0.05c	34.79 ± 0.1c	265	157
E	4.06	10.9	32.53 ± 0.2c	26.13 ± 0.2bc	36.92 ± 0.9de	177	114
F	4.27	13.5	32.49 ± 0.2c	32.58 ± 0.5e	35.69 ± 0.1cd	520	-[1]

Scores with the same letters within a column are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.
[1] Could not be measured.

Chroma values were significantly different between samples. Sample C (24.84 ± .06) had a significantly lower degree of saturation where as sample F (32.58 ± .49) had a significantly higher degree of saturation than the other pasta sauces. Mean chroma of the commercial pasta sauces was 27.46 ± 2.61. The hue angle of sample C was significantly redder than all other pasta sauces and sample B was significantly more reddish-brown compared to the other pasta sauces. Mean hue angle of the commercial pasta sauce was 33.66 ± 4.21. Apparent viscosity of the commercial pasta sauces appeared to be different between brands. Sample E had a thinner apparent viscosity whereas samples C and F had thicker apparent viscosities.

Table 3.6 presents the nutritional characteristics of the commercial pasta sauces selected from Winnipeg grocery stores. Only three commercial pasta sauces are sources of fibre (CFIA, 2010) containing 3 g of fibre per serving, where the other three contain less than 2 g of fibre per serving. Sodium content of one commercial pasta sauce is as low as 330 mg where the highest amount is 670 mg indicating a wide range of sodium content in pasta sauces. One commercial pasta sauce contains 250 mg of sodium per serving as well as 440 mg of potassium. Fat content also varies in commercial pasta sauces with the highest being 2 g per serving and the lowest 0 g per serving.

Table 3.6. Commercial Pasta Sauce Nutritional Profiles[1]

	A	B	C	D	E	F	K
Calories	70	50	60	50	60	70	60
Fat (g)	1	1.5	0	0.5	2	2	1.5
Saturated (g)	0.2	0.5	0	0	0.4	0	0.3
Trans (g)	0	0	0	0	0	0	0
Polyunsaturated		√					
Monounsaturated		√					
Sodium (mg)	330	430	400	670	630	510	250
Potassium (mg)							440
Fibre (g)	3	2	3	2	2	1	3

[1] per serving size of 125 ml (CFIA, 2010)

Internal Taste Panel

The internal taste panel concluded that one day was enough for the flavour profile of the PSP to mature for sensory analysis. Internal taste panel consultations found differences between the use of fresh tomatoes and canned tomatoes. Although canned tomatoes provide a consistent product, overall quality was not comparable to fresh tomatoes. Regarding the source of fibre, consultants expressed concern over the effect of PF and OF on the sensory profile of the PSP. The PF imparted a metallic taste to the PSP and the OF imparted an unpleasant flavour at all levels. Finally, responses from the internal taste panel suggest that the off flavour of the PF and OF may hinder commercialization of the PSP. Appendix A presents comments of the internal taste panel.

Formulation

The ingredients in the base PSP for all formulations were tomato sauce, fresh roma tomatoes, tomato paste, vegetables (onion, celery, carrot, zucchini, red and green peppers), canola oil, brown sugar, citric acid and spices (garlic powder, roasted garlic powder, onion powder, bay leaf, basil, oregano, thyme, black pepper, cayenne pepper, and red pepper flakes).

Table 3.7 presents the characteristics of the PSP formulations. Soluble solids were significantly different between formulations where all PSP formulations (RL, OF and PF) at 6 g fibre with inulin had significantly higher soluble solids than other PSP formulations and the control. Formulations PSP-RL and PSP-OF with 4 g fibre were statistically similar to the control in terms of soluble solids and different from the other formulations. The pH of the PSP-RL formulations were significantly higher than the control and the six other PSP formulations, whereas the pH of the PSP-OF and PSP-PF formulations were

not significantly different to the control (except PSP-OF 6f with inulin). The addition of RL in all formulations significantly increased L* values of the PSP resulting in a lighter product. Similar results were seen in the PSP-PF 6 g formulation. The addition of OF to the PSP had the lowest significant difference on color compared to the PSP-control. No difference in color saturation of all PSP formulations was found. The PSP formulations with added PF and OF appeared to be similar with the PSP-control. The PSP-RL formulation had significantly increased hue angles and a reddish-brown color compared to the PSP-control, PSP-OF and PSP-PF. The formulations PSP-OF 4 g and PSP-PF 6 g were not significantly different to the PSP-RL 6 g with inulin. Apparent viscosity was significantly increased at the 6 g level with inulin for the PSP-OF and PSP-PF compared to the PSP-control and the PSP-RL formulations. Apparent viscosity of the PSP-RL formulations was not significantly different to the apparent viscosity of the PSP-control.

Table 3.7. Physical and Chemical Analysis of the PSP Formulations (n=3)

	Scores ± SD					
	◦Brix	pH	L*	C	h	Viscosity (cP/s)
Control	10.9 ± 0.1ac	3.95 ± .01ab	31.83 ± 0.1a	25.47 ± 0.5a	40.37 ± 0.7a	159 ± 13ab
RL 4 g Fibre	10.5 ± 0.2ab	4.12 ± .02d	35.49 ± 1.0d	26.89 ± 1.5a	47.11 ± 1.3e	152 ± 19a
RL 6 g Fibre	10.1 ± 0.2b	4.21 ± .02e	35.44 ± 0.3d	24.60 ± 2.1a	47.60 ± 1.2e	174 ± 23ab
RL 6 g Fibre + In	13.8f	4.11 ± .02d	34.52 ± 0.2cd	26.75 ± 1.6a	45.55 ± 0.7de	207 ± 12abc
OF 4 g Fibre	11.1c	3.98 ± .02bc	33.80 ± 0.5bc	27.07 ± 0.9a	43.88 ± 1.9cd	182 ± 33ab
OF 6 g Fibre	11.7 ± 0.1d	3.97 ± .01abc	33.07 ± 0.6abc	26.74 ± 2.6a	42.44 ± 1.1abc	232 ± 10bcd
OF 6 g Fibre + In	13.5 ± 0.1ef	4.01 ±.02c	33.61 ± 0.1bc	28.26 ± 0.4a	41.20 ± 0.5abc	281 ± 17cd
PF 4 g Fibre	11.3 ± 0.2cd	3.91 ± .04a	32.53 ± 0.3ab	24.80 ± 0.5a	39.65 ± 0.1a	198 ± 60ab
PF 6 g Fibre	11.3 ± 0.2cd	3.97 ± .01bc	34.48 ± 1.0cd	25.36 ± 1.0a	43.46 ± 1.4bcd	232 ± 16bcd
PF 6 g Fibre + In	13.1 ± 0.1e	3.96 ± .02abc	32.52 ± 0.7ab	25.26 ± 1.7a	40.57 ± 0.4ab	298 ± 25d

Scores with the same letters within a column are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Appendix B presents the nutritional fact tables of the ten PSP formulations. Table 3.8 presents other key nutrients found in the PSP formulations. PSP-control offered 3 g of total fibre (12% DV) and 490 mg sodium (20% DV). The PSP-RL formulations offered a lower sodium content of 360–380 mg (15% DV) and an added gram of protein due to the protein content of the RL. Moreover, the PSP-RL formulations were also higher in folate, double that from the control and PSP-OF and –PF, almost double the amount of protein and contained higher amounts of iron and magnesium. The advantages of including RL in the PSP are that it provides more than simply fibre content (although rather minimal) such as iron, folate, protein and magnesium. Whereas OF and PF simply provide added fibre.

Table. 3.8. Other Key Nutrients of the PSP Formulations

Nutrient	Control	PSP-OF	PSP-PF	PSP-RL
Fat (g)	1.1	1.1	1.1	1.2
CHO (g)	12.7	14.5 – 15.6 (16.4 w/ In)	14.4 -15.5 (16.3 w/ In)	14.7-15.8 (16.6 w/ In)
Protein (g)	2.6	2.5	2.6 -2.7	3.6 - 4.2
Sodium (mg)	493.6	472.5 - 483.6	471.6 - 482.7	355.2 - 383.0
Folate (mcg)	11.3	11.3	11.3	23.0 -28.0
Iron (mg)	1.8	1.8	1.8	1.9 -2.1
Magnesium (mg)	9.5	9.8	9.5	13.8 – 15.4
Potassium (mg)	457.3	445.3 - 451.3	445.2 - 451.2	420.2 - 430.9

Discussion

The objective of the study was to develop a pasta sauce with added health benefits using Manitoba grown ingredients such as red lentils, pea fibre, carrots and canola oil. The study was successful in developing a PSP with higher fibre than commercial pasta sauces. The PSPs were low in fat and the PSP-RL formulations offered a lower in sodium content than two thirds of the commercial pasta sauces.

Analysis of commercial pasta sauces indicated that there is a wide range of product characteristics targeting various flavour, color and texture preferences of potential consumers.

The pH of the PSP formulations were within pH range of the commercial pasta sauces. The PSP-control, PSP-PF and PSP-OF formulations have pH at the lower end of the range and the PSP-RL formulations were similar to the mean pH of the commercial pasta sauces. The addition of RL to the PSP base significantly increased the pH of the pasta sauce compared to PSP-OF and PSP-PF formulations and the PSP-control. Numbers are comparable to that measured by Koh et al. (2008) in commercial pasta sauces with a pH range of 3.71 to 4.34. Soluble solids of the PSP formulations were also comparable to the commercial pasta sauces. The addition of inulin significantly increased soluble solids in the PSP formulations. Apparent viscosity of the PSP formulations was in the wide range of apparent viscosity values seen for the commercial pasta sauces even with the added fibre at the highest level of 6 g. However there was a significant increase in apparent viscosity with the addition of PSP-OF and PSP-PF at all levels and with and without inulin. Thakur et al. (1996) found that with increasing soy protein concentration in tomato sauce, viscosity gradually increased. Their panel found that a soy protein

concentration up to 2.0% was acceptable (Thakur et al., 1996). The OF and PF concentrations in the PSP were 1.4% and 2.3%. Claybon and Barringer (2002b) reported that consumers could not perceive slight difference in viscosity of pasta sauces whereas differences could be measured instrumentally.

Color values, L and h but not c, of commercial pasta sauces were lower than those of the PSP formulations including the control. The higher values of the PSP formulations may be a result of added fibre to the PSP, different processing techniques, length of processing and/or ingredient composition. Claybon and Barringer (2002a) reported a hue angle range of 29.8 to 32.7 of commercially available pasta sauces with no added fibre. Consumers in their study reported accepting pasta sauces with a hue angle of 35.8, which is higher than what is commercially available, and appear to have a wide acceptability range of pasta sauce color. The hue angle of the commercial pasta sauces B, E and F were 37.85, 36.92 and 35.69, respectively. These values are equal to and higher than hue angles of commercial pasta sauces analysed by Claybon and Barringer(2002a) and acceptable to consumers in that study. Consumers are already purchasing and consuming pasta sauces with higher hue angles than expected. This may indicate that consumers may be more likely to accept a reddish-brown pasta sauces resulting from the addition of fibre and may be sceptical of a pasta sauce with an abnormally bright red color (Claybon and Barringer, 2002a).

The PSP formulations with added fibre (RL, OF and PF) provided 1-3 g of fibre more per serving (125 ml) than the PSP-control and commercial pasta sauces. Results from provincial nutrition surveys conducted in the 1990s indicate that inadequate fibre intake is a nutritional concern for all Canadian adults (18-84 years of age) (Dolega-

Cieszkowski et al., 2006). Reduced consumption of fibre not only negatively affects the digestive system but other systems as well. Adequate intake of fibre has been shown to be beneficial in cardiovascular disease, bowel function, weight control, diabetes, and various cancers (American Dietetic Association, 2008). Adult (19-50 year) recommendations are to consume 38 g/day (males) and 25 g/day (females) and older adult (>51 years) recommendations are to consume 30 g/day (males) and 21 g/day (females) (Institute of Medicine, 2002); however, many do not consume nearly enough. Sodium content of the PSP-control, PSP-OF and PSP-PF per serving is comparable to commercial pasta sauces at a mean of 480 mg at 20% DV. The PSP-RL formulations have the lowest sodium content at a mean of 360 mg at 15-16% DV. Consumers are encouraged to choose foods with a % DV of 5% or less of sodium and to avoid or limit foods with a % DV of 20% and higher as these are considered high in sodium (Heart & Stroke Foundation, 2011). The PSP-RL formulations may aid baby boomers in attaining the daily recommendations of fibre and be a better pasta sauce alternative in offering lower sodium content than half of the commercial pasta sauces. Moreover, the PSP-RL contains higher amounts of protein, iron, folate and magnesium compared to the control and PSP-OF and –PF formulations.

Limitations to this study include the lack of a trained sensory panel to fully describe differences between the control and the PSP-RL, PSP-OF and PSP-PF formulations. However, a panel testing ten products may have proved to be overwhelming. The number of samples depends on the type of product, the number of characteristics being evaluated, the type of test and experience of the panel in order to avoid both sensory and mental fatigue (Poste et al., 1991). Accordingly, the sensory

profile of pasta sauce is complex and having too many formulations would have lead to sensory and mental fatigue for the panel. As such, a smaller sample size would be more effective. Another limitation to the study is the use of fresh products, especially tomatoes. The quality of the fresh tomatoes varies per season and it was difficult to guarantee a consistent product. In order to control for the variance in fresh tomato quality, the total percentage of fresh tomatoes was slightly decreased and substituted by tomato sauce.

Future work could investigate possible combinations of OF and PF with other ingredients. A sensory panel may be a part of the investigation where descriptive analysis can be undertaken to analyse the effect of OF and PF on the sensory aspects of pasta sauce. As OF and PF are novel fibres and need special approval to be used in pasta sauces (CFIA, 2010); more research needs to be undertaken. As a result, the PSP-RL formulations will be principally investigated further to identify the ideal concentration. Future work includes re-formulation of the PSP to identify key RL concentration through chemical, physical, nutritional and sensory analysis.

This study suggests that there were no differences between apparent viscosity of commercial pasta sauces and the PSP formulations with added RL, OF and PF. Apparent viscosity values of PSP formulations were within the range of apparent viscosity values seen for commercial pasta sauces. There were significant differences in apparent viscosity between a PSP-control and PSP-OF and PSP-PF formulations at 6g fibre with and without inulin. These results suggest that the increase in thickness of the PSP due to added fibre may still be acceptable to consumers if sold commercially. There were apparent differences in color values between the PSP formulations and the sampled commercial pasta sauces. Added RL significantly increased hue angles of the PSP which

can be attributed to the substitution of tomato sauce for RL. Research suggests that this increase may once again be acceptable to consumers as consumers are exposed to a wide range of commercial and restaurant produced pasta sauces which may result in a wide range of red color disparities (Claybon & Barringer, 2002a). The nutritional profiles of the PSP-RL formulations, with and without inulin were more beneficial in terms of fibre (with inulin), sodium and protein content compared to the other PSP-formulations and the commercial pasta sauces.

CHAPTER 4

EFFECT OF ADDED RED LENTILS ON THE QUALITY OF A PASTA SAUCE: SENSORY ANALYSIS AND SHELF-LIFE STUDY

Introduction

Pasta sauce is a widely consumed tomato product. Pasta sauce is defined as a 'value-added tomato-based product, including seasoning and/or meat' (p. 30, Food For Thought, 2010). In Canada the estimated sale for pasta sauces in 2008 was $273 million and is expected to increase annually to an estimated $326.4 million by 2011. The pasta sauce market share has been continuously growing from 6.7% in 2003 to almost double 11.6% (est.) by 2011 (Food for Thought, 2010, p. 30).

Good sources of fibre are pulses, the seed of legumes. Canada is a world leader in pulse production accounting for 35% of pulse trade in the world (Pulse Canada, 2010c). Within the last 20 years pulse production has increased fivefold from one million tonnes in the early 1990s to 5.6 million tonnes in 2009 (Pulse Canada, 2010c). Manitoba produces white and coloured beans, in addition to peas and lentils (Pulse Canada, 2010d). Pulses are very nutritious and are a source of complex carbohydrates, dietary fibre, protein (incomplete source), vitamins and minerals (folate, potassium and iron), minimal fat, mostly mono- and poly-unsaturated fats (Wang & Daun, 2004) and no saturated fat or cholesterol (1 g/ 100 g dry red lentils; Pulse Canada, 2010b; Pulse Canada, 2010e). Research also indicates a link between pulse consumption and the prevention of cardiovascular diseases, weight management, diabetes, and gut health (Pulse Canada, 2010e). Health benefits identified in clinical trials were reduction of total and LDL

cholesterol levels, reduction of blood pressure, a decrease in appetite, improvement in insulin resistance, and increased levels of gut bacteria (Pulse Canada, 2010e).

Red lentils production in Manitoba is not predominant, nonetheless their functionality and application is noteworthy. The province of Saskatchewan produces 95% of the lentils (green and red) in Canada (AAFC, 2010). Production of red lentils increased to about 60% of the lentil area seeded up from 32% seeded in 2007 (AAFC, 2007). Red lentils cook quickly without soaking and are readily used in soups and tomato sauces (Pulse Canada, 2010a). The use of red lentils in commercial pasta sauces would have great potential, but has not yet been researched. The addition of red lentils may have beneficial effects on the sensory attributes (color, texture, viscosity, and taste) and nutritional profile of pasta sauces.

One of the key descriptors in the quality of tomato products and pasta sauce is color. The red color of a tomato is due to the presence of lycopene, a carotenoid, which makes up a large portion of the carotenoid content of a tomato (> 90%) with the highest concentration found in the skin (Shi & Le Maguer, 2000). Lycopene is an antioxidant and has been linked to prevention of cardiovascular diseases, osteoporosis and cancers such as prostate, breast, ovarian and cervical (Rao & Rao, 2007). The average lycopene content found in raw tomatoes is 4.7 mg/100 g (Krebbers et al., 2003) and between 4.3–13.17 mg/100 g in commercial pasta sauces (Koh et al., 2008). The USDA carotenoid database reports the lycopene content of raw tomatoes and pasta sauce as 3.02 mg/100 g and 15.99 mg/100 g respectively (USDA, 1998).

Hue angle is measured to describe color quality. Research indicates that prototypical (Caucasian) consumers show the widest range of color acceptability of pasta

sauces with hue angles of 20.9–35.8, wherein the commercial pasta sauces available ranged from 29.8–32.7 (Claybon & Barringer, 2002a). According to this study, consumers appear to have a greater range of color acceptability for pasta sauces than what is commercially available. This may indicate, according to Claybon and Barringer (2002), that consumers have a 'wide range of expectations' of pasta sauces as they are easy to make at home and widely available at restaurants (p. 494). Their participants found sauces (including pasta sauces) that were too red or too brown unacceptable; it is the middle range of the two that is preferred by consumers. The addition of soy protein and beef has been shown to alter the color of pasta sauces; however, overall acceptability was favourable (Thakur et al., 1996; Armstrong and McIlveen, 2000). Ultimately, for the consumers, overall eating experience influences their color acceptability of the pasta sauce (Claybon and Barringer, 2002a).

Key sensory attributes of pasta sauce are viscosity, texture, and flavour such as tomato, spices, sweet and salty (Chambers et al., 2004; Moskowitz, 1996; Rapp et al., 2007; and Hongsoongneri & Chambers, 2008). Claybon & Barringer (2002b) reported consumers were unable to differentiate between slight differences in viscosity. The researchers also reported that consumers preferred pasta sauces that were thicker than what was commercially available. Claybon & Barringer (2002a) speculate that consumers may want thicker pasta sauces to better adhere to the pasta compared to thinner pasta sauces, thus recommending manufacturers invest in producing thicker pasta sauces.

It has been reported that chemical and physical characteristics of tomato products do not change during storage. Lycopene, pH, °Brix and viscosity do not change over time for both commercial scaled pulsed electric field (PEF) processing and thermal processing

of tomato juice stored at 4 °C for 112 days (Min et al., 2003). Similar results were found by García-Alonso et al. (2009) where overall lycopene, total phenolic and flavonoids remained stable during storage for 12 months regardless of storage temperature and packaging material (glass jar and Tetra pack).

Sensory characteristics of tomato products during storage have differing results depending on products and processing techniques. Armstrong and McIlveen (2000) measured the effect of prolonged storage on sous vide meat-based pasta sauces for 40 days stored at 1.5 °C. Results indicated no significant differences perceived by a trained panel for the meat based pasta sauce over the 40 day period. Color of the meat-based pasta sauce was acceptable to panellists until day 20. Thereafter, the sauce became bright red, less viscous with increased clumping of meat particles, however it was still moderately acceptable. Whereas Min et al. (2003) identified significant sensory differences between thermal processing and PEF treatments of tomato juice over 112 days.

The objective of this work was to determine the level of RL that could be added to a pasta sauce prototype (PSP), to conduct a sensory analysis and a 12 week shelf-life study.

Methods

This study was conducted in two parts. Part A evaluated the acceptable level of RL in the PSP formulation through sensory, nutritional, physical and chemical analyses. Part B evaluated sensory, nutritional, microbial, physical and chemical changes of the selected scaled-up pasta sauce, referred to as pasta sauce final (PSF), during a 12 week storage period.

Part A

Sensory Panel

Sensory analysis was conducted in order to evaluate possible sensory differences between levels of added RL and inulin to the PSP. The effect of added fibre on the aroma, flavour, texture and aftertaste attributes of the PSP were evaluated. Nine panellists were recruited from the Food Development Centre, Portage la Prairie, Manitoba for the sensory panel (n = 9). Panellists took part in four training sessions of one hour each. The training sessions were conducted on two days; two sessions on each day: one session in the morning and one session in the afternoon. During the training two aroma attributes (*cooked tomato and herbs*), four flavour attributes (*cooked tomato, acidic, oregano and heat*), two aftertaste attributes (*oregano and heat*), and two texture attributes (*grainy and viscosity*) were identified. Panellists agreed that the overall tomato aroma and flavour was best defined as '*cooked tomato*' as it has different characteristics of a '*fresh tomato'* aroma and flavour. It was also agreed upon that the flavour and aftertaste attribute '*oregano'* was easily distinguishable however the aroma attribute '*oregano'* was not, hence the attribute '*herb*' was used to identify the aroma. Finally, the flavour attribute '*sweet'* was not appropriate in characterising the PSP rather it was the absence of acidity in the PSP. Hence only the flavour attribute '*acidic'* was used. An attribute definitions sheet was developed based on the consensus of the panellists and provided to the panellists at each sensory session (Appendix C). Color was not analyzed by the panellists as it could influence overall results as the addition of fibre may alter the color of the PSP (McDaniel and Chan, 1988). Since the expected color difference could insinuate more or less fibre, panellists were not asked to rate color. Panellists were oriented to a 7-point

interval scale with labeled endpoints low and high (1 = low to 7 = high) used to evaluate the samples of PSP formulations (Kilcast, 1999) (Appendix D). Following the training, panellists participated in three sensory analysis sessions (n = 3) of approximately 30 minutes each session on subsequent days. During the sensory sessions, panellists rated the PSP formulations on an attribute descriptor scale. Panellists were asked to rinse their mouth with filtered water and unsalted soda crackers between samples. All sensory assessments were conducted in individual booths at the Food Development Centre, Portage la Prairie, Manitoba.

Product Preparation

Four PSPs, one control (no added fibre) and three experimental (10% RL, 15% RL and 20% RL) with added inulin, were prepared in the food laboratory at the Food Development Centre. Table 4.1 illustrates the ingredients and procedures for the product preparation. Amounts of ingredients are represented in percentages (%) of the total amount in the recipe. The RL was incorporated into the PSP-RL as a RL purée. Procedures for the RL purée at found in table 4.2. Samples were cooked for 45 minutes at 85 °C and hot filled in sanitized jars. The jars were labelled with three digit codes and stored at room temperature (22 °C). Sensory, chemical and physical analyses were conducted the following day in order to allow the flavours of the PSPs time to develop.

Table 4.1. Pasta Sauce Prototype Formulations and Procedures

Ingredients	Control Amnt (%)	10 % RL Amnt (%)	15 % RL Amnt (%)	20 % RL Amnt (%)	Procedures
Tomato Base					
Tomato sauce	62	50	46	41	- Weight out ingredients.
Tomato paste	4	4	4	4	- Add ingredients to the pot.
Canola oil	0.5	0.5	0.5	0.5	
Vegetables					
Yellow onion	1.4	1.4	1.4	1.4	- Clean and weight out vegetables.
Zuchinni	1.1	1.1	1.1	1.1	- Cut vegetables in pieces.
Carrots	1.1	1.1	1.1	1.1	- Chop vegetables in food processor.
Celery	0.9	0.9	0.9	0.9	- Add vegetables to pot.
Red peppers	0.5	0.5	0.5	0.5	
Green peppers	0.5	0.5	0.5	0.5	
Roma tomatoes	25	25	25	24	
Spices/Herbs					
Brown sugar	1.1	0.4	0.4	0.4	- Weight out every ingredient and place in a bowl.
Inulin	-	2.13	2.13	2.06	- Stir ingredients so the inulin is dispersed evenly throughout the
Citric acid	0.1	0.1	0.1	0.1	mixture.
Onion powder	0.9	0.9	0.9	0.9	- Add the mixture to the pot.
Garlic powder	0.4	0.4	0.4	0.4	
Roasted garlic powder	0.2	0.2	0.2	0.2	
Oregano leaves	0.1	0.1	0.1	0.1	- With all ingredients in the pot, stir and cook to a boil –minimum
Basil leaves	0.2	0.2	0.2	0.2	temperature of 85°C for 45 minutes
Thyme leaves	0.04	0.04	0.04	0.04	- Cover and stir occasionally
Bay leaves	0.02	0.02	0.02	0.02	- Before canning, check pH of product –must be below a pH 4.5
Black pepper	0.01	0.01	0.01	0.01	
Cayenne pepper	0.01	0.01	0.01	0.01	
Crushed red pepper flakes	0.02	0.02	0.02	0.02	

Table 4.2. Red Lentils Purée Procedures

Ingredients	Amnt (%)	Procedures
Raw red lentils Water	22 78	- Weight out the raw red lentils an water. - Put ingredients in a pot and cook for 15 minutes at a boil, covered –until red lentils are cooked. - Purée the red lentils using a hand mixer

Sample Preparation

Four samples, one from each PSP formulation, were re-heated to 60 °C. Panellists were provided with 30 g of sample (ASTM, 1992). All samples were labelled with three digit codes and randomized using a balanced-block design for a four-product test (Stone & Sidel, 2004). Samples were evaluated by the panellists in individual booths under red lights. The red lights mask any colour differences between the samples (McDaniel & Chan, 1988).

Part B

Sensory Panel

Sensory analysis was conducted to evaluate possible changes in the key sensory attributes; aroma (cooked tomato and herbs), flavour (cooked tomato, acidic, oregano and heat), texture (grainy and viscosity), and aftertaste (oregano and heat) of the selected PSP formulation from Part A during 12 weeks of storage. This sample will be referred to as pasta sauce final (PSF) from this point on.

Eight of the nine panellists (one panellist was no longer at the facility) from Part A (recruited from the Food Development Centre) participated in the sensory panel (n = 8). Sensory analysis was conducted at weeks 0, 2, 4, 8 and 12. Samples were analyzed in duplicate (n = 2). Sessions were conducted on one day of the test week; one session in the morning and in the afternoon of approximately ten minutes each session.

A 7-point interval scale with labelled endpoints low and high (1 = low to 7 = high) was used by panellists to evaluate the samples of PSF (Kilcast, 1999) (Appendix E). An attribute definitions sheet developed during the training session in Part A was provided to the panellists at each session (Appendix C). Panellists were asked to rinse

their mouth with distilled water and unsalted soda crackers between samples. All sensory assessments were conducted in individual booths at the Food Development Centre, Portage la Prairie, Manitoba.

Product Preparation

The PSF was scaled-up to 60 L and prepared in the pilot plant at the Food Development Centre. Table 4.3 illustrates the ingredients and procedures for the scaled-up product preparation. A HACCP (Hazard Analysis and Critical Control Points) plan was also developed by the Food Development Centre's HACCP and Regulatory Affairs Coordinator prior to scale-up to ensure quality control and compliance with CFIA standards. The sample was cooked in a steam kettle for 50 minutes at 85 °C and hot filled in sanitized jars. The samples were labelled with three digit codes and stored at room temperature (22 °C). Sensory, chemical and physical analyses were conducted the following day at week 0 in order to allow the flavours of the PSF time to develop. Microbial analysis was conducted the day of production to represent time at week 0.

Sample Preparation

One sample was re-heated to 60 °C. Panellists were provided with 30 g of sample (ASTM, 1992). The sample was labelled with a three digit code. The sample was evaluated by the panellists in individual booths under red lights. The red lights mask any colour differences between the samples (McDaniel & Chan, 1988).

Table 4.3. Pasta Sauce Final Formulation and Procedures

Ingredients	Amnt	Procedures
Red Lentils Purée		
Raw red lentils	2.7 kg	- Weight out raw red lentils and water.
Water	9.6 L	- Put ingredients in 30 L kettle and cook for 30 minutes at a boil, covered –until lentils are cooked.
		- Purée the red lentils using the colloid mill.
		- Add puree to the 140 L kettle after tomato base has been added.
Tomato Base		
Tomato sauce	31.25 kg	- Weight out ingredients.
Tomato paste	2.8 kg	- Add ingredients to the 140 L kettle.
Canola oil	85 ml	
Vegetables		
Yellow onion	950 g	- Clean and weight out vegetables.
Zuchinni	700 g	- Cut the vegetables in pieces.
Carrots	700 g	- Chop the vegetables in the Hobart silent cutter.
Celery	600 g	- Add the vegetables to the 140 L kettle.
Red peppers	350 g	
Green peppers	350 g	
Roma tomatoes	16.5 kg	
Spices/Herbs		
Brown sugar	230 g	- Weight out every ingredient and place in a bowl.
Inulin	1.4 kg	
Citric acid	85 g	- Stir ingredients so the inulin is dispersed evenly throughout the mixture.
Onion powder	615 g	
Garlic powder	380 g	- Add the mixture to the 140 L kettle.
Roasted garlic powder	45 g	
Oregano leaves	60 g	- With all ingredients in the pot, stir and cook to a boil.
Basil leaves	160 g	
Thyme leaves	25 g	–minimum temperature of 85°C for 50 minutes.
Bay leaves	12 g	- Cover and stir occasionally.
Black pepper	6 g	- Before canning, check pH of product –must be below a pH 4.5
Cayenne pepper	6 g	
Crushed red pepper flakes	10 g	

Physical and Chemical Analyses

Physical and chemical analyses were conducted on PSP and PSF formulations during both Part A (10 formulations) and B (1 formulation). Analyses were performed in Part A to evaluate the effect of added RL in the PSP. The formulations in Part A were analyzed the same day as sensory analysis was conducted, thus on three consecutive days. Chemical and physical analyses were performed in Part B to evaluate changes in the PSF formulation during 12 week storage. The samples were analyzed at week 0, 2, 4, 8, and 12.

All analyses were conducted at room temperature (22 °C). Samples were tested in replicates of six (n = 6). The Abbe Refractometer Model #10450 (Reichert Mark II Plus) was used to determine the °Brix calibrated with distilled water. The pH Meter (Accumet XL50) was used to determine the pH level calibrated with pH 4, 7 and 10 buffers.

Apparent Viscosity

Apparent viscosity was measured in 500 ml samples with a model RVDVII + viscometer (Brookfield). Spindle #5 was used at 20, 50 and 100 rotations per minute (rpm). Reading was taken after 15 s of starting the motor. Apparent viscosity was expressed in centipoises (cP).

Colour Measurement

The color of the samples was measured using the Chroma Meter CR-400/410 (Konica Minolta Inc., 2002) calibrated with a white standard tile (Y= 94.0, x= .3129, y=.3190). The color of the PSPs and PSF was analyzed in Petri dishes using the CIE lab color scale L* (lightness), a* (red-green) and b* (yellow-blue). Samples were measured three times each, averaged and recorded. Results were expressed in L*C*h color scale

where saturation (or chroma) $C = (a^2 + b^2)^{½}$ and Hue angle (h) = arctangent of b*/a* x 57.296.

Microbiological Analysis

Microbiological analysis of the PSF was conducted during the shelf-life study. Analyses were conducted at weeks 0, 2, 4, 8 and 12. Samples were analyzed for aerobic bacteria, coliforms, *E. coli* and yeast and molds. Samples were tested at 10^1 (11 g of the pasta sauce into 99 ml buffer), 10^2 (11 g from the 10^1 sample into a 99 ml buffer) and 10^3 (1 g from the 10^1 sample into a 99 ml buffer). One millilitre of the homogenized sample was inserted on the Petrifilm. Plates were done in replicates of three (n = 3) and averaged.

Aerobic Count Plate (AC Plate)

The PSF was analyzed for aerobic bacteria using the 3M™ Petrifilm™ AC Plate (3M Microbiology, St. Paul, MN). The Petrifilm is a sample-ready-culture-medium system containing Standard Medium nutrients, a cold-water-soluble gelling agent, and a tetrazolium indicator that facilitates colony enumeration. Plates were incubated at 30 °C for 48 hours. Counts of the aerobic bacteria were conducted using a 3M™ Petrifilm™ AC Plate Reader (product number 6499).

Escherichia coli/Coliform Count Plate (CC Plate)

The PSF was analyzed for coliforms and *E.coli* using the 3M™ Petrifilm™ CC Plate (3M Microbiology, St. Paul, MN). The Petrifilm is a sample-ready-culture-medium system containing Violet Red Bile nutrients, a cold-water-soluble gelling agent, and a tetrazolium indicator that facilitates colony enumeration. Plates were incubated at 35 °C. After 24 hours the plates were read for coliform and after an additional 12 hours plates were read for *E.coli*.

Yeast and Mold Count Plate (YM Count Plate)

The PSF was analyzed for yeast and mold using the 3M™ Petrifilm™ YM Count Plate (3M Microbiology, St. Paul, MN). The Petrifilm is a sample-ready-culture-medium system containing nutrients supplemented with antibiotics, a cold-water-soluble gelling agent and an indicator that facilitates yeast and mold enumeration. Plates were incubated at 20-25 °C for 5 days.

Ethical Approval

Ethical approval for this study was obtained from the Joint-Faculty Research Ethics Board at the University of Manitoba. See Appendix F and G for copies of the consent forms and Appendix D and E for the ballots provided to the panellists used in both Parts A and B.

Data Analysis

Nutritional

Nutritional analysis for each of the PSP and PSF formulations was conducted using the Genesis SQL® R&D (Version 9.6; 2010) by ESHA Research (Salem, Oregon 97306). Nutrition fact labels were also developed using this program. A sample of the PSF was sent out to SGS Canada Inc. (Vancouver, B.C.) for verification on the lycopene content by high-performance liquid chromatography (HPLC). For verification of the final total fibre content a sample was sent to Medallion Labs (Minneapolis, MN) for analysis using the following method AOAC: 2009.01 method.

Statistical

Data was analyzed using SPSS® software version 18.0.0 (IBM® Corporation, Somer, NY, USA). Analysis of variance was used to evaluate statistical differences

within the data. Tukeys test was used to evaluate where statistical differences were between samples. Statistical significance was considered at $p < 0.05$.

Results

Part A

Effect of Added Red Lentils on Soluble Solids and pH of the PSPs

Table 4.4 presents the physicochemical characteristics of the PSPs. There were significant differences in soluble solids. Soluble solids was lowest in the control (11.5 ± 0.43) and highest in the PSP-15% RL formulation (12.70 ± 0.11). There were no significant differences between RL concentrations (10%, 15% and 20%). There were significant increases in pH with increasing RL concentration.

Effect of Added Red Lentils on Color Values of the PSPs

Table 4.5 illustrates differences in color values. Increasing RL concentration significantly increased L* values of the PSP between the PSP-control and PSP-20% RL. Formulations PSP-10% RL and PSP-15% RL had no significant differences. Hue angles significantly increased with increasing RL concentrations, where formulations PSP-10% RL and PSP-15% RL were not significantly different. Chroma values were unaffected by the addition of RL.

Table 4.4. Chemical Analysis of Increasing Red Lentils Concentration in PSPs (n=6)

	Score ± SD			
	Control	10% RL	15% RL	20% RL
◦Brix	11.5 ± 0.4a	12.47 ± 0.3bc	12.70 ± 0.1c	12.20 ± 0.2b
pH	3.95 ± 0.02a	4.05 ± 0.03b	4.11 ± 0.02c	4.17 ± 0.01d

Scores with the same letters within a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Table 4.5. Effect of Increasing Red Lentils Concentration on Color Values of the PSPs (n=6)

	Score ± SD			
	Control	10% RL	15% RL	20% RL
L*	31.37 ± 0.3a	32.98 ± 0.3b	33.39 ± 1.0b	35.45 ± 0.6c
C	25.41 ± 0.7a	25.05 ± 1.7a	25.37 ± 1.9a	27.24 ± 1.5a
h	38.23 ± 0.8a	42.61 ± 1.5b	45.00 ± 2.1b	48.00 ± 1.5c

Scores with the same letters within a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Effect of Added Red Lentils on Apparent Viscosity of the PSPs

Table 4.6 illustrates the apparent viscosity of the PSPs at differential rotational speeds. There are no significant differences in apparent viscosity between PSPs at differential rotational speeds of 50 and 100. However, apparent viscosity at 20 rpm was significantly lower for the PSP-15% RL sample than the PSP-control.

Effect of Added Red Lentils on the Sensory Profile of the PSPs

Figure 4.1 presents the sensory profile of the four PSPs (Raw data in Appendix H). There were no significant differences in aroma attributes '*cooked tomato*' and *'herb'*, flavour attributes '*tomato*' and '*oregano*', and aftertaste attributes '*oregano*' and '*heat*'. There were significant changes in the flavour attribute '*acidic*' where the PSP-control was ranked as higher acidic than the PSP-15% RL and PSP-20% RL. There was significant difference in the flavour attribute '*heat*' where PSP-20% RL had significantly lower heat than the PSP-control, PSP-10% RL and PSP-15% RL. The texture attribute '*grainy*' showed significant differences between the pasta sauces. The PSP-10% RL and PSP-15% RL were not significantly different from each other; however, they had a significantly higher graininess than the PSP-control. The PSP-20% RL was significantly grainier than both of the PSP-10% RL and PSP-15% RL as well as the PSP-control. The texture attribute '*viscosity*' was not significantly different between the PSP-control and PSP-10% RL, and there were no differences between the three RL formulations (10%, 15% and 20%). The PSP-15% RL and PSP-20% RL formulations had significantly higher viscosities than the PSP-control.

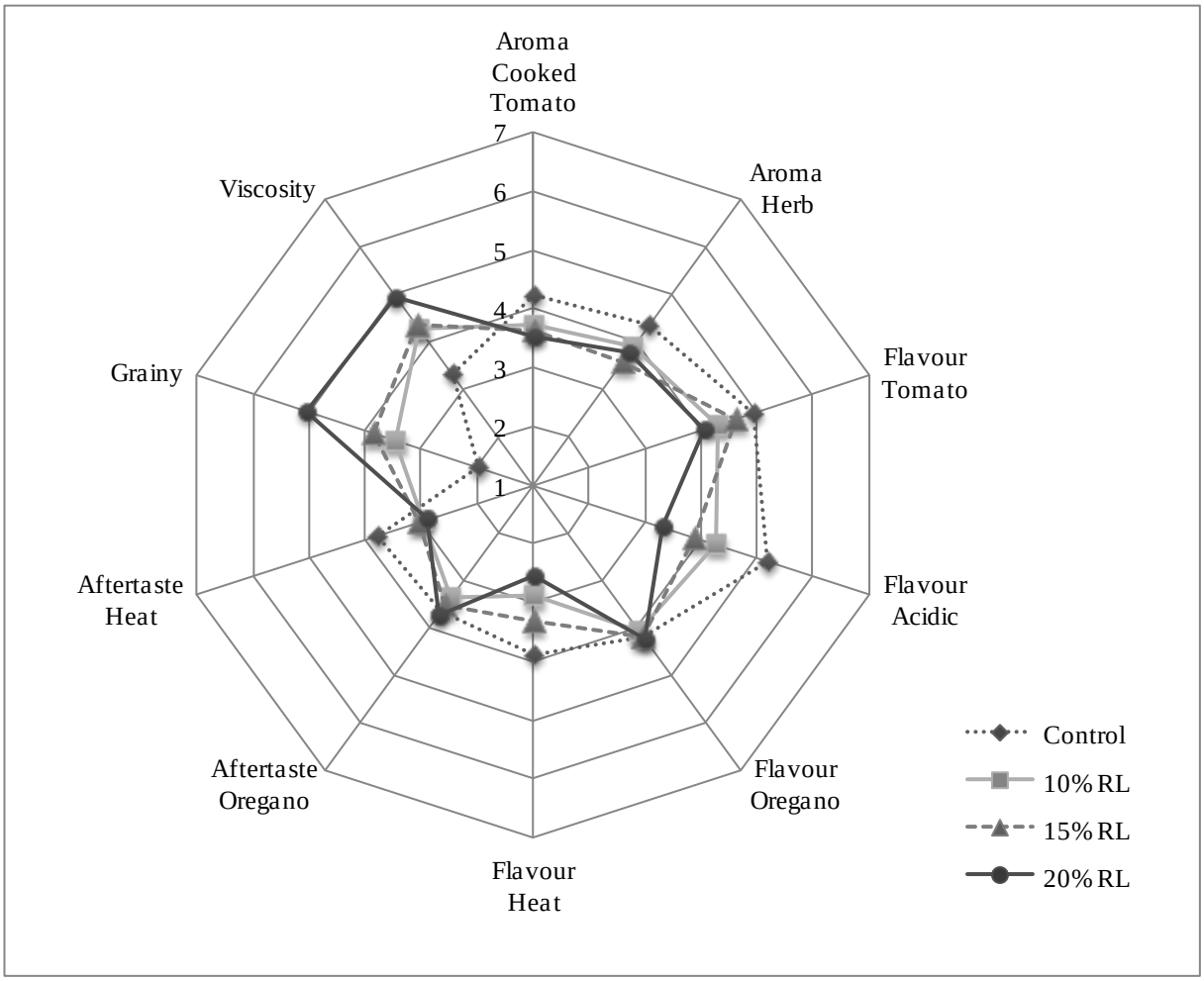
Table 4.6. Effect of Increasing Red Lentils Concentration on Apparent Viscosity at Differential Rotational Speeds in PSPs (n=6)

	Score ± SD			
	Control	10% RL	15% RL	20% RL
20 rpm	363.78 ± 50.3b[1]	308.33 ± 42.9ab	296.33 ± 24.5a	302.33 ± 37.5ab
50 rpm	171.60 ± 14.3a	149.11 ± 12.9a	163.87 ± 19.6a	161.31 ± 20.5a
100 rpm	120.24 ± 11.5a	108.96 ± 9.2a	119.56 ± 11.2a	118.64 ± 10.2a

[1] Expressed in cP/s

Scores with the same letters within a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Figure 4.1. Effect of Increasing Red Lentils Concentration on Sensory Profile of the PSPs (n=3)



Nutritional Analysis of the PSP Formulations

Table 4.7 presents a summary of the nutritional analyses generated from Genesis SQL®. Fibre content of the PSP formulations with added RL, at all levels, were analyzed to have doubled the fibre content of the PSP-control from 3 g (2.8 g) (12% DV) to 6 g (5.8 g)(24% DV). Moreover, with increasing RL concentration the total amount of sodium in the PSP simultaneously decreased. The PSP-control had a sodium content of 490 mg (20% DV) whereas the PSP-RL formulations contained 400 mg (17% DV), 370 mg (15% DV) and 340 mg (14% DV) for the PSP-10%, PSP-15% and PSP-20%, respectively. The PSP-RL formulations also contain double the amount of folate and higher amounts of protein, iron and magnesium. (See Appendix I for the nutritional analysis of the PSP formulations).

Table 4.7. Summary of Nutritional Analysis of the PSP Formulations (per 125 g)

Nutrient	Control	10% RL	15% RL	20% RL
Fibre (g)	2.8	5.8	5.8	5.8
CHO (g)	12.7	16.3	16.8	17.3
Protein (g)	2.6	3.3	3.6	4.0
Fat (g)	1.1	1.1	1.1	1.2
Sodium (mg)	494.4	400.0	372.3	337.6
Iron (mg)	1.8	1.9	2.0	2.0
Folate (mcg)	10.1	19.0	21.9	25.7
Magnesium (mg)	9.5	12.9	13.9	15.3

Part B

Effect of Added Red Lentils on the pH and °Brix of the PSF During 12 Week Storage

Table 4.8 presents the characteristics of chemical analysis during storage of the PSF. There were no significant changes in °Brix of the PSF during the 12 week storage at room temperature. There was a significant increase in pH at week 8, which did not change at week 12. There were no other changes in pH between week 0 and week 4.

Effect of Added Red Lentils on Color Values of the PSF During 12 Week Storage

Table 4.9 presents the characteristics of the color values during 12 week storage. There was no significant change in color values of the PSF during 12 week storage. None of the analyzed three values, L*, C and h were affected by storage.

Table 4.8. Effect of Red Lentils on the pH and °Brix of the PSF During 12 Week Storage (n=6)

	Score ± SD				
	Wk 0	Wk 2	Wk 4	Wk 8	Wk 12
◦Brix	14.93 ± 0.1a	14.88 ± 0.1a	14.88 ± 0.2a	14.88 ± 0.2a	14.97 ± 0.1a
pH	4.13 ± 0.01a	4.12 ± 0.01a	4.11 ± 0.01a	4.15 ± 0.01b	4.16 ± 0.01b

Scores with the same letters with a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Table 4.9. Effect of Red Lentils on Color Values of the PSF During 12 Week Storage (n=6)

	Score ± SD				
	Wk 0	Wk 2	Wk 4	Wk 8	Wk 12
L*	34.02 ± 0.38a	33.90 ± 0.44a	33.72 ± 0.77a	33.59 ± 0.53a	33.16 ± 0.53a
C	25.94 ± 0.56a	25.30 ± 0.76a	24.68 ± 1.60a	24.58 ± 0.98a	24.26 ± 0.93a
h	43.55 ± 0.71a	42.50 ± 1.04a	42.74 ± 1.22a	42.31 ± 1.36a	42.74 ± 0.70a

Scores with the same letters with a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Effect of Added Red Lentils on Apparent Viscosity of the PSF During 12 Week Storage

Table 4.10 presents the characteristics of apparent viscosity at differential rotational speeds. After week 0, apparent viscosities were not measurable at 100 rpm. Values measured at 20 rpm were lower than values measured at 50 rpm. After the 12 week storage period, the thickness of the PSF was significantly higher.

Effect of Added Red Lentils on the Sensory Profile of the PSF During 12 Week Storage

There were no significant changes to the sensory profile of the PSF over the 12 week storage period. Figure 4.2 presents the characteristics of the sensory profile of the PSF during the 12 week storage (raw data in Appendix J).

Effect of Added Red Lentils on the Microbiological Analysis of the PSF During 12 Week Storage

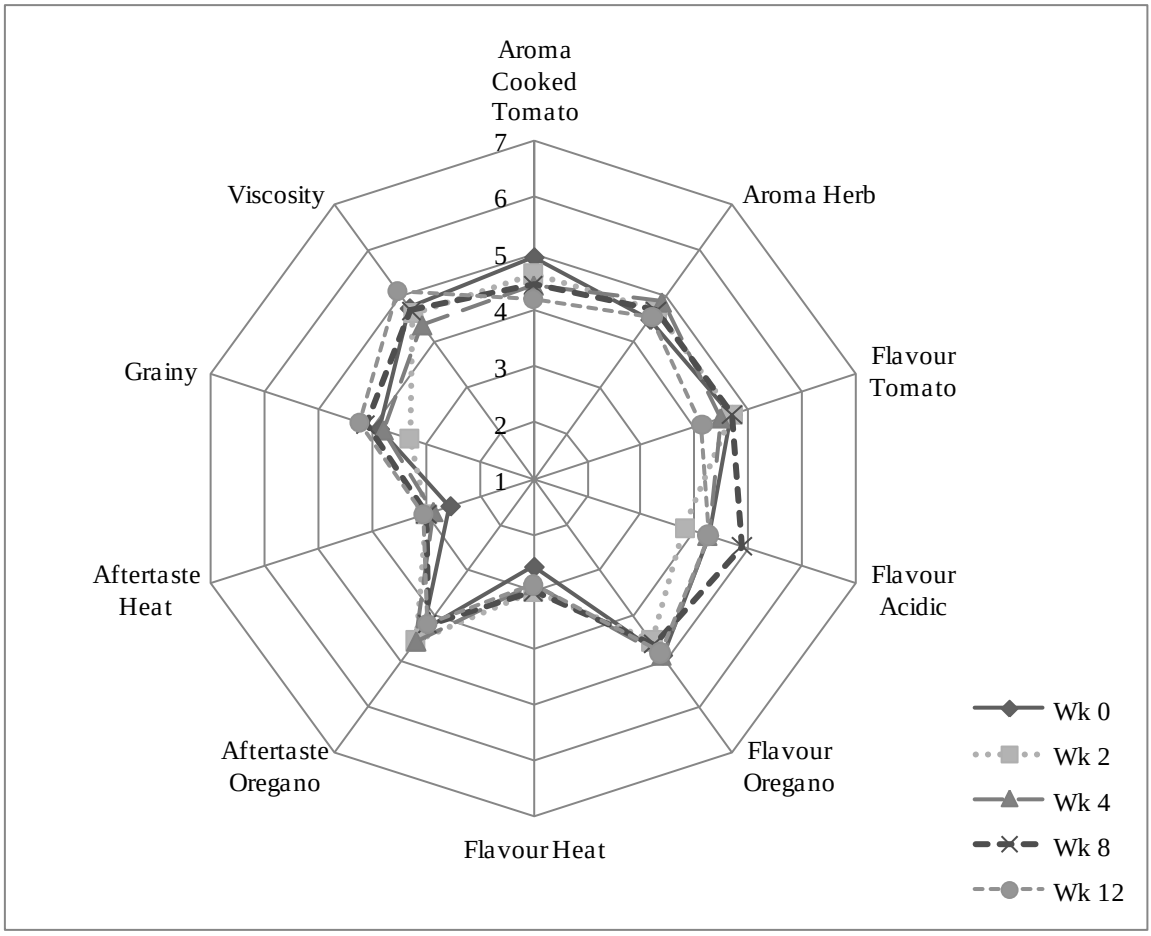
There were no significant changes in the microbiological analysis of the PSF during the 12 week storage period. Microbiological counts remained below 10. There was however, a slight increase in mold counts at week 12. (Raw data in Appendix K)

Table 4.10. Effect of Red Lentils on Apparent Viscosity at Differential Rotational Speeds of the PSF During 12 Week Storage (n=6)

	Score ± SD				
	Wk 0	Wk 2	Wk 4	Wk 8	Wk 12
20 rpm[1]	307 ± 26a	388 ± 52b	372 ± 57ab	381 ± 48ab	413 ± 36b
50 rpm	177 ± 13a	210 ± 11bc	220 ± 10c	202 ± 10b	220 ± 6c
100 rpm	127 ± 40	-[2]	-	-	-

[1] Expressed in cP/s.
[2] At 100 rpm, could not be measured.
Scores with the same letters within a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Figure 4.2. Effect of Red Lentils on the Sensory Profile of the PSF During 12 Week Storage (n=2)



Nutritional Analysis of the PSF Formulation

Table 4.11 presents a summary of the nutritional analyses generated from Genesis SQL®, SGS Canada Inc. and Medallion Labs. Fibre analysis from SGS Canada Inc. does not the specific method for measure inulin hence the lower fibre content estimated by Genesis SQL® and measured by Medallion Labs. The PSP-RL formulations also contained double the amount of folate and higher amounts of protein, iron and magnesium. The PSF had a lycopene content of 6 mg/ 100g. (See Appendix L, M and N nutritional analyses of the PSF formulations).

Table 4.11. Summary of Nutritional Analysis of the PSF Formulation

Nutrient	Genesis SQL® (per 125 g)	SGS Canada Inc. (per 100 g)	Medallion Labs (per 125 g)
Fibre (g)	6.34	3.4	5.75
CHO (g)	18.42	13.9	18.25
Protein (g)	3.99	2.6	3.29
Fat (g)	1.12	0.8	0.79
Sodium (mg)	323.33	270.8	350
Folate (mcg)	24.42	N/A	N/A
Iron (mg)	1.54	1.7	2.99
Magnesium (mg)	15.30	N/A	N/A
Lycopene (mg/100g)	N/A	6	N/A

Discussion

The objectives of the study were to conduct sensory analysis (Part A) and shelf-life study (Part B) on a pasta sauce (PSP and PSF) with added red lentils. Four formulations were analysed in Part A: a PSP-control, PSP-10% RL, PSP-15% RL and PSP-20% RL (all RL formulations included inulin). One formulation, 15% RL with inulin (PSF), was selected for scale-up for Part B. This study was successful in identifying an optimum pasta sauce formulation with added red lentils.

The significant increase in soluble solids of the PSP formulations with added RL may be predominantly attributed to the addition of inulin compared to the PSP-control. Inulin increases the total carbohydrate content which increases total soluble solids. The pH of the PSP formulations increased significantly with increasing RL concentration. Nonetheless, the numbers are within the pH range of 3.71 to 4.34 of commercial pasta sauces investigated by Koh et al. (2008) and the pH range of 3.95 to 4.32 of commercial pasta sauce previously investigated by Bugera (2011a).

Results of color L* values suggest adding RL to the PSP generated a lighter color with increasing RL concentration. There were no significant differences between chroma values indicating color saturation remains the same regardless of the addition of RL. Hue angle results suggest that increasing RL concentration imparted an apparent reddish-brown color to the PSP. When comparing to color values of commercial pasta sauces from Bugera (2011a) and Claybon and Barringner (2002a), values of the PSP formulations were higher. Thakur et al. (1996) reported that adding soy protein to tomato sauce ‘opened up’ the color, that is it became lighter and eventually whitish with protein concentrations greater than 1.0%. The L* values increased significantly for a tomato

sauce with added soy protein in Thakur et al. (1996) and pasta sauce with added RL in this study compared to samples without legumes. The PSF in the 12 week storage period did not have any significant changes in color values. Comparatively, a panel in a study by Armstrong and McIlveen (2000) reported significant differences in color in a sous vide meat-based pasta sauce over 40 days at 0-3 °C. Their panel found the color of the meat-based pasta sauce to be acceptable up to 20 days. Storage beyond 20 days produced a pasta sauce with a bright red colour which unacceptable to panellists (Armstrong and McIlveen, 2000).

Increasing concentrations of RL added to the PSP did not significantly increase the apparent viscosity of the PSPs. Results are contradictory to what was expected to happen where additional RL would increase the thickness of the PSP. Panellists' did rate an increase in both graininess and viscosity between the PSP-control and the PSP- 20% RL. Thakur et al. (1996) found significant increases in tomato sauce viscosity with increasing soy protein due to its water holding capacity. During the 12 week storage period the PSF did show significant differences in apparent viscosity. At 20 and 50 rpm, there was a significant increase at week 2. The panellists did not perceive any significant changes in thickness of the PSF during the storage period. A panel in Armstrong and McIlveen's study reported a decrease in viscosity during a 40 day storage in a sous vide meat-based pasta sauce. Differences in results of the two studies may be attributed to processing techniques, storage temperatures and times, ingredient formulations and sensory panels.

The PSP-RL formulations provide 3 g of fibre more per serving than the PSP-control. Adult (19-50 year) recommendations are to consume 38 g/day (males) and 25

g/day (females) and older adult (>51 years) recommendations are to consume 30 g/day (males) and 21 g/day (females) (Institute of Medicine, 2002); however, many do not consume nearly enough. Adequate intake of fibre has been shown to be beneficial in cardiovascular disease, bowel function, weight control, diabetes, and various cancers (American Dietetic Association, 2008). Sodium content of the PSP-RL formulations decreased with increasing RL concentration. Consumers are encouraged to choose foods with a % DV of 5% or less of sodium and to avoid or limit foods with a % DV of 20% and higher as these are considered high in sodium (Heart & Stroke Foundation, 2011). Although sodium levels are not below a DV of 5% it is still a better option than more than half of the pasta sauces found on grocery store shelves. The final formulation, PSF, provided per serving 6 g of fibre (a very high source of fibre), less than 1 g of far as per SGS Canada Inc and Medallion Labs analyses (low in fat) and provides between 270 and 350 mg of sodium (values were different between the analyses conducted by SGS Canada Inc. and Medallion Labs) which is lower in sodium than half of the commercial pasta sauces on grocery store shelves. The PSF also provides high amounts of protein, folate and magnesium than the PSP-control (in Part A) and commercial pasta sauces on grocery store shelves.

The lycopene content of the PSF was 6 mg /100 g. Results are within range of the commercial marinara pasta sauces investigated by Koh et al. (2008), which was 4.3–13.17 mg /100 g. However, the USDA reports higher lycopene content in commercial pasta sauces of 15.99 mg/100 g (USDA, 1998).

Limitations of the study included sensory panel training and testing different storage temperatures during shelf-life. Panellists participated in four hours of training for

the sensory panel in Parts A and B. Research has indicated that four hours of training is adequate to discriminate between products where general attributes are required, such as flavour and texture, which is what was required in this study (Hongsoongnern & Chambers, 2008). Regarding the shelf-life study, investigation of storage at two different storage temperatures (22 °C and either 40 °C or 6 °C) may have been conducted or a second pasta sauce could have been used to make final comparisons. The objective of this study was to identify an optimum level of added RL to a newly developed pasta sauce and conducting a 12 week shelf-life study on the selected formulation.

Future work may look at a shelf-life study at differential storage temperatures (22 °C and 40 °C) and may include an accelerated shelf-life component as well to compare and identify where sensory, chemical, physical and/or microbiological changes may occur. The study may include more than one PSP with 15% RL with different ingredient formulations. Different processing and/or packaging may be investigated. In this study, only a jar packaging was investigated. Future work may look at tray-film packaging (Olivieri-style) which needs to be refrigerated. Re-formulation of the PSF may be conducted to investigate ways to decrease even more the sodium content. One option would be to research the market for tomato sauces with lower or no sodium content and substituting it for the Primo tomato sauce used in the PSF.

In this study, there were significant differences among color and apparent viscosity analyses between the PSP-control and PSP-20% RL. Major differences were seen in the sensory profiles between the formulations. Perceived '*thickness*' and '*graininess*' increased whereas flavour attribute '*heat*' decreased in the 20% RL compared to other formulations. Although the 10% and 15% RL were at times

significantly different from the control there were no differences between the two formulations. As a result the PSP-15% RL formulation was selected and scaled-up for further analysis and shelf-life study. The shelf-life study showed that there were no significant changes in chemical, physical, microbiological and sensory in the pasta sauce during the 12 week storage which is a favourable outcome.

CHAPTER 5

BABY BOOMERS' ACCEPTABILITY OF A PASTA SAUCE MADE WITH LOCALLY GROWN PRODUCTS

Introduction

Baby boomers, individuals born between 1946 and 1965, represent a third of the Canadian population (Statistics Canada, 2006b). Baby boomers are driven, determined, independent, and health-conscious individuals. They have the highest annual income, $72,000 per year, compared to all other demographics (The Futures Company, 2009 & Yankelovich Inc., 2008). Baby boomers identify the following characteristics with healthy foods: whole grain, high fibre, trans fat free, low sodium, fresh, heart healthy and low fat (Lengyel & Utioh, 2009; Urala & Lähteenmäki, 2005; Krystallis et al., 2008). Major drivers to their food purchasing behaviour are health benefits, taste, price and freshness (Krystallis et al., 2008; Verbeke 2006). Fifty-five percent of baby boomers were more likely to purchase a food product if it were locally grown which makes this one of the most important characteristics in purchasing behaviour of this demographic (The Futures Company, 2009; Yankelovich Inc., 2008).

In 2000/2001, there was a 19% increase in the number of baby boomers who report suffering from a chronic illness compared to the same age group in 1978/1979 (Wister, 2005). With an aging baby boomer population looking for health-conscious and disease prevention properties in foods, food developers need to focus on the consumers' needs to be successful (Shelke, 2008). Food companies have realized that the aging population is an under-marketed segment of the population and more research and product development needs to be undertaken to better cater to their specific needs. Baby

boomers specifically seek out food products with disease prevention properties rather than energy enhancing benefits (Krystallis et al., 2008). Middle-aged adults and older (> 35 years) tend to seek out food products with the following attributes: cholesterol lowering, gut friendly, heart healthy, and blood pressure lowering (Krystallis et al., 2008, Urala et al., 2004, Landström et al., 2007, Urala & Lähteenmäki, 2005).

Baby boomers are aware of some benefits from functional foods and try to incorporate them into their daily diet. Functional foods are defined as being "similar in appearance to, or may be, a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions" (Health Canada, 1998). However, most are sceptic about the credibility (van Kleef et al., 2005) of these products, their ingredients and processing techniques. Baby boomers would rather see more locally produced functional foods (Lengyel & Utioh, 2009) made with locally grown ingredients to put a familiar face to the food product and producer (Arès et al., 2008; Messina et al., 2008). Moreover, the respondents noted that they would consider purchasing cereal (breakfast food), fish, flax, and consume more fruits and vegetables to increase nutrient intake (Lengyel & Utioh, 2009).

Pasta sauce is a widely consumed tomato product. In Canada the estimated total sale for pasta sauces in 2008 was $273 million and this is expected to increase annually to an estimated $326.4 million by 2011. The pasta sauce market share is estimated to grow from 6.7% in 2003 to almost double 11.6% by 2011 (Food for Thought, 2010, p. 30). There is a wide range of pasta sauces found on grocery store shelves. The majority are name brands or store brands, a smaller number are produced by private companies,

however none are locally produced. There are countless varieties promoting chunkiness, various flavour attributes, some are marketed as a 'healthier choice' than others, however they are limited.

One of the key descriptors in the quality of tomato products is color. Prototypical (Caucasian) consumers showed the widest range of color acceptability, with hue angles between 20.9–35.8; wherein the commercial pasta sauces available ranged from 29.8–32.7 in a study by Claybon & Barringer (2002a). Thus, consumers appear to have a greater range of color acceptability for pasta sauces than what is commercially available. According to Claybon and Barringer (2002a), consumers have a '*wide range of expectations*' for pasta sauces as they are easy to make at home and widely available in restaurants (p. 494). Consumers found pasta sauces that were too red or too brown to be unacceptable; it is the middle range, between bright red and brown, that is preferred by consumers. Claybon & Barringer (2002b) also found that consumers were not able to differentiate between slight differences in viscosity only obvious differences. Consumers preferred pasta sauces that were thicker than what is commercially available. Claybon & Barringer (2002b) speculated this is because consumers may want a thicker pasta sauce that will adhere to the pasta whereas a thinner pasta sauce may not. They recommend that manufacturers invest in producing thicker pasta sauces as the additional cost of doing so may be worthwhile for consumers.

The objective of this study was to identify consumer acceptability of a pasta sauce with added health benefits referred to as pasta sauce final (PSF).

Methods

Consumer acceptability tests were conducted to measure sensory, pricing, packaging and overall acceptability of the PSF. The tests were carried out by Baby Boomers, born between 1946 and 1965, who regularly consume tomato-based pasta sauces (more than once a month) and who are not allergic to any of the ingredients. Participants were recruited at four Farmers' Markets (Pineridge Hollow, Saint-Norbert, Portage la Prairie and Saint-Malo) located in Manitoba. A booth was set-up at the locations and baby boomers' were recruited by intercepts. The purpose of the study and criteria for participation were briefly explained to the participants. Participants were provided with a consent form, 2 questionnaires, a sample of the PSF, and a bottle of water for mouth cleansing. They were instructed to taste the sample and rate their acceptability. Demographic information was also collected (Appendix O). Participants were asked one question on where they resided, either in rural or urban Manitoba. Urban Manitoba was defined as Winnipeg and Brandon with populations greater than 25,000 (Government of Manitoba, 2011). Those who participated in the taste testing were entered in a draw for a chance to win 1 of 4 fifty dollar gift certificates to a grocery store of their choice (one draw per location). The tasting process took approximately 10 minutes.

Consumer Acceptability Questionnaire

Consumers were asked to complete an acceptability questionnaire (Appendix P). Color, aroma, taste and texture of the PSF were rated on a nine-point hedonic scale where nine is '*like extremely*' and one is '*dislike extremely*' and one question on the likelihood of purchasing the PSF rated on a five-point scale where five is '*would definitely*

purchase' and one is '*would definitely not purchase*'. Consumers were asked whether they preferred a 750 ml or 500 ml jar and how much they were willing to pay for the 750 ml jar of the PSF they just sampled.

Sample Preparation

Samples of PSF were selected from the shelf-life study, between eight to twelve weeks into the storage, from Chapter 4 of this study. The PSF from the shelf-life study was a scaled-up product. The PSF was developed at the Food Development Centre in Portage la Prairie, Manitoba. The ingredient profile of the PSF is presented in Table 5.1. Locally grown ingredients were selected, when possible, to use in the PSF formulation. Manitoba grown ingredients included canola oil, zucchini and carrots. Saskatchewan grown ingredients included red lentils. A 125 ml sample of PSF was served with 125 ml pasta (rotini). The PSF was re-heated to 70 °C and the pasta was cooked according to package instructions. The pasta (rotini) was prepared as per package instruction, 250 g pasta in 1 L boiling water. The PSF and pasta were both hot held at 60 °C during the consumer acceptability testing using a chafing dish for the pasta and a soup warmer for the pasta sauce. Temperature was periodically recorded. The guidelines for serving potential hazardous foods at farmers markets were followed as per the Manitoba Farmers' Market Guidelines (Government of Manitoba, 2009b).

Ethical Approval

Ethical approval was obtained from the Joint-Faculty Research Ethics Board at the University of Manitoba for this study. Consent was obtained from each participant (Appendix Q).

Table 5.1. Ingredients of the Pasta Sauce Final

Ingredients	Amnt (%)
Tomato Base	
Tomato sauce	46
Tomato paste	4
Canola oil	0.5
Vegetables	
Yellow onion	1.4
Zucchini	1.1
Carrots	1.1
Celery	0.9
Red peppers	0.5
Green peppers	0.5
Roma tomatoes	25
Red Lentils	15
Spices/Herbs	
Brown sugar	0.4
Inulin	2.13
Citric acid	0.1
Onion powder	0.9
Garlic powder	0.4
Roasted garlic powder	0.2
Oregano leaves	0.1
Basil leaves	0.2
Thyme leaves	0.04
Bay leaves	0.02
Black pepper	0.01
Cayenne pepper	0.01
Crushed red pepper flakes	0.02

Statistical Analysis

Data was entered and analyzed using SPSS software version 18.0.0 (IBM® Corporation, Somer, NY, USA) and SAS software version 9.2 (SAS Institute Inc., Cary, NC, USA). Analysis of variance was used to evaluate statistical differences within the data. Descriptive analyses were conducted (frequencies and percentages). Tukeys test was used to evaluate where statistical differences were between samples. Responses from the nine-point hedonic scale greater than seven were merged together to represent the '*like*' categories and responses less than 6 were merged together to represent the '*dislike*' categories. Responses from the purchasing question where responses greater than four were merged together to represent '*likeliness to purchase*' and responses less than three were merged together to represent '*likeliness to not purchase*'. Regression analysis was conduct for 'amount willing to pay' (or cost) and 'willingness to purchase' a 750 ml jar of the PSF and their association with other variables. The variables tested were gender, area of residence, baby boomer age category (young or old), number of times consumed pasta sauce in a month, number of individuals in a household, children living in the household, number of supper home cooked meals prepared in a week, and acceptability of the pasta sauce (sensory characteristics). Statistical significance was considered at $p < 0.05$.

Results

Participants

Table 5.2 represents the demographic characteristics of the participants in the study. One hundred and twenty-three baby boomers participated in the study (male = 25%; female = 75%). Equal representation from the older baby boomers born between

Table 5.2. Demographic Characteristics of Baby Boomer Participants

Variable	Female (n = 92) n (%)	Male (n = 31) n (%)	Total (n = 123) n (%)
Year of Birth			
1946 – 1955 (old baby boomer)	53 (58)	16 (52)	69 (56)
1956 – 1965 (young baby boomer)	38 (41)	15 (48)	53 (43)
Area of Residence			
Rural	38 (41)	16 (52)	54 (44)
Urban	54 (59)	15 (48)	69 (56)
Location of Session			
Pineridge Hollow	29 (32)	11 (36)	40 (32)
Saint-Norbert	28 (30)	6 (19)	34 (28)
Portage la Prairie	20 (22)	9 (29)	29 (24)
Saint-Malo	15 (16)	5 (16)	20 (16)
Annual Household Income			
Less than $10,000	-	1(3)	1 (-)
$10,000 to $19,999	4 (4)	-	4 (3)
$20,000 to $29,999	7 (8)	2 (6)	9 (7)
$30,000 to $39,999	6 (7)	2 (6)	8 (7)
$40,000 to $49,999	8 (9)	6 (19)	14 (11)
$50,000 to $59,999	7 (8)	1 (3)	8 (7)
$60,000 and over	40 (43)	15 (48)	55 (45)
Overall Health			
Poor/Bad	1 (1)	-	1 (-)
Fair	4 (4)	1 (3)	5 (4)
Good	31 (34)	14 (45)	45 (37)
Very Good	44 (48)	15 (48)	59 (48)
Excellent	12 (13)	1 (3)	13 (11)
Number of Individuals Living in the Household			
1 person	11 (12)	-	11 (9)
2 people	54 (59)	18 (58)	72 (59)
3 people	10 (11)	4 (13)	14 (11)
4 people	10 (11)	4 (13)	14 (11)

Continued ...

5 people	6 (7)	3 (10)	9 (7)
6 people	-	-	-
7 people	-	1 (3)	1 (-)
Number of Households with/without Children			
Without Children	64 (70)	17 (55)	81 (66)
With Children	26 (28)	11 (35)	37 (30)

1946 and 1955 and younger baby boomers born between 1956 and 1965, 56% and 44% respectively. The mean age was 56 ± 5.4 years. Equal representation from urban and rural, 56% and 44% respectively. Forty-eight percent of participants had household incomes greater than $60,000 per year. The majority of participants rated their own overall health as greater or equal to '*good*' (95%), lived in a two person household (59%) and did not have children living in the household (66%).

Table 5.3 represents participants' responses to consumer and purchasing behaviour. Participants were more likely to consume pasta sauce 4 ± 2.6 times a month. Women were more likely to purchase groceries and prepare meals in the household. Seventy percent of participants' prepared and consumed six to seven home cooked supper meals at home in a week.

Table 5.3. Baby Boomer Participants' Responses to Consumption and Purchasing Behaviour Questions

Variable	Female (n = 92) n (%)	Male (n = 31) n (%)	Total (n = 123) n (%)
How often do you consume a meal with a tomato-based pasta sauce in a month?			
Less than 5 times a month	72 (78)	25 (81)	97 (79)
Between 6 and 10 times a month	17 (18)	5 (16)	22 (18)
Between 11 and 15 times a month	1 (1)	-	1 (-)
Greater than 16 meals a month	1 (1)	-	1 (-)
In your household, who purchases the groceries?			
Male	5 (5)	5 (16)	10 (8)
Female	69 (75)	13 (42)	82 (67)
Both	17 (18)	13 (42)	30 (24)
In your household, who prepares over 50% of the meals?			
Male	6 (7)	5 (16)	11 (9)
Female	74 (80)	21 (68)	95 (77)
Both	9 (10)	4 (13)	13 (11)
On average, how many home cooked supper meals do you have per week?			
0-1 meals	-	-	-
2-3 meals	4 (4)	1 (3)	5 (4)
4-5 meals	23 (25)	8 (26)	31 (25)
6-7 meals	65 (71)	21 (68)	86 (70)

Consumer Acceptability

Table 5.4 represents overall acceptability of the PSF attributes from the baby boomers. Over 90% of baby boomer participants liked the color, aroma, flavour and texture of the sampled pasta sauce. There were no differences in overall acceptability of the PSF between genders, area of residence and Farmers' Market location. Eighty-three percent of the participants were willing to purchase the pasta sauce where older baby boomer women were the most willing to purchase the pasta sauce (Figure 5.1). There were no significant differences between jar size (500 ml and 750 ml) preference regardless of age (old or young baby boomer), children living in the household or not and number of times pasta sauce is consumed in a month.

Table 5.5 represents the costs baby boomer participants were willing to pay for a 750 ml jar of the PSF. Baby boomer participants were willing to pay an average cost of $4.38 ± $1.64 for a 750 ml jar of the PSF. A significant difference was found between respondents from the St-Norbert location and the St-Malo location, where respondents from the St-Malo Farmers' Market were willing to pay more for a 750 ml jar of the PSF. Males were willing to pay, on average, significantly more than females for a 750 ml jar of the PSF.

Cost regression model identified that participants that consumed tomato-based pasta sauces greater than six times a month were willing to pay significantly more, $0.81, than participants who consumed tomato-based pasta sauce less than five times a month.

Appendix R represents the comments from the baby boomer participants regarding the PSF. Participants comments on the flavour was '*absolutely delicious*', '*nice taste','I would use this product*', and '*it tastes wonderful*'. Regarding the texture,

participants found the '*texture [was] a bit odd at first for a pasta sauce, but once I connected it to the lentils it was OK*'. Overall comments were positive.

Table 5.4. Baby Boomer Participants' Acceptability of the PSF

	Like	Dislike
Color	96.8%	3.2%
Aroma	95.2%	4.8%
Taste	93.5%	6.5%
Texture	91%	9%

Figure 5.1. Baby Boomer Participants' Willingness to Purchase the PSF

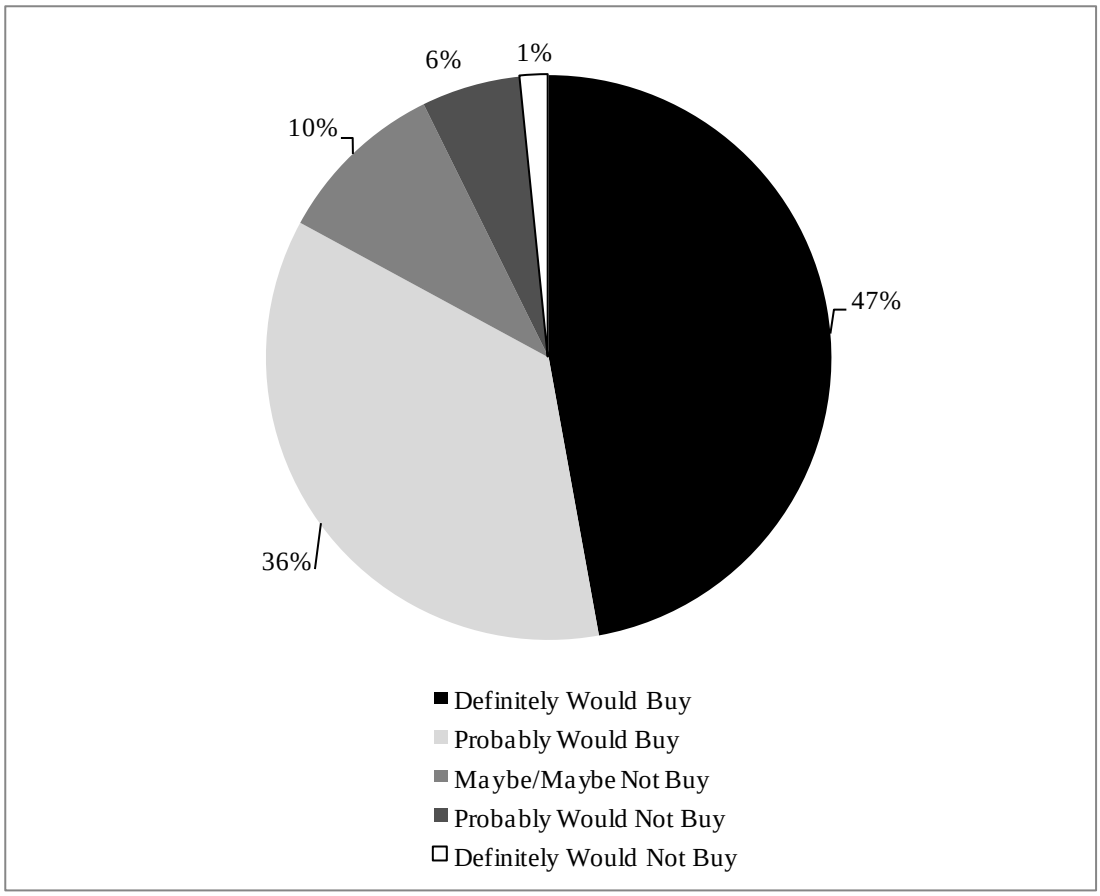


Table 5.5. Cost Participants were Willing to Pay for the PSF (n=121)

Area	Cost ($)		
	Female	Male	Average
Pineridge Hollow (R)	3.98	5.54	4.41ab
St-Norbert (U)	3.95	3.40	3.86a
Portage la Prairie (R)	4.19	4.71	4.35ab
St-Malo (R)	4.97	5.80	5.18b
All 4 areas	4.18a	4.98b	4.38

Scores with the same letters are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.
R: rural; U: urban
750 ml jar

Discussion

The objective of the study was to conduct a consumer acceptability study of the PSF among baby boomers. Consumer tasting of the pasta sauce was successful throughout the province of Manitoba at four Farmers' Markets. Comments from the participants were positive and the majority would be willing to purchase the pasta sauce.

The demographics of the study participants at Farmers' Markets were similar to those of Elepu & Mazzocco (2010). The majority of their participants were women (76%), 38% were baby boomers (largest group), 54% had a household size of 2-3 individuals, and 65% had incomes greater than $50,000 per year.

Participants were willing to pay $4.38 ± $1.64 for a 750 ml jar of the pasta sauce with added health benefits. Cost regression model identified that men were willing to pay $0.69 more for a jar than women. The average cost of a 750 ml jar of commercial pasta sauces on grocery store shelves in Winnipeg, Manitoba is $4.04 ± $1.06. Prices of commercial pasta sauces varied by brand and store and ranged from $2.47 to $6.69. Based on suggested costs from participants, on average they were willing to pay $0.34 more for a 750 ml jar of PSF compared to what the average commercially available price. West et al. (2002) reported that consumers were willing to pay $0.66 more for a tomato sauce with anti-cancer properties. Similar results by Terattanavat & Hooker (2006) reported that respondents were willing to pay $0.93 more for a tomato juice with a 'single health benefit', $0.28 more for 'multiple health benefits' and $0.41 more for 'naturalness' where the base price was at $3.00 per pack (6 cans, 8 fl oz/can, $0.50 per unit). Asselin (2005) identified that very health conscious consumers were willing to pay $0.72 more

for eggs with health benefits. The price participants were willing to pay for the PSF may not only be linked to the added health benefits but to the inclusion of local food products.

Eighty-three percent of participants were willing to purchase the PSF which is made with locally grown food ingredients (Manitoban and Saskatchewan). Research has shown that familiarity with a product or ingredient increases the willingness of consumers to use and/or purchase a functional food (Messinaet al., 2008). Along with familiarity is trust, knowing where the product is produced and with local ingredients strengthens the bond of trust between the consumer and the food manufacturer which increases willingness to use and/or purchase (Siegrist et al., 2008). Consumers identify the following attributes of food products as highly important; trust in the food product, the health message with the product, the food industry and the ingredients with willingness to use and/or purchase (Siegrist et al., 2008, West et al., 2002, Urala & Lähtennmäki et al., 2004, Arès et al., 2008).

The following associations were found between cost and tested variables however none were significant. Preparing home cooked supper meals between six to seven times a week was associated with willingness to pay slightly more, $0.19, for the PSF than those who prepared less than five home cooked supper meals. Baby boomers without children were willing to pay $0.28 more for a jar of the pasta sauce than baby boomers with children.

Research by Hunter & Worsley (2009) suggested that as baby boomers age they will be purchasing foods in smaller quantities and portions. Conversely, this study found that baby boomers did not show significant differences in purchasing a larger jar size (750 ml) versus a smaller jar size (500 ml) of pasta sauce. No significant differences in

preference in size of jar between households with children and households without children. No significant difference between willingness to purchase the PSF and the presence of children living in the household. Peng et al. (2006) found a relationship between purchasing functional foods and children in the household. They concluded that adults with children less than 12 years were less likely to purchase functional foods. These results are contrary to what this study found where the presence of children in the household did not influence the parents (baby boomers) decision in purchasing a functional pasta sauce.

Participants who ranked highly (>7 on scale) all sensory attributes (color, aroma, taste and texture) and prepared six to seven home cooked supper meals a week were significantly more willing to purchase the PSF. Highly ranking all sensory attributes were individually significantly associated with preparing six to seven home cooked supper meals a week, however they were no longer significant when added to the regression model together.

Limitations of the study included sampling and number of sampled products. Purposive sampling was selected for this study. Farmers' Markets were strategically selected to conduct the consumer tasting in order to have participants who were already looking for locally grown and/or produced products. The second limitation was the number of products being sampled by the consumers. Only one product formulation was used in the consumer tasting. A commercial product was not selected for comparison with the PSF as there were no comparable commercial pasta sauces on the market. It would have been ineffective to compare two products that were completely different. As a result, only the test product was selected for the testing.

Future work could look at product optimization based on results the shelf-life study. Consumer acceptability may be conducted once more to investigate acceptability of the optimized pasta sauce in order to bring it to market.

This study suggested that baby boomer participants really liked the color, aroma, flavour and texture of the PSF. Participants would purchase the PSF if it were on the market and pay a premium for this product. Income, gender, area of residence, and whether there are children or not living in the household did not affect the participants' willingness to purchase or pay a premium for the PSF. Overall, baby boomer participants were positive about the PSF made with locally grown ingredients.

CHAPTER 6

GENERAL DISCUSSION

The first objective of the study was to develop a pasta sauce prototype (PSP) with increased health benefits by using Manitoba grown ingredients when available. A PSP formulation was developed utilizing the following Manitoba grown products: carrots, zucchini, and canola oil. Three sources of fibre, red lentils (RL), pea fibre (PF) (both locally sourced and produced) and oat fibre (OF) (not locally sourced however oat is produced in Manitoba) were investigated. Results showed that red lentils, added to the PSP, had the least effect on chemical and physical characteristics compared to the addition of oat fibre and pea fibre. The nutritional profile of the PSP-RL formulations was more beneficial as it offered lower sodium content than the PSP-control, PSP-OF, PSP-PF and 50% of the sampled commercial pasta sauces. The PSP-RL formulation may be a healthier option for baby boomers in terms of lower sodium content than what is commercially available. The PSP-RL with inulin is a very high source of fibre, providing 6 g of fibre per serving (125 ml), where no commercial pasta sauces on the market offers more than 3 g of fibre per serving (125 ml).

The second objective of the study was to conduct sensory and shelf-life testing on the PSP-RL formulations. The RL formulations were chosen as they imparted the least significant differences in chemical and physical characteristics compared to the PSP-control and provided a lower sodium content than the PSP-OF and PSP-PF formulations. Also, the addition of OF and PF imparted negative off-flavours in the PSP. Three levels of RL with inulin were investigated and compared to a control-PSP with no RL and inulin. The PSP-15% RL had the least significant differences in sensory, chemical and

physical characteristics compared to the PSP-control. The PSP-15% RL was similar to the PSP-10% RL in analyses. The PSP-20% RL showed the greatest significant differences compared to the three PSP formulations. Results were unfavourable. A shelf-life study was then conducted with the PSP-15% RL now referred to as pasta sauce final (PSF). There were no significant sensory, physical, chemical and microbiological changes over a 12 week storage period.

The third objective of the study was to conduct consumer acceptability tests on the PSF. One hundred and twenty-three baby boomers, 75% females with a mean age of 56 ± 5.4 years, were recruited from four Farmers' Markets across southern Manitoba. Participants consumed pasta sauce on average four times a month. Over 90% of baby boomer participants liked the color, aroma, flavour and texture of the sampled pasta sauce. Eighty-three percent of participants were willing to purchase the pasta sauce if it were commercially available. Men were willing to pay significantly more for a 750 ml jar of the PSF than females. Participants were willing to pay a premium of $0.34 more for the PSF. Participants sampled from rural Farmers' Markets were willing to pay more than participants sampled from the urban Farmers' Market. Participants at the St-Malo Farmers' Market were willing to pay significantly more than participants at the St-Norbert Farmers' Market. Overall, baby boomer participants were positive about the PSF which was made with locally grown ingredients. Income, gender, area of residence and the presence of children in the household did not impact the participants' willingness to purchase or pay for the PSF. Participants, no matter their demographic characteristics, were equally as likely to purchase and pay a premium for the PSF.

Overall, this study was successful in developing a pasta sauce targeting the nutritional needs and interests of baby boomers, which has not yet been previously investigated. Research indicates that baby boomers are looking for food products that offer disease prevention properties (Krystallis et al., 2008) with the following key attributes: cholesterol lowering, gut friendly, heart healthy, and blood pressure lowering (Krystallis et al., 2008, Urala et al., 2004, Landström et al., 2007, Urala & Lähteenmäki, 2005). Baby boomers are very affluent, have the highest annual household incomes, $72,000 per year, compared to all other demographics (The Futures Company, 2009 & Yankelovich Inc., 2008) and are extremely health conscious. They thrive to stay young, healthy and active as much and as long as possible. Baby boomers are aware that unhealthy eating habits may not have an immediate impact on health, but a long-term effect in their later years (Statistics Canada, 2005b). Over an eight year period, individuals who adopted healthy behaviours in early to mid-life continued to report good health through older age (Statistics Canada, 2005c). This further emphasizes that health behaviours, even if adopted in the middle-aged years may still influence the development of positive outcomes later in life. The PSF may be a healthier functional food option that baby boomers can adopt in their diet.

Limitations

The study design for sensory analysis in the product development phase was limited to incorporating all ten PSP formulations. The number of samples depends on the type of product, the number of characteristics being evaluated, the type of test and experience of the panel in order to avoid both sensory and mental fatigue (Poste et al., 1991). Accordingly, the sensory profile of pasta sauce is complex and having too many

formulations would have lead to sensory and mental fatigue for the panel. As such, a smaller sample size would be more effective. Developing three separate studies to investigate each source of fibre individually in the PSP may have been more beneficial.

A second limitation is the limited use of fresh and local products for this pasta sauce. Variability in the freshness of produce may affect overall quality of the final product and can be difficult to control. Availability and consistency in prices of local products also cannot be controlled. These challenges are greatly affected by the environment, economy and demand for the products.

Another limitation may be the production and investigation of only one PSF. In the shelf-life study, there was no product of comparison; however, no differences were seen in chemical, physical, sensory and microbiological analyses among the sample during storage. It can be assumed that the same may have been seen if another PSF formulation was developed to compare. Lack of significant differences identified in the consumer acceptability testing may also be due to only one product being investigated. It had been assumed that there would be significant differences in the willingness to purchase and the amount participants were willing to pay between baby boomers with and without children, however, no significance was found. Differences were expected between preferred sample sizes and number of individuals living in the household, but again no differences were seen. This may also be attributed to a small sample size of 123 participants. If a much larger sample size was questioned there may have been differences found. A commercial pasta sauce could not have been used as a comparison as there are no similar pasta sauces on the market, thus only the PSF was used in the consumer acceptability tests.

Future Work

Further investigation on the effect of added OF and PF on the PSP formulation should be analyzed to identify their possible application to pasta sauces. Although initial results indicated off flavours with the addition OF and PF, product re-formulation may provide desirable results. Sensory analysis with a trained panel is needed to identify the flavour profile of the pasta sauce with added OF or PF to develop a final formulation for commercialization. The study should include a shelf-life study to identify and compare chemical, physical, sensory and microbiological changes during storage of two or three formulations at different temperatures, such as 22 °C and 5 °C.

Regarding the PSF formulation investigated in this study, in both the shelf-life study and the consumer acceptability, further optimization trials incorporating comments from consumer participants should be conducted. Reformulation should be conducted to improve the present PSF formulation to enhance the flavour profile and stabilization. An additional shelf-life study should be undertaken with the new PSF formulation(s) compared to the original PSF to identify improvements and new characteristics. Once a successful new formulation has been developed, a subsequent consumer acceptability testing may be conducted or the new scaled-up re-formulation to market and/or sold at Farmers' Markets.

Summary

Findings from this study emphasize that a pasta sauce with added health benefits, primarily increased fibre content, can be developed with the use of locally grown Manitoba products. Red lentils were identified as the ideal source of fibre to be used in the PSP as it showed only minimal differences in chemical, physical and sensory changes

compared to the control. The nutritional profile of the PSF provided 6 g of fibre per serving, doubling what is provided by commercially available pasta sauces. The PSF also contained 370 mg (15% DV) sodium; lower sodium content compared to 50% of the commercial pasta sauces sampled.

The results from this study may be used to optimize the present pasta sauce formulation and provide further insight into the purchasing behaviour and interests of baby boomers. Product development targeting baby boomers and their health interests is an underdeveloped area and this study provides insight into the potential market. The study also provides additional information on purchasing and consumption behaviour of foods with added health benefits marketed to baby boomers.

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Appendix A

Product Development Comments: Internal Taste Panel

Analysis/Trial	Comments	Conclusions
Homemade (HM) tomato sauce vs Store bought (SB) tomato sauce	- SB tomato sauce also contains spices - HM tomato sauce is not as smooth in texture - HM tomato sauce has increased processing time - SB tomato sauce provides a consistent product	- Due to processing, time constraints and because products are similar we will continue to investigate the use of SB tomato sauces
Store bought tomato sauce: Heinz® vs Hunt's®	- Tomato sauces have similar viscosity, pH, Brix and color - Flavours are similar - Heinz® is made from fresh tomatoes - Hunt's® is made from reconstituted tomato paste	- Because the Hunt's® tomato sauce is made from reconstituted tomato paste it is more processed than the Heinz® tomato sauce. - Further investigation into the Heinz® tomato sauce
Heinz® tomato sauce: regular vs low in salt variety	- No difference in flavour	- The low in salt variety is only available in 287 ml cans and not available from food suppliers such as Sysco™ - Future trials will be conducted with Heinz® regular tomato sauce
Pasta sauce made with: fresh tomatoes vs canned tomatoes	- Fresh tomato quality is not always consistent and may vary which will affect the pasta sauce - Canned tomatoes are consistent in quality - Canned tomatoes gave the pasta sauce a pizza sauce flavour - Flavour, heat and herbs, were less pronounced in pasta sauce made with canned tomatoes	- As we are trying to provide a pasta sauce with fresh product and less processed, future trials will be conducted with fresh tomatoes - To manage the effect of variability in fresh tomatoes we will reduce the content in the pasta sauce formulation

Continued ...

Pasta sauce made with: fresh tomatoes & sundried tomatoes	- The sundried tomatoes needed to be reconstituted in order to be used in the pasta sauce - Added time for processing also included puree-ing the sundried tomatoes - Gave the pasta sauce a tomato paste flavour and a dark red to brown color - The sundried tomatoes are also very costly	- As a result we did not continue to investigate the incorporation of sundried tomatoes in the pasta sauce
Heinz® tomato sauce with: Red Lentils (RL), or Pea Fibre (PF), or Oat Fibre (OF)	- RL in tomato sauce: o Color a little red-brown o Texture a little grainy o Viscosity increased slightly over time o Overall flavour was good - PF in tomato sauce: o Color a little lighter orange-red o Initial texture was grainy but over time disappeared o Gave the sauce a metallic taste –not acceptable - OF in tomato sauce o No visible drastic color changes o Mixes well in sauce o Over time it gave the tomato sauce an unpleasant taste –not acceptable	- Thus we conducted further investigations with RL in combination with inulin. - Note, RL alone cannot provide 4 or 6 grams of fibre in 125 grams of pasta sauce alone. It would require too much RL to provide this. As a result a combination of RL and inulin will be used. - Also, seeing as PF and OF are novel fibres and would need special approval from Health Canada to incorporate into a commercial pasta sauce more trials would need to be completed to achieve this.

Appendix B

Nutritional Analysis (Genesis SQL® R&D) of PSP Control and Fibre Formulations

Pasta Sauce Prototype-Control

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 70	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 490 mg	**20** %
Carbohydrate / Glucides 13 g	**4** %
Fibre / Fibres 3 g	**12** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-RL-2

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 380 mg	**16** %
Carbohydrate / Glucides 15 g	**5** %
Fibre / Fibres 3 g	**12** %
Sugars / Sucres 6 g	
Protein / Protéines 4 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-RL-1

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

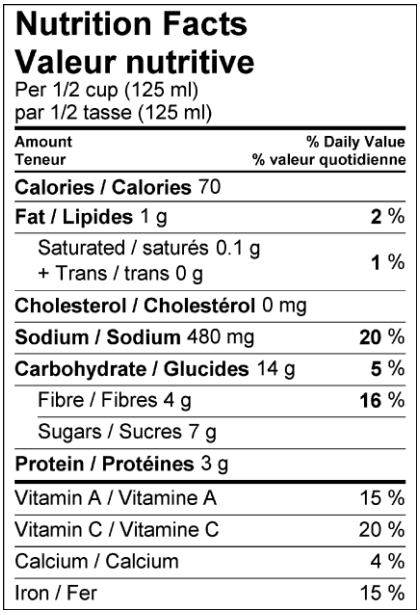
Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 90	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 360 mg	**15** %
Carbohydrate / Glucides 16 g	**5** %
Fibre / Fibres 3 g	**12** %
Sugars / Sucres 6 g	
Protein / Protéines 4 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-RL-3

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 370 mg	**15** %
Carbohydrate / Glucides 17 g	**6** %
Fibre / Fibres 5 g	**20** %
Sugars / Sucres 6 g	
Protein / Protéines 4 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

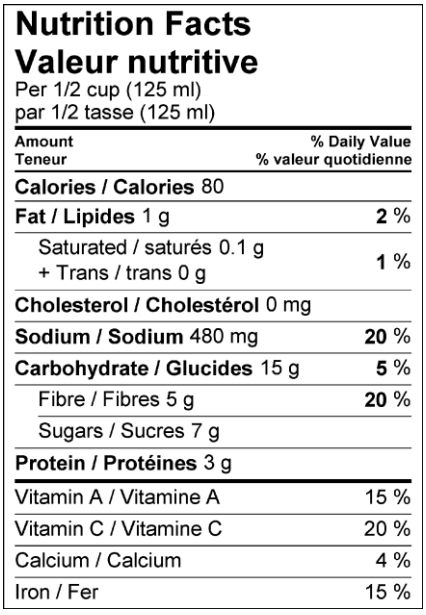
Pasta Sauce Prototype-PF-1



Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 70	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 480 mg	**20** %
Carbohydrate / Glucides 14 g	**5** %
Fibre / Fibres 4 g	**16** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

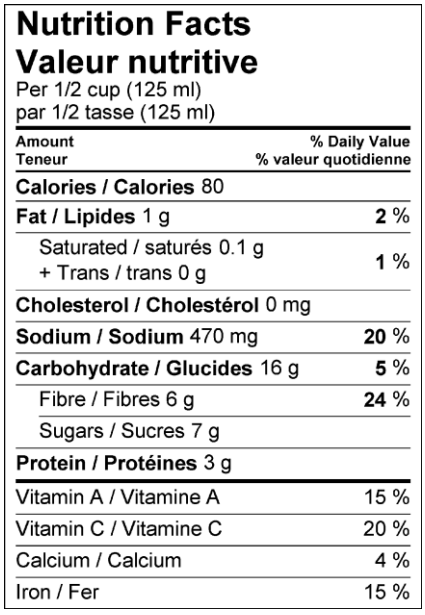
Pasta Sauce Prototype-PF-2



Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 480 mg	**20** %
Carbohydrate / Glucides 15 g	**5** %
Fibre / Fibres 5 g	**20** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

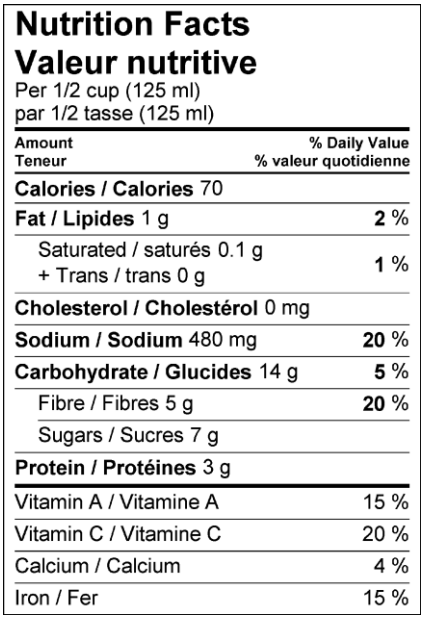
Pasta Sauce Prototype-PF-3



Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 470 mg	**20** %
Carbohydrate / Glucides 16 g	**5** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

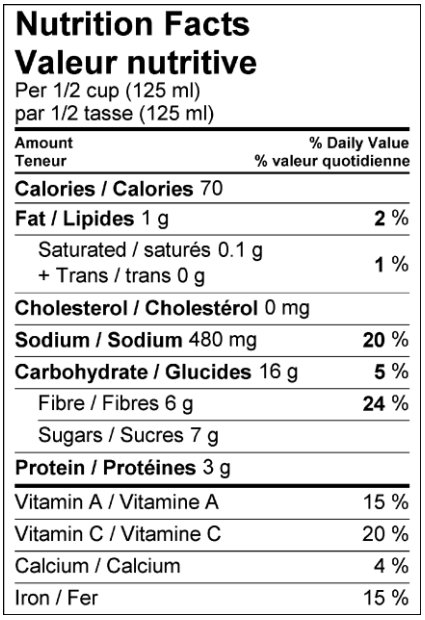
Pasta Sauce Prototype-OF-1



Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 70	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 480 mg	**20** %
Carbohydrate / Glucides 14 g	**5** %
Fibre / Fibres 5 g	**20** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

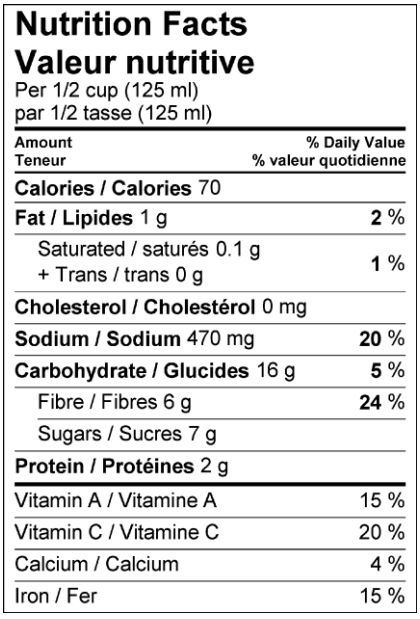
Pasta Sauce Prototype-OF-2



Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 70	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 480 mg	**20** %
Carbohydrate / Glucides 16 g	**5** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-OF-3



Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 70	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 470 mg	**20** %
Carbohydrate / Glucides 16 g	**5** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 7 g	
Protein / Protéines 2 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-Control

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3207-10 BB Pasta Sauce, Original (Feb. 9-10)

Number of Servings: 9.51 (125 g per serving)
Weight: 1407.75 g (Yield: 1188.6 g)

Nutrient	*Value*
Gram Weight (g)	125.00
Calories (kcal)	65.95
Calories from Fat (kcal)	9.47
Calories from SatFat (kcal)	0.60
Protein (g)	2.55
Carbohydrates (g)	12.71
Dietary Fiber (g)	2.69
Soluble Fiber (g)	0.03
Total Sugars (g)	7.04
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.21
Fat (g)	1.06
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.41
Vitamin A - IU (IU)	1642.22
Vitamin A - RE (RE)	164.33
Vitamin A - RAE (RAE)	33.86
Vitamin A - Carotenoid RE (RE)	67.73
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.83
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.46
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.63
Vitamin C (mg)	12.03
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.33
Folate, DFE (mcg)	11.33
Vitamin K (mcg)	11.56
Pantothenic Acid (mg)	0.13
Calcium (mg)	39.50
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.80

Nutrient	*Value*
Magnesium (mg)	9.51
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	43.83
Potassium (mg)	457.29
Selenium (mcg)	0.30
Sodium (mg)	493.62
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	0.08

Pasta Sauce Prototype-RL-1

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3207-11 BB Pasta Sauce, Lentils, 4g (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	*Value*
Gram Weight (g)	125.00
Calories (kcal)	78.63
Calories from Fat (kcal)	10.26
Calories from SatFat (kcal)	0.79
Protein (g)	3.63
Carbohydrates (g)	14.69
Dietary Fiber (g)	2.96
Soluble Fiber (g)	0.03
Total Sugars (g)	6.33
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.20
Fat (g)	1.15
Saturated Fat (g)	0.09
Mono Fat (g)	0.05
Poly Fat (g)	0.13
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	35.31
Vitamin A - IU (IU)	1445.64
Vitamin A - RE (RE)	144.64
Vitamin A - RAE (RAE)	33.97
Vitamin A - Carotenoid RE (RE)	67.94
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	352.24
Vitamin B1 - Thiamin (mg)	0.11
Vitamin B2 - Riboflavin (mg)	0.06
Vitamin B3 - Niacin (mg)	1.33
Niacin Equivalents (mg)	0.73
Vitamin B6 (mg)	0.11
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.38
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	22.98
Folate, DFE (mcg)	22.98
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.15
Calcium (mg)	39.30
Chromium (mcg)	0.60
Copper (mg)	0.11
Fluoride (mg)	0.02
Iodine (mcg)	0.06
Iron (mg)	1.95

Nutrient	*Value*
Magnesium (mg)	13.82
Manganese (mg)	0.17
Molybdenum (mcg)	2.25
Phosphorus (mg)	56.40
Potassium (mg)	430.88
Selenium (mcg)	0.76
Sodium (mg)	382.96
Zinc (mg)	0.39
Omega 3 Fatty Acid (g)	0.03
Omega 6 Fatty Acid (g)	0.10
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	0.08

Pasta Sauce Prototype-RL-2

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3207-12 Baby Boomer Pasta Sauce, Lentils, 6g (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	Value
Gram Weight (g)	125.00
Calories (kcal)	85.80
Calories from Fat (kcal)	10.65
Calories from SatFat (kcal)	0.88
Protein (g)	4.21
Carbohydrates (g)	15.82
Dietary Fiber (g)	3.12
Soluble Fiber (g)	0.03
Total Sugars (g)	6.02
Monosaccharides (g)	1.03
Disaccharides (g)	1.57
Other Carbs (g)	1.20
Fat (g)	1.19
Saturated Fat (g)	0.10
Mono Fat (g)	0.06
Poly Fat (g)	0.16
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	38.31
Vitamin A - IU (IU)	1353.78
Vitamin A - RE (RE)	135.44
Vitamin A - RAE (RAE)	31.87
Vitamin A - Carotenoid RE (RE)	63.74
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	329.67
Vitamin B1 - Thiamin (mg)	0.12
Vitamin B2 - Riboflavin (mg)	0.06
Vitamin B3 - Niacin (mg)	1.28
Niacin Equivalents (mg)	0.84
Vitamin B6 (mg)	0.12
Vitamin B12 (mcg)	0
Biotin (mcg)	1.41
Vitamin C (mg)	10.57
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.28
Folate (mcg)	28.02
Folate, DFE (mcg)	28.02
Vitamin K (mcg)	11.12
Pantothenic Acid (mg)	0.15
Calcium (mg)	39.47
Chromium (mcg)	0.56
Copper (mg)	0.15
Fluoride (mg)	0.03
Iodine (mcg)	0.06
Iron (mg)	2.09

Nutrient	Value
Magnesium (mg)	15.41
Manganese (mg)	0.20
Molybdenum (mcg)	1.98
Phosphorus (mg)	62.50
Potassium (mg)	420.19
Selenium (mcg)	1.00
Sodium (mg)	355.22
Zinc (mg)	0.49
Omega 3 Fatty Acid (g)	0.04
Omega 6 Fatty Acid (g)	0.12
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	3.76
Insoluble Fiber (g)	0.08

Pasta Sauce Prototype-RL-3

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3207-13 BB Pasta Sauce, Lentils, 6g + Inulin (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	*Value*
Gram Weight (g)	125.00
Calories (kcal)	82.38
Calories from Fat (kcal)	10.23
Calories from SatFat (kcal)	0.79
Protein (g)	3.59
Carbohydrates (g)	16.57
Dietary Fiber (g)	4.75
Soluble Fiber (g)	1.86
Total Sugars (g)	6.46
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.20
Fat (g)	1.15
Saturated Fat (g)	0.09
Mono Fat (g)	0.05
Poly Fat (g)	0.13
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	35.38
Vitamin A - IU (IU)	1425.72
Vitamin A - RE (RE)	142.64
Vitamin A - RAE (RAE)	33.97
Vitamin A - Carotenoid RE (RE)	67.94
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	352.24
Vitamin B1 - Thiamin (mg)	0.11
Vitamin B2 - Riboflavin (mg)	0.06
Vitamin B3 - Niacin (mg)	1.30
Niacin Equivalents (mg)	0.73
Vitamin B6 (mg)	0.11
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.30
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	22.98
Folate, DFE (mcg)	22.98
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.15
Calcium (mg)	39.04
Chromium (mcg)	0.60
Copper (mg)	0.11
Fluoride (mg)	0.02
Iodine (mcg)	0.06
Iron (mg)	1.94

Nutrient	*Value*
Magnesium (mg)	13.82
Manganese (mg)	0.17
Molybdenum (mcg)	2.25
Phosphorus (mg)	55.98
Potassium (mg)	424.94
Selenium (mcg)	0.76
Sodium (mg)	371.88
Zinc (mg)	0.39
Omega 3 Fatty Acid (g)	0.03
Omega 6 Fatty Acid (g)	0.10
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	0.08

Pasta Sauce Prototype-PF-1

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3207-14 BB Pasta Sauce, Pea Fiber, 4g (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	Value
Gram Weight (g)	125.00
Calories (kcal)	73.27
Calories from Fat (kcal)	9.60
Calories from SatFat (kcal)	0.60
Protein (g)	2.62
Carbohydrates (g)	14.43
Dietary Fiber (g)	4.39
Soluble Fiber (g)	0.15
Total Sugars (g)	6.96
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.20
Fat (g)	1.08
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.43
Vitamin A - IU (IU)	1621.54
Vitamin A - RE (RE)	162.26
Vitamin A - RAE (RAE)	33.81
Vitamin A - Carotenoid RE (RE)	67.61
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.24
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.44
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.94
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.32
Folate, DFE (mcg)	11.32
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.13
Calcium (mg)	39.15
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.77

Nutrient	Value
Magnesium (mg)	9.49
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	43.38
Potassium (mg)	451.17
Selenium (mcg)	0.30
Sodium (mg)	482.71
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	1.68

Pasta Sauce Prototype-PF-2

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3207-15 BB Pasta Sauce, Pea Fibre, 6g (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	Value
Gram Weight (g)	125.00
Calories (kcal)	77.69
Calories from Fat (kcal)	9.68
Calories from SatFat (kcal)	0.60
Protein (g)	2.66
Carbohydrates (g)	15.47
Dietary Fiber (g)	5.40
Soluble Fiber (g)	0.23
Total Sugars (g)	6.92
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.20
Fat (g)	1.08
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.46
Vitamin A - IU (IU)	1609.59
Vitamin A - RE (RE)	161.06
Vitamin A - RAE (RAE)	33.81
Vitamin A - Carotenoid RE (RE)	67.61
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.24
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.43
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.90
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.32
Folate, DFE (mcg)	11.32
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.13
Calcium (mg)	38.96
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.76

Nutrient	Value
Magnesium (mg)	9.49
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	43.12
Potassium (mg)	447.60
Selenium (mcg)	0.30
Sodium (mg)	475.99
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	2.65

Pasta Sauce Prototype-PF-3

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3207-16 BB Pasta Sauce, Pea Fibre, 6g + Inulin (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	Value
Gram Weight (g)	125.00
Calories (kcal)	77.02
Calories from Fat (kcal)	9.57
Calories from SatFat (kcal)	0.60
Protein (g)	2.59
Carbohydrates (g)	16.32
Dietary Fiber (g)	6.18
Soluble Fiber (g)	1.98
Total Sugars (g)	7.09
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.20
Fat (g)	1.07
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.50
Vitamin A - IU (IU)	1601.62
Vitamin A - RE (RE)	160.27
Vitamin A - RAE (RAE)	33.81
Vitamin A - Carotenoid RE (RE)	67.61
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.24
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.42
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.87
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.32
Folate, DFE (mcg)	11.32
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.13
Calcium (mg)	38.89
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.76

Nutrient	Value
Magnesium (mg)	9.49
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	42.96
Potassium (mg)	445.23
Selenium (mcg)	0.30
Sodium (mg)	471.63
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	1.68

Pasta Sauce Prototype-OF-1

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3207-17 BB Pasta Sauce, Oat Fibre, 4g (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	*Value*
Gram Weight (g)	125.00
Calories (kcal)	65.63
Calories from Fat (kcal)	9.46
Calories from SatFat (kcal)	0.62
Protein (g)	2.53
Carbohydrates (g)	14.48
Dietary Fiber (g)	4.54
Soluble Fiber (g)	0.13
Total Sugars (g)	6.97
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.24
Fat (g)	1.06
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.48
Vitamin A - IU (IU)	1621.54
Vitamin A - RE (RE)	162.26
Vitamin A - RAE (RAE)	33.81
Vitamin A - Carotenoid RE (RE)	67.61
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.24
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.44
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.94
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.32
Folate, DFE (mcg)	11.32
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.13
Calcium (mg)	40.00
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.80

Nutrient	*Value*
Magnesium (mg)	9.79
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	43.45
Potassium (mg)	451.27
Selenium (mcg)	0.30
Sodium (mg)	483.55
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	1.94

Pasta Sauce Prototype-OF-2

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3207-18 BB Pasta Sauce, Oat Fibre, 6g (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	Value
Gram Weight (g)	125.00
Calories (kcal)	65.47
Calories from Fat (kcal)	9.47
Calories from SatFat (kcal)	0.63
Protein (g)	2.51
Carbohydrates (g)	15.55
Dietary Fiber (g)	5.64
Soluble Fiber (g)	0.20
Total Sugars (g)	6.93
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.26
Fat (g)	1.06
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.54
Vitamin A - IU (IU)	1609.59
Vitamin A - RE (RE)	161.06
Vitamin A - RAE (RAE)	33.81
Vitamin A - Carotenoid RE (RE)	67.61
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.24
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.43
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.90
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.32
Folate, DFE (mcg)	11.32
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.13
Calcium (mg)	40.32
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.79

Nutrient	Value
Magnesium (mg)	9.97
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	43.25
Potassium (mg)	447.76
Selenium (mcg)	0.30
Sodium (mg)	477.34
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	3.07

Pasta Sauce Prototype-OF-3

esha RESEARCH
1.800.659.3742 www.esha.com info@esha.com

3207-19 BB Pasta Sauce, Oat Fibre, 6g + Inulin (Feb. 9-10)

Number of Servings: 9.52 (125 g per serving)
Weight: 1409.75 g (Yield: 1190.6 g)

Nutrient	*Value*
Gram Weight (g)	125.00
Calories (kcal)	69.39
Calories from Fat (kcal)	9.43
Calories from SatFat (kcal)	0.62
Protein (g)	2.49
Carbohydrates (g)	16.37
Dietary Fiber (g)	6.33
Soluble Fiber (g)	1.96
Total Sugars (g)	7.10
Monosaccharides (g)	1.17
Disaccharides (g)	1.57
Other Carbs (g)	1.24
Fat (g)	1.06
Saturated Fat (g)	0.07
Mono Fat (g)	0.02
Poly Fat (g)	0.07
Trans Fatty Acid (g)	0
Cholesterol (mg)	0
Water (g)	19.54
Vitamin A - IU (IU)	1601.62
Vitamin A - RE (RE)	160.27
Vitamin A - RAE (RAE)	33.81
Vitamin A - Carotenoid RE (RE)	67.61
Vitamin A - Retinol RE (RE)	0
Beta-Carotene (mcg)	350.24
Vitamin B1 - Thiamin (mg)	0.10
Vitamin B2 - Riboflavin (mg)	0.07
Vitamin B3 - Niacin (mg)	1.42
Niacin Equivalents (mg)	0.43
Vitamin B6 (mg)	0.09
Vitamin B12 (mcg)	0
Biotin (mcg)	1.62
Vitamin C (mg)	11.87
Vitamin D - IU (IU)	0
Vitamin D - mcg (mcg)	0
Vitamin E - Alpha-Toco (mg)	0.31
Folate (mcg)	11.32
Folate, DFE (mcg)	11.32
Vitamin K (mcg)	11.54
Pantothenic Acid (mg)	0.13
Calcium (mg)	39.74
Chromium (mcg)	0.60
Copper (mg)	0.04
Fluoride (mg)	0.00
Iodine (mcg)	0.06
Iron (mg)	1.78

Nutrient	*Value*
Magnesium (mg)	9.79
Manganese (mg)	0.09
Molybdenum (mcg)	2.25
Phosphorus (mg)	43.03
Potassium (mg)	445.33
Selenium (mcg)	0.30
Sodium (mg)	472.47
Zinc (mg)	0.17
Omega 3 Fatty Acid (g)	0.02
Omega 6 Fatty Acid (g)	0.05
Alcohol (g)	0
Caffeine (mg)	0
Choline (mg)	4.11
Insoluble Fiber (g)	1.94

Appendix C

Pasta Sauce: Attribute Definitions

Aroma	**Definitions**
Cooked Tomato	Aroma associated with fresh tomato that has been cooked to concentrate solids.
Herb	Aroma associated with bouquet of herbs with not one predominant type.
Flavor	
Cooked Tomato	Flavor associated with fresh tomato that has been cooked to concentrate solids.
Acidic	Flavor associated with citric acid.
Oregano	Flavor associated with oregano.
Heat	Flavor associated with hot peppers.
Aftertaste	
Oregano	Flavor associated with oregano.
Heat	Flavor associated with hot peppers.
Texture	
Grainy/Mealy	Presence of soft particles in the samples.
Viscosity	The degree of thinness (low viscosity)/ thickness (high viscosity) in the sample as perceived in the mouth.

Appendix D

Ballot: Sensory Panel

Panellist # _____

Instructions:
Evaluate the coded samples in the order from left to right as listed below.
Circle the number from 1 to 7 that corresponds to the intensity of each of the attributes.

Code No. _____		**Code No. _____**		**Code No. _____**		**Code No. _____**	
Cooked Tomato Aroma							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Herb Aroma							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Cooked Tomato Flavor							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High

Code No. _____		**Code No. _____**		**Code No. _____**		**Code No. _____**	
Acidic Flavor							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Oregano Flavor							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Heat Flavor							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Oregano Aftertaste							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High

Code No. _____		**Code No. _____**		**Code No. _____**		**Code No. _____**	
Heat Aftertaste							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Grainy/Mealy Texture							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High
Viscosity							
1	Low	1	Low	1	Low	1	Low
2		2		2		2	
3		3		3		3	
4		4		4		4	
5		5		5		5	
6		6		6		6	
7	High	7	High	7	High	7	High

Appendix E

Ballot: Sensory Panel for Shelf-Life Study

Panellist #_____
page 1 of 3

Instructions:
Evaluate the coded sample.
Circle the number from 1 to 7 that corresponds to the intensity of each of the attributes.

Code No._____

Cooked Tomato Aroma

1 Low
2
3
4
5
6
7 High

Herb Aroma

1 Low
2
3
4
5
6
7 High

Cooked Tomato Flavor

1 Low
2
3
4
5
6
7 High

Code No._____

Acidic Flavor

1 Low
2
3
4
5
6
7 High

Oregano Flavor

1 Low
2
3
4
5
6
7 High

Heat Flavor

1 Low
2
3
4
5
6
7 High

Oregano Aftertaste

1 Low
2
3
4
5
6
7 High

Code No._____

Heat Aftertaste

1 Low
2
3
4
5
6
7 High

Grainy/Mealy Texture

1 Low
2
3
4
5
6
7 High

Viscosity

1 Low
2
3
4
5
6
7 High

Appendix F

Consent Form: Sensory Panel

UNIVERSITY OF MANITOBA

Winnipeg, Manitoba
Canada R3T 2N2
Phone: (204) 474-9554
Fax: (204) 474-7592

Faculty of Human Ecology

Department of Human Nutritional Sciences

April 26, 2010

Dear Colleague,

We are seeking food sensory assessors to participate in a study to conduct sensory evaluation for pasta sauces. This information will be used as part of the process in developing a more nutritional pasta sauce for Baby Boomers

Criteria for assessors are that you regularly consume pasta sauce *(≥1 a month)* and have no allergies to the ingredients. You are asked to examine and taste pasta sauces to determine the appearance, aroma, flavor, texture, and aftertaste and rate the attributes intensities on structured descriptive scales. Training sessions will cover discussion on descriptors and familiarization of the scale. Training sessions will take place on 2 days; 2 training sessions per day of approximately 45 minutes in length each. Sensory panels will take place on 3 days; 1 sensory session per day of approximately 30 minutes each.

A known risk is an allergy to ingredients within the pasta sauce. A question regarding allergies will be asked on the attached questionnaire which will inform the researcher of any possible risk for participants. Information regarding the project objectives will be given at the end of the panel sessions.

Sensory panel sessions will be held at the Food Development Centre in Portage la Prairie, Manitoba. The training sessions will be held in the board room and the panel sessions in the sensory booths.

Results will not be reported by individuals' names nor will any names be associated with the results. All data will be kept strictly confidential by the researcher and under lock and key until published or for five years whichever is shorter.

If you would like to be part of this research, please read and fill in the required consent form and questionnaire attached to this request and return it to Jacqueline Bugera. Any questions you have can be directed to Jacqueline Bugera at 474-6051 or by email umbugerj@cc.umanitoba.ca.

We hope you will be able to assist us with this project. We appreciate it very much.

Sincerely,

JACQUELINE BUGERA
MSc. Student

Dr. CHRISTINA LENGYEL
Assistant Professor

UNIVERSITY
OF MANITOBA

Winnipeg, Manitoba
Canada R3T 2N2
Phone: (204) 474-9554
Fax: (204) 474-7592

Faculty of Human Ecology

Department of Human Nutritional Sciences

Consent Form

Research Project Title: **Formulating Food Products for the Aging Baby Boomer Population**

Researcher(s): **Jacqueline Bugera & Dr. Christina Lengyel** **Panellist Number** ____

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The study is being done to evaluate sensory characteristics regarding pasta sauce.

Criteria for assessors are that you regularly consume pasta sauce *(≥1 a month)* and have no allergies to the ingredients. You are asked to examine and taste pasta sauces to determine the appearance, aroma, flavor, texture, and aftertaste and rate the attributes intensities on structured descriptive scales. Sessions will be held approximately 2-3 times per week and no longer than 45 minutes each. The total commitment time is approximately 4.5 hours for a maximum of 7 sessions over a 2 to 3 week period. Sessions will take place at the Food Development Center. Training sessions will be in the board room and the panel sessions will be in the sensory booths.

A known risk is an allergy to ingredients within the pasta sauce. A question regarding allergies will be asked on the attached questionnaire which will inform the researcher of any possible risk for participants. Information regarding the project objectives will be given at the end of the panel sessions.

Respondents will be identified by number during the sessions (no names will be recorded during sessions) and all data related to personal information and results obtained will be kept in a locked cabinet for 5 years or until data are published whichever comes first.

Access to information will be limited strictly to the researchers named above. All data will be shredded/destroyed after the time has expired.

Beverages and snacks will be available after the session.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to serve as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. This study is being conducted by Jacqueline Bugera, under the supervision of Dr. Christina Lengyel 474-9554.

This research has been approved by the Joint-Faculty Research Board of Ethical Review at the University of Manitoba. If you have any concerns or complaints about this project you may contact the above-named person or the Human Ethics Secretariat at 474-7122. A copy of this consent form has been given to you to keep for your records and reference.

_____

Participant's Name (Please Print) Signature Date

_____

Researcher and/or Delegate's Signature Date

If you are interested in receiving more information and results from the study please complete the following information.

_____NA

ME (please print)

Preferred mailing address: ☐ email ☐ post

_____

EMAIL

_____

STREET

_____

POSTAL CODE

_____

CITY/TOWN

Questionnaire –**Baby Boomer Pasta Sauce**

This information will be kept strictly confidential.

Panellist # _____

1. Have you participated on sensory evaluation panels before?
   Yes □ No □

   a. Was training part of the evaluation procedure?
      Yes □ No □

2. Are you allergic to any food products?
   Yes □ No □

   If yes, note them below.

   _____

   _____

Appendix G

Consent Form: Sensory Panel for Shelf-Life Study

UNIVERSITY OF MANITOBA

Winnipeg, Manitoba
Canada R3T 2N2
Phone: (204) 474-9554
Fax: (204) 474-7592

Faculty of Human Ecology

Department of Human Nutritional Sciences

June 21, 2010

Dear Colleague,

We are seeking food sensory assessors to participate in a study to conduct sensory evaluation for pasta sauces. This information will be used as part of the process in developing a more nutritional pasta sauce for Baby Boomers

Criteria for assessors are that you regularly consume pasta sauce *(≥1 a month)* and have no allergies to the ingredients. You are asked to examine and taste a pasta sauce to determine the effect of storage on the aroma, flavor, texture, and aftertaste and rate the attributes intensities on structured descriptive scales. Previous training sessions covered discussion on descriptors and familiarization of the scale. Sensory panels will take place on weeks 0, 2, 4, 8 and 12; 2 sensory sessions per week of approximately 30 minutes each.

A known risk is an allergy to ingredients within the pasta sauce. A question regarding allergies will be asked on the attached questionnaire which will inform the researcher of any possible risk for participants. Information regarding the project objectives will be given at the end of the panel sessions.

Sensory panel sessions will be held at the Food Development Centre in Portage la Prairie, Manitoba. The panel sessions will be held in the sensory booths.

Results will not be reported by individuals' names nor will any names be associated with the results. All data will be kept strictly confidential by the researcher and under lock and key until published or for five years whichever is shorter.

If you would like to be part of this research, please read and fill in the required consent form and questionnaire attached to this request and return it to Jacqueline Bugera. Any questions you have can be directed to Jacqueline Bugera at 474-6051 or by email umbugerj@cc.umanitoba.ca.

We hope you will be able to assist us with this project. We appreciate it very much.

Sincerely,

JACQUELINE BUGERA
MSc. Student

Dr. CHRISTINA LENGYEL
Assistant Professor

UNIVERSITY
OF MANITOBA

Winnipeg, Manitoba
Canada R3T 2N2
Phone: (204) 474-9554
Fax: (204) 474-7592

Faculty of Human Ecology

Department of Human Nutritional Sciences

Consent Form

Research Project Title: **Formulating Food Products for the Aging Baby Boomer Population**

Researcher(s): **Jacqueline Bugera & Dr. Christina Lengyel** **Panellist Number** ____

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The study is being done to evaluate sensory characteristics regarding pasta sauce.

Criteria for assessors are that you regularly consume pasta sauce *(≥1 a month)* and have no allergies to the ingredients. You are asked to examine and taste a pasta sauce to determine the effect of storage on the aroma, flavor, texture, and aftertaste and rate the attributes intensities on structured descriptive scales. Sessions will be held approximately twice per week and no longer than 30 minutes each. The total commitment time is approximately 5 hours for a maximum of 10 sessions for 5 weeks (not consecutive) over a 3 month period. Sessions will take place at the Food Development Center. The panel sessions will be held in the sensory booths.

A known risk is an allergy to ingredients within the pasta sauce. A question regarding allergies will be asked on the attached questionnaire which will inform the researcher of any possible risk for participants. Information regarding the project objectives will be given at the end of the panel sessions
Respondents will be identified by number during the sessions (no names will be recorded during sessions) and all data related to personal information and results obtained will be

kept in a locked cabinet for 5 years or until data are published whichever comes first. Access to information will be limited strictly to the researchers named above. All data will be shredded/destroyed after the time has expired.
Beverages and snacks will be available after the session.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to serve as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. This study is being conducted by Jacqueline Bugera, under the supervision of Dr. Christina Lengyel 474-9554.

This research has been approved by the Joint-Faculty Research Board of Ethical Review at the University of Manitoba. If you have any concerns or complaints about this project you may contact the above-named person or the Human Ethics Secretariat at 474-7122. A copy of this consent form has been given to you to keep for your records and reference.

_____

Participant's Name (Please Print) Signature
Date

_____

Researcher and/or Delegate's Signature Date

If you are interested in receiving more information and results from the study please complete the following information.

_____

NAME (please print)

Preferred mailing address: ☐ email ☐ post

_____ _____

EMAIL STREET

_____

POSTAL CODE

_____

CITY/TOWN

Questionnaire –**Baby Boomer Pasta Sauce –Shelf Life**

This information will be kept strictly confidential.

Panellist # _____

3. Have you participated on sensory evaluation panels before?
   Yes □ No□

   b. Was training part of the evaluation procedure?
   Yes□ No□

4. Are you allergic to any food products?
   Yes□ No□

   If yes, note them below.

   _____

   _____

Appendix H

Effect of Increasing Red Lentils Concentration on Sensory Profile of the PSPs (n=3)

	Score ± SD			
	Control	RL 10%	RL 15%	RL 20%
Aroma Cooked Tomato	4.22 ± 1.42a	3.74 ± 1.43a	3.63 ± 1.36a	3.52 ± 1.28a
Aroma Herb	4.37 ± 1.67a	3.89 ± 1.74a	3.59 ± 1.62a	3.78 ± 1.31a
Flavour Tomato	4.93 ± 1.30a	4.30 ± 1.59a	4.63 ± 1.45a	4.04 ± 1.51a
Flavour Acidic	5.19 ± 1.24b	4.26 ± 1.53ab	3.89 ± 1.25a	3.33 ± 1.36a
Flavour Oregano	4.19 ± 1.59a	4.07 ± 1.30a	4.19 ± 1.15a	4.22 ± 1.40a
Flavour Heat	3.89 ± 1.65b	2.89 ± 1.19ab	3.33 ± 1.75ab	2.56 ± 1.40a
Aftertaste Oregano	3.67 ± 1.49a	3.37 ± 1.39a	3.52 ± 1.25a	3.74 ± 1.26a
Aftertaste Heat	3.78 ± 1.81a	2.96 ± 1.34a	3.04 ± 1.79a	2.89 ± 1.60a
Grainy	1.96 ± 1.23a	3.44 ± .145b	3.85 ± 1.38b	5.04 ± 1.02c
Viscosity	3.33 ± 1.27a	4.30 ± 1.38ab	4.37 ± 1.52b	4.96 ± 1.51b

Scores with the same letters within a row are not significantly different whereas scores with different letters are significantly different at $p < 0.05$.

Appendix I

Nutritional Analysis (Genesis SQL® R&D) of the PSP Control and RL Formulations

Pasta Sauce Prototype-Control

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 70	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 490 mg	**20** %
Carbohydrate / Glucides 13 g	**4** %
Fibre / Fibres 3 g	**12** %
Sugars / Sucres 7 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-RL-15%

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 370 mg	**15** %
Carbohydrate / Glucides 17 g	**6** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 5 g	
Protein / Protéines 4 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-RL-10%

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 400 mg	**17** %
Carbohydrate / Glucides 16 g	**5** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 5 g	
Protein / Protéines 3 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-RL-20%

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount / Teneur	% Daily Value / % valeur quotidienne
Calories / Calories 90	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 340 mg	**14** %
Carbohydrate / Glucides 17 g	**6** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 5 g	
Protein / Protéines 4 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

Pasta Sauce Prototype-Control

esha RESEARCH
1.800.659.3742 www.esha.com info@esha.com

3207-20 BB Pasta Sauce, Original (Apr. 19-10)

Number of Servings: 9.52 (125 g per serving)

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Gram Weight (g)	125.00	Mono Fat (g)	0.02
Calories (kcal)	65.77	Poly Fat (g)	0.06
Calories from Fat (kcal)	9.39	Trans Fatty Acid (g)	0
Calories from SatFat (kcal)	0.59	Cholesterol (mg)	0
Protein (g)	2.55	Water (g)	19.38
Carbohydrates (g)	12.69	Vitamin A - IU (IU)	1634.90
Dietary Fiber (g)	2.81	Vitamin A - RE (RE)	163.60
Soluble Fiber (g)	0.03	Vitamin A - RAE (RAE)	33.48
Total Sugars (g)	6.53	Carotenoid RE (RE)	66.96
Monosaccharides (g)	1.21	Retinol RE (RE)	0
Disaccharides (g)	1.63	Beta-Carotene (mcg)	346.33
Other Carbs (g)	1.57	Vitamin B1 (mg)	0.10
Fat (g)	1.05	Vitamin B2 (mg)	0.07
Saturated Fat (g)	0.07	Vitamin B3 (mg)	1.46

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Vitamin B3 - Niacin Equiv (mg)	0.41	Copper (mg)	0.04
Vitamin B6 (mg)	0.07	Fluoride (mg)	0.00
Vitamin B12 (mcg)	0	Iodine (mcg)	0.06
Biotin (mcg)	1.62	Iron (mg)	1.83
Vitamin C (mg)	11.98	Magnesium (mg)	9.47
Vitamin D - IU (IU)	0	Manganese (mg)	0.10
Vitamin D - mcg (mcg)	0	Molybdenum (mcg)	2.25
Vitamin E - Alpha-Toco (mg)	0.31	Phosphorus (mg)	43.47
Folate (mcg)	10.11	Potassium (mg)	457.66
Folate, DFE (mcg)	10.11	Selenium (mcg)	0.39
Vitamin K (mcg)	11.54	Sodium (mg)	494.36
Pantothenic Acid (mg)	0.07	Zinc (mg)	0.19
Calcium (mg)	39.78	Omega 3 Fatty Acid (g)	0.01
Chromium (mcg)	0.60	Omega 6 Fatty Acid (g)	0.05

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Alcohol (g)	0		
Caffeine (mg)	0		
Choline (mg)	4.11		
Insoluble Fiber (g)	0.08		

Pasta Sauce Prototype-RL-10%

esha RESEARCH
1.800.659.3742 www.esha.com info@esha.com

3207-21 BB Pasta Sauce, 10% Lentils (Apr. 19-10)

Number of Servings: 9.52 (125 g per serving)

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Gram Weight (g)	125.00	Saturated Fat (g)	0.08
Calories (kcal)	78.34	Mono Fat (g)	0.04
Calories from Fat (kcal)	9.98	Poly Fat (g)	0.11
Calories from SatFat (kcal)	0.75	Trans Fatty Acid (g)	0
Protein (g)	3.31	Cholesterol (mg)	0
Carbohydrates (g)	16.27	Water (g)	31.44
Dietary Fiber (g)	5.75	Vitamin A - IU (IU)	1468.12
Soluble Fiber (g)	2.77	Vitamin A - RE (RE)	146.89
Total Sugars (g)	5.22	Vitamin A - RAE (RAE)	33.60
Monosaccharides (g)	1.18	Carotenoid RE (RE)	67.21
Disaccharides (g)	0.65	Retinol RE (RE)	0
Other Carbs (g)	1.75	Beta-Carotene (mcg)	347.83
Fat (g)	1.12	Vitamin B1 (mg)	0.11

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Vitamin B2 (mg)	0.07	Pantothenic Acid (mg)	0.09
Vitamin B3 (mg)	1.33	Calcium (mg)	38.79
Vitamin B3 - Niacin Equiv (mg)	0.64	Chromium (mcg)	0.60
Vitamin B6 (mg)	0.09	Copper (mg)	0.10
Vitamin B12 (mcg)	0	Fluoride (mg)	0.01
Biotin (mcg)	1.62	Iodine (mcg)	0.06
Vitamin C (mg)	11.44	Iron (mg)	1.94
Vitamin D - IU (IU)	0	Magnesium (mg)	12.86
Vitamin D - mcg (mcg)	0	Manganese (mg)	0.17
Vitamin E - Alpha-Toco (mg)	0.31	Molybdenum (mcg)	2.25
Folate (mcg)	19.00	Phosphorus (mg)	53.77
Folate, DFE (mcg)	19.00	Potassium (mg)	434.41
Vitamin K (mcg)	11.54	Selenium (mcg)	0.80

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Sodium (mg)	400.02		
Zinc (mg)	0.37		
Omega3 Fatty Acid (g)	0.02		
Omega6 Fatty Acid (g)	0.09		
Alcohol (g)	0		
Caffeine (mg)	0		
Choline (mg)	4.30		
Insoluble Fiber (g)	0.08		

Pasta Sauce Prototype-RL-15%

esha RESEARCH
1.800.659.3742 www.esha.com info@esha.com

3207-22 BB Pasta Sauce, 15% Lentils (Apr. 19-10)

Number of Servings: 9.52 (125 g per serving)

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Gram Weight (g)	125.00	Saturated Fat (g)	0.09
Calories (kcal)	81.52	Mono Fat (g)	0.05
Calories from Fat (kcal)	10.18	Poly Fat (g)	0.12
Calories from SatFat (kcal)	0.80	Trans Fatty Acid (g)	0
Protein (g)	3.58	Cholesterol (mg)	0
Carbohydrates (g)	16.77	Water (g)	35.42
Dietary Fiber (g)	5.82	Vitamin A - IU (IU)	1419.17
Soluble Fiber (g)	2.77	Vitamin A - RE (RE)	141.99
Total Sugars (g)	5.04	Vitamin A - RAE (RAE)	33.64
Monosaccharides (g)	1.18	Carotenoid RE (RE)	67.29
Disaccharides (g)	0.65	Retinol RE (RE)	0
Other Carbs (g)	1.75	Beta-Carotene (mcg)	348.33
Fat (g)	1.14	Vitamin B1 (mg)	0.11

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Vitamin B2 (mg)	0.06	Pantothenic Acid (mg)	0.09
Vitamin B3 (mg)	1.30	Calcium (mg)	38.75
Vitamin B3 - Niacin Equiv (mg)	0.71	Chromium (mcg)	0.60
Vitamin B6 (mg)	0.10	Copper (mg)	0.12
Vitamin B12 (mcg)	0	Fluoride (mg)	0.02
Biotin (mcg)	1.62	Iodine (mcg)	0.06
Vitamin C (mg)	11.28	Iron (mg)	1.98
Vitamin D - IU (IU)	0	Magnesium (mg)	13.94
Vitamin D - mcg (mcg)	0	Manganese (mg)	0.19
Vitamin E - Alpha-Toco (mg)	0.31	Molybdenum (mcg)	2.25
Folate (mcg)	21.91	Phosphorus (mg)	56.92
Folate, DFE (mcg)	21.91	Potassium (mg)	427.85
Vitamin K (mcg)	11.54	Selenium (mcg)	0.92

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Sodium (mg)	372.28		
Zinc (mg)	0.42		
Omega 3 Fatty Acid (g)	0.03		
Omega 6 Fatty Acid (g)	0.10		
Alcohol (g)	0		
Caffeine (mg)	0		
Choline (mg)	4.30		
Insoluble Fiber (g)	0.08		

Pasta Sauce Prototype-RL-20%

esha RESEARCH
1.800.659.3742 www.esha.com info@esha.com

3207-23 BB Pasta Sauce, 20% Lentils (Apr. 19-10)

Number of Servings: 9.72 (125 g per serving)

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Gram Weight (g)	125.00	Saturated Fat (g)	0.09
Calories (kcal)	85.37	Mono Fat (g)	0.06
Calories from Fat (kcal)	10.30	Poly Fat (g)	0.14
Calories from SatFat (kcal)	0.85	Trans Fatty Acid (g)	0
Protein (g)	3.95	Cholesterol (mg)	0
Carbohydrates (g)	17.32	Water (g)	40.55
Dietary Fiber (g)	5.84	Vitamin A - IU (IU)	1342.44
Soluble Fiber (g)	2.71	Vitamin A - RE (RE)	134.31
Total Sugars (g)	4.77	Vitamin A - RAE (RAE)	33.01
Monosaccharides (g)	1.16	Carotenoid RE (RE)	66.03
Disaccharides (g)	0.63	Retinol RE (RE)	0
Other Carbs (g)	1.72	Beta-Carotene (mcg)	341.90
Fat (g)	1.15	Vitamin B1 (mg)	0.12

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Vitamin B2 (mg)	0.06	Pantothenic Acid (mg)	0.10
Vitamin B3 (mg)	1.25	Calcium (mg)	38.27
Vitamin B3 - Niacin Equiv (mg)	0.81	Chromium (mcg)	0.58
Vitamin B6 (mg)	0.11	Copper (mg)	0.15
Vitamin B12 (mcg)	0	Fluoride (mg)	0.02
Biotin (mcg)	1.59	Iodine (mcg)	0.06
Vitamin C (mg)	10.90	Iron (mg)	2.03
Vitamin D - IU (IU)	0	Magnesium (mg)	15.25
Vitamin D - mcg (mcg)	0	Manganese (mg)	0.21
Vitamin E - Alpha-Toco (mg)	0.30	Molybdenum (mcg)	2.20
Folate (mcg)	25.74	Phosphorus (mg)	60.89
Folate, DFE (mcg)	25.74	Potassium (mg)	416.69
Vitamin K (mcg)	11.31	Selenium (mcg)	1.07

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Sodium (mg)	337.58		
Zinc (mg)	0.49		
Omega3 Fatty Acid (g)	0.03		
Omega6 Fatty Acid (g)	0.11		
Alcohol (g)	0		
Caffeine (mg)	0		
Choline (mg)	4.21		
Insoluble Fiber (g)	0.07		

Appendix J

Effect of Red Lentils on the Sensory Profile of the PSF During 12 Week Storage (n=2)

	Score ± SD				
	Wk 0	Wk 2	Wk 4	Wk 8	Wk 12
Aroma Cooked Tomato	4.94 ± 1.29	4.63 ± 1.36	4.44 ± 1.41	4.44 ± 1.09	4.19 ± 0.98
Aroma Herb	4.50 ± 1.61	4.69 ± 1.30	4.88 ± 0.62	4.69 ± 1.14	4.56 ± 1.41
Flavour Tomato	4.69 ± 1.45	4.69 ± 1.45	4.50 ± 1.32	4.69 ± 1.14	4.13 ± 1.46
Flavour Acidic	4.25 ± 1.34	3.81 ± 1.64	4.25 ± 1.61	4.88 ± 1.71	4.25 ± 1.73
Flavour Oregano	4.87 ± 1.09	4.56 ± 1.09	4.87 ± 0.72	4.63 ± 0.89	4.81 ± 1.28
Flavour Heat	2.56 ± 1.50	3.00 ± 1.55	2.88 ± 1.59	3.00 ± 1.41	2.88 ± 1.09
Aftertaste Oregano	4.31 ± 1.20	4.56 ± 1.50	4.56 ± 0.96	4.19 ± 1.05	4.19 ± 1.47
Aftertaste Heat	2.56 ± 1.63	3.00 ± 1.59	2.88 ± 1.67	3.00 ± 1.63	3.06 ± 1.65
Grainy	3.88 ± 1.31	3.31 ± 1.30	3.81 ± 1.05	4.13 ± 1.31	4.25 ± 1.48
Viscosity	4.75 ± 0.86	4.63 ± 1.20	4.38 ± 1.20	4.69 ± 1.30	5.12 ± 1.02

Significantly different at $p < 0.05$.

Appendix K

Microbiological Analysis of the PSF During 12 Week Storage (n=3)

	SPC	Yeast	Mold	Coliforms	E-coli
Wk0	<10	<10	<10	<10	<10
Wk2	<10	<10	<10	<10	<10
Wk4	<10	<10	<10	<10	<10
Wk8	<10	<10	<10	<10	<10
Wk12	<10	<10	2.0E+02	<10	<10

Appendix L

Nutritional Analysis (Genesis SQL® R&D) of the PSF Formulation

Nutrition Facts
Valeur nutritive
Per 1/2 cup (125 ml)
par 1/2 tasse (125 ml)

Amount Teneur	% Daily Value % valeur quotidienne
Calories / Calories 80	
Fat / Lipides 1 g	**2** %
Saturated / saturés 0.1 g + Trans / trans 0 g	**1** %
Cholesterol / Cholestérol 0 mg	
Sodium / Sodium 370 mg	**15** %
Carbohydrate / Glucides 17 g	**6** %
Fibre / Fibres 6 g	**24** %
Sugars / Sucres 5 g	
Protein / Protéines 4 g	
Vitamin A / Vitamine A	15 %
Vitamin C / Vitamine C	20 %
Calcium / Calcium	4 %
Iron / Fer	15 %

3207-24 BB Pasta Sauce, 15% Lentils (Jun 9-10 scale up)

Number of Servings: 414 (125 g per serving)

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Gram Weight (g)	125.00	Other Carbs (g)	1.91
Calories (kcal)	83.56	Fat (g)	1.12
Calories from Fat (kcal)	9.98	Saturated Fat (g)	0.10
Calories from SatFat (kcal)	0.87	Mono Fat (g)	0.06
Protein (g)	3.99	Poly Fat (g)	0.14
Carbohydrates (g)	18.42	Trans Fatty Acid (g)	0
Dietary Fiber (g)	6.34	Cholesterol (mg)	0
Soluble Fiber (g)	2.97	Water (g)	26.22
Total Sugars (g)	6.75	Vitamin A - IU (IU)	828.00
Monosaccharides (g)	1.28	Vitamin A - RE (RE)	107.92
Disaccharides (g)	0.69	Vitamin A - RAE (RAE)	36.08

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Carotenoid RE (RE)	72.16	Vitamin D - IU (IU)	0
Retinol RE (RE)	0	Vitamin D - mcg (mcg)	0
Beta-Carotene (mcg)	373.61	Vitamin E - Alpha-Toco (mg)	0.33
Vitamin B1 (mg)	0.08	Folate (mcg)	24.42
Vitamin B2 (mg)	0.03	Folate, DFE (mcg)	24.42
Vitamin B3 (mg)	0.63	Vitamin K (mcg)	12.59
Vitamin B3 - Niacin Equiv (mg)	0.79	Pantothenic Acid (mg)	0.10
Vitamin B6 (mg)	0.11	Calcium (mg)	31.00
Vitamin B12 (mcg)	0	Chromium (mcg)	0.65
Biotin (mcg)	1.76	Copper (mg)	0.14
Vitamin C (mg)	20.92	Fluoride (mg)	0.01

Nutrient Analysis

Nutrient	Value	Nutrient	Value
Iodine (mcg)	0.06	Omega 6 Fatty Acid (g)	0.11
Iron (mg)	1.54	Alcohol (g)	0
Magnesium (mg)	15.30	Caffeine (mg)	0
Manganese (mg)	0.21	Choline (mg)	4.66
Molybdenum (mcg)	2.43	Insoluble Fiber (g)	0.08
Phosphorus (mg)	47.82	Sugar Alcohol (g)	0
Potassium (mg)	255.27		
Selenium (mcg)	1.02		
Sodium (mg)	323.33		
Zinc (mg)	0.47		
Omega 3 Fatty Acid (g)	0.03		

Appendix M

Nutritional Analysis (Medallion Labs) of the PSF Formulation

MEDALLION LABS

9000 Plymouth Avenue North, Minneapolis MN 55427
1-800-245-5615 (763) 764-4453 Fax: (763) 764-4010

Final Report

Completion Date: February 28, 2011
Date Submitted: February 14, 2011
Medallion Company ID: FOODDEV01
Company Code: 11204

Meeling Nivet
Food Development Centre
Box 1240
810 Phillips Street
Portage la Prairie, MB R1N 3J9 Canada
Email: meeling.nivet@gov.mb.ca

Library Number: 2011-MED-1685
PO Number: 9803
Fax:

Medallion Labs Sample ID: 2011-MED-1685-01
Customer Sample ID: 3207

Pasta Sauce (contains Inulin)

Assay Group	Test	Results
² Calories	Calories	75 Calories/100 g
	Calories from Fat	6 Calories/100 g
	Calories from Saturated Fat	1 Calories/100 g
² Carbohydrates	Carbohydrates	14.6 %
Metals Screen 1	Metals Screen	Discount
Moisture	Moisture	80.502 %
Ash, Overnight	Ash	1.595 %
Protein, by Dumas	Protein (6.25)	2.63 %
Fats, by Gas Chromatography	Total Fat	0.63 %
	Saturated Fat	0.07 %
	Monounsaturated Fat	0.31 %
	cis-cis Polyunsaturated Fat	0.21 %
	trans Fat	0.01 %
Cholesterol	Total Cholesterol	Less than 1.0 mg/100g
² Dietary Fiber, CODEX Definition	Total Dietary Fiber	4.6 %
Sugars	Fructose	3.67 %
	Glucose	2.07 %
	Sucrose	0.764 %
	Maltose	Less than 0.1 %
	Lactose	Less than 0.1 %
	Total Sugars	6.50 %
Calcium	Calcium	29.0 mg/100g
Iron	Iron	2.39 mg/100g
Sodium	Sodium	280 mg/100g
Vitamin C	Vitamin C	0.730 mg/100g
² Carotenoids	alpha carotene	75.4 IU/100 g
	trans beta carotene	727 IU/100 g
	cis beta carotene	122 IU/100 g
	Total beta Carotene	849 IU/100 g
	Total Carotene	924 IU/100 g

Medallion Labs maintains A2LA accreditation to ISO/IEC 17025 for the specific tests listed in A2LA Certificate # 2769.01.

Medallion's services, including this report, are provided subject to all provisions of Medallion's Standard Terms and Conditions, a copy of which appears at www.medlabs.com.

Limits of Detection and Measurement Variability are available upon request.

² This test is not considered in-scope of our current A2LA accreditation. For a listing of in-scope tests, please visit www.medlabs.com.

Appendix N

Nutritional Analysis (SGS Canada Inc.) of the PSF Formulation

SGS

FOOD DEVELOPMENT CENTRE
810 PHILLIPS ST.
BOX 1240
PORTAGE LA PRAIRE MB R1N 3J9

Report of Analysis

Date: July 13, 2010
File No.: 1201-103105-1

WE HAVE ANALYZED the herein described submitted sample and report as follows:

DESCRIPTION : Sample #2; Pasta Sauce
SAMPLE RECEIVED : June 28, 2010
ANALYSIS:

TESTS	METHOD REFERENCE	RESULTS
Energy	(03-01-SLM-FD-0022based on Atwater method)	73 Cal/100g
Energy	(03-01-SLM-FD-0022based on Atwater method)	306 KJ/100g
Protein (N X 6.25)	(03-01-SLM-FD-0005 based on AOAC 990.03)	2.6 g/100g
Fat	(03-01-SLM-FD-0058 based on AOAC 996.06)	0.8 g/100g
Calories from Fat	(03-01-SLM-FD-0022based on Atwater method)	7 Cal/100g
Saturated Fat	(03-01-SLM-FD-0058 based on AOAC 996.06)	0.1 g/100g
Monounsaturated Fat	(03-01-SLM-FD-0058 based on AOAC 996.06)	0.4 g/100g
Polyunsaturated fat	(03-01-SLM-FD-0058 based on AOAC 996.06)	0.3 g/100g
Trans Fat	(03-01-SLM-FD-0058 based on AOAC 996.06)	<0.1 g/100g
Cholesterol	(03-01-SLM-FD-0028)	<1 mg/100g
Carbohydrates	(03-01-SLM-FD-0021based on Atwater method)	13.9 g/100g
Total Sugar	(03-01-SLM-FD-0050 based on AACC 80-04)	6.5 g/100g
Sodium	(03-01-SLM-FD-0015 based on AOAC 968.08)	270.8 mg/100g
Calcium	(03-01-SLM-FD-0015 based on AOAC 968.08)	31.1 mg/100g
Iron	(03-01-SLM-FD-0015 based on AOAC 968.08)	1.7 mg/100g
Moisture	(03-01-SLM-FD-0009 based on AOAC 935.29)	81.2 g/100g
Ash	(03-01-SLM-FD-0001 based on AOAC 942.05)	1.5 g/100g
Vitamin A	(03-01-SLM-VM-0002 & -0028)	398 IU/100g
Vitamin A	(03-01-SLM-VM-0002 & -0028)	119 RE/100g
Vitamin C	(03-01-SLM-VM-0029)	1.75 mg/100g
Total Dietary Fiber	(03-01-SLM-FD-0002 based on AOAC 991.43)	3.4 g/100g
Insoluble Dietary Fibre	(03-01-SLM-FD-0002 based on AOAC 991.43)	2.4 g/100g
Soluble Dietary Fibre	(03-01-SLM-FD-0002 based on AOAC 991.43)	1.0 g/100g
Lycopene	(HPLC)	6 mg/100g

Appendix O

Consumer Demographic Questionnaire
Formulating Food Products for the Aging Baby Boomer Population

This information will be kept strictly confidential. Panelist Number ____

1. Year of Birth. _____

2. Gender. □ Male
□ Female

3. Area of Residence? □ Urban (Winnipeg and Brandon *only*)
□ Rural ; Town: _____

4. Please indicate how often you consume a meal with a tomato-based pasta sauce within a month. _____

5. How many people live in your household (including yourself)?
Please check all that apply.
_____ Older Adults (>65 years of age)
_____ Adults (parent)
_____ Children (<18 years of age)
_____ Children (>19 years of age)

6. Annual household income before taxes.

Less than $10,000 _____
$10,000 to $19,999 _____
$20,000 to $29,999 _____
$30,000 to $39,999 _____
$40,000 to $49,999 _____
$50,000 to $59,999 _____
$60,000 and over _____

7. How would you describe your health compared to others your age?

□ Poor/Bad □ Fair □ Good □ Very Good □ Excellent

8. Do you take any medications which affect your senses, especially taste and smell?
Yes ____ No____
Name:_____

9. Do you smoke? Yes ____ No ____

10. In your household, who purchases the groceries? _____

11. In your household, who prepares over 50% of the meals? _____

12. On average, how many home cooked meals do you have per week? _____

Appendix P

Consumer Acceptability Questionnaire
Formulating Food Products for the Aging Baby Boomer Population

This information will be kept strictly confidential. Panelist Number _____

In front of you is a sample of pasta sauce served with pasta. After tasting the sample rate your acceptability on the following scales. Choose the phrase that best describes how much you like this product for each attribute.

Pasta Sauce Sample

1. How much do you like the COLOR of the pasta sauce?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
□	□	□	□	□	□	□	□	□

2. How much do you like the TEXTURE of the pasta sauce?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
□	□	□	□	□	□	□	□	□

3. How much do you like the TASTE of the pasta sauce?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
□	□	□	□	□	□	□	□	□

4. How much do you like the ODOR of the pasta sauce?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
□	□	□	□	□	□	□	□	□

5. Would you PURCHASE this pasta sauce?

Definitely Would Not Buy	Probably Would Not Buy	Maybe/ Maybe Not Buy	Probably Would Buy	Definitely Would Buy
□	□	□	□	□

Packaging Samples

6. Which size packaging do you prefer? *(See display table for jar sizes)*

□ 500mL □ 750mL

Cost

7. How much would you be willing to pay for a standard size jar (750mL) of this pasta sauce from your grocery store made with local, fresh ingredients? *(Please provide amount in dollars and cents.)*

_____

Comments:

Thank you very much for you time.

Appendix Q

Consent Form: Consumer Acceptability

UNIVERSITY OF MANITOBA

Faculty of Human Ecology

Department of Human Nutritional Sciences

Winnipeg, Manitoba
Canada R3T 2N2
Phone: (204) 474-9554
Fax: (204) 474-7592

July 24, 2010

Dear Colleague,

We are seeking volunteers to participate in a study to find out their overall acceptance for pasta sauce. This information will be used as part of the process in developing a more nutritional pasta sauce for you.

Volunteers will be included in the research if you: 1) are a Baby Boomer (born between 1946 and 1965); 2) regularly consume tomato-based pasta sauce *(more than 1 meal a month)*; and 3) have no allergies to the ingredients. You will be asked to fill out a short 2 page questionnaire concerning your socio-demographic background and taste and rate your overall acceptability for a pasta sauce (½ cup serving served with pasta). This should take you no longer than approximately 10 minutes.

A known risk is an allergy to ingredients within the pasta sauce. The ingredients of the pasta sauce are tomato sauce, tomatoes, red lentils, tomato paste, inulin, onion, carrot, zucchini, celery, peppers, canola oil, sugar, and spices. The list of ingredients will also be available at the booth. This will alert the researcher of any possible risks for the participants. Information regarding the project objectives will be given at the end of the taste testing.

Consumer Acceptability Tests are being held at Farmers Markets and Fairs throughout Manitoba. There will be a booth set up at each location for one day of the event.

Results will not be reported by individuals' names nor will any names be associated with the results. All data will be kept strictly confidential by the researcher and under lock and key until published or for five years whichever is shorter.

If you would like to be part of this research, please read and fill in the required consent form and questionnaire attached to this request and return it to Jacqueline Bugera. Any questions you have can be answered by calling Jacqueline at 474-6051.

You will be eligible for one of 3 prize draws for a $50 gift certificate to a local food store of your choice upon completion of the consumer acceptability questionnaire.
We hope you will be able to assist us with this project. We appreciate it very much.

Sincerely,

JACQUELINE BUGERA
MSc. Student

Dr. CHRISTINA LENGYEL
Assistant Professor

UNIVERSITY
OF MANITOBA

Winnipeg, Manitoba
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Phone: (204) 474-9554
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Faculty of Human Ecology

Department of Human Nutritional Sciences

Consent Form

Research Project Title: **Formulating Food Products for the Aging Baby Boomer Population**

Researcher(s): **Jacqueline Bugera & Dr. Christina Lengyel** **Panellist Number** ____

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The study is being done to evaluate the acceptability of consumers regarding pasta sauce.

Criteria for volunteers are as follows *(please check boxes that apply):*

1) □ you are a Baby Boomer (born between 1946 and 1965);
2) □ you regularly consume pasta sauce (*more than 1 meal a month);* and
3) □ you are not allergic to any of the ingredients.

You will also be asked to fill in a questionnaire regarding your socio-demographic background and asked to taste and rate your overall acceptability for a pasta sauce sample (*125 ml*) served with pasta (*125 ml*). The taste testing should take approximately 10 minutes. Information about the project will be given at the end of the session.

A known risk is an allergy to ingredients within the pasta sauce. The ingredients of the pasta sauce are tomato sauce, tomatoes, red lentils, tomato paste, inulin, onion, carrot, zucchini, celery, peppers, canola oil, sugar, and spices. Are you allergic to any of the mentioned ingredients? □ Yes □ No

The list of ingredients will also be available at the booth. This will alert the researchers of any possible risks for participants.

Respondents will be identified by number during the sessions (no names will be recorded during sessions) and all data related to personal information and results obtained will be kept in a locked cabinet for 5 years or until data are published whichever comes first. Access to information will be limited strictly to the researchers named above. All data will be shredded/destroyed after the time has expired.

You will be eligible for 1 of 3 prize draws for a $50 gift certificate to a local food store of your choice upon completion of the consumer acceptability questionnaire.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to serve as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. This study is being conducted by Jacqueline Bugera, under the supervision of Dr. Christina Lengyel 474-9554.

_____

Participant's Name (Please Print) Signature
Date

_____

Researcher and/or Delegate's Signature Date

If you are interested in receiving more information and results from the study please complete the following information.

_____

NAME (Please Print)

Preferred mailing address: ☐ email ☐ post

_____ _____

EMAIL STREET

_____

POSTAL CODE

_____

CITY/TOWN

Appendix R

Consumer Acceptability Comments: Baby Boomer Participants

Participating Sites	Consumer	Comments
1	560	It tastes wonderful. Love the fact it has lentils and not meat.
	806	Tastes Great
	524	Knowing that the product is Manitoba grown and produced is very important and I would go out of my way to purchase it if it became available. Thanks!
	115	The sauce is good...I usually prefer a white alfredo sauce so...may be more partial to enjoying that rather than a red sauce.
	45	Excellent
	47	Close to supermarket prices (regarding question on cost)
	628	Absolutely delicious.
	340	I think the texture of sauce influenced the way I thought it tasted. The texture almost seemed to have a dryness to it.
	411	Prefer a pasta sauce that has more of creamy texture to better adhere to pasta and coat evenly.
	481	Would like to know nutritional values.
2	998	Too spicy, too much of something -more of maranara type, fillers can taste, like starch or flour.
	816	Texture somewhat to 'chalky' either should be more chunky or more smooth (for my liking).
	641	I would prefer to add my own sources and amounts of 'heat'. Since MSG and other nasties can be hiding in the word 'spices'. I would like to see all substances listed explicitily.
	353	A little spicy for those with sensitive digestion but really good. Perhaps have a milder & stronger/spicier version so there's a choice when purchasing.
	746	Delicious
	329	Quite liked it -texture is a bit 'odd' at first for a pasta sauce, but once I connected it tho the lentils it was OK. Seem to be a tangy taste I couldn't quite connect to the ingredient.
	432	Except I can't eat anything spicy.
	425	Very good. Hurry & make is soon!
	667	Aroma-good. Color-appealing. Taste-a little more towards soury side. Texture is good-thick consistency.
	464	Gently spiced = very good.
	15	very taste
3	919	Delicious - nice amount of heat. Thank you.
	479	For a low sodium product, it has an amazing taste, enough to make you groan!!

Continued ...

	346	My only comment is its a little bitter. I think a bit of sugar would even out the taste.
	876	likes chunkier
	624	enough heat in the sauce to snap it up, but not too much to burn; the fact that it is made with local ingredients would certainly encourage me to buy this product over another one
	810	I found the texture grainy
	834	Very nice. Like the consistency - just a nice amount of spices.
	945	I found that it had a sour over taste that was a bit off-putting.
	607	Nice taste. I would use this product.
4	272	The sauce was slightly spicy (delicious) but had a bit of acidic edge to it.
	934	Excellent pasta sauce with great taste. I would definitely buy some. I know my family (their tastes) & they would love it.
	342	Tried this sauce & it's so good & tasty.