

Mount Saint Vincent University
Department of Applied Human Nutrition

The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety and Short-Term Food Intake in Children

By
Teresa Chiu

A thesis submitted in conformity with the requirements for the degree of
Master of Science in Applied Human Nutrition

October 2017
Halifax, NS
© Teresa Chiu, 2017

The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety and Short-Term Food Intake in Children

Teresa Chiu

Master of Science in Applied Human Nutrition, 2017

Department of Applied Human Nutrition

Mount Saint Vincent University

Epidemiological data indicate that the regular consumption of pulses is associated with improved body weight control. However, there are no reports regarding the effect of whole pulse consumption on short-term subjective appetite and food intake in children. The purpose of the study was to investigate how adding whole pulses will affect the satiety (feeling of fullness arising between meals), food intake (calories and nutrients consumed), in addition to how children perceive sensory characteristics of the mixed meal containing cooked rice with or without added whole pulses, providing 44% energy, in thirty-three children aged 12-14 years. Due to the variability of weight status, children were separated into lighter-to-normal weight group and heavier weight group. Children attended one screening, three weekend study sessions, one week apart, and consumed one of three randomized iso-caloric (300 kcal), 200 g treatments: 1) rice with added navy beans, 2) rice with added yellow split pea, and 3) rice (control). There was no effect of treatment on subsequent food intake at the test meal 120 min later in all participants, lighter-to-normal participants, or heavier participants. Analysis of subjective appetite measures showed a lower average appetite after the control compared to the navy bean treatment ($P=0.04$), and a lower hunger after the control compared to the navy bean treatment ($P=0.03$) in all participants. The intake of added pulses did not result in gastrointestinal discomfort. In conclusion, whole cooked pulses added to rice did not lead to a greater satiety or reduced short term food intake compared to the control; however, had acceptable palatability, were tolerable, without gastrointestinal discomfort, and improved the nutrient profile. This study presented an effective and practical approach to improving dietary intake of fiber, protein, and nutrients by incorporating pulses.

Acknowledgements

Firstly, I would like to express my appreciation to my thesis supervisor, Dr. Bohdan Luhovyy, for allowing me to complete this study. As a great mentor, whom I sought out for his expertise and experience, he has provided me with abundant guidance, support and direction throughout the research process. However, he has also allowed me to grow and to become more confident in my own abilities as a researcher. It is through his patience and encouragement that has enabled me to persevere in the knowledge translation and transfer of this project, and for this I am truly indebted. I would like to also express thanks to my thesis committee members, Professor Judy Fraser-Arsenault, and Dr. Rebecca Mollard for agreeing to serve as my committee members and for providing valuable feedback.

Secondly, I must acknowledge and give thanks to the Manitoba Pulse and Soybean Growers Association for their financial support with this research. Additionally, I am appreciative of the following awards and scholarships that I've received: Canada's Graduate Master's Scholarship – Canadian Institute of Health Research (CIHR), Nova Scotia Health Research Fund Master's Award (NSHRF), Mount Saint Vincent University Graduate Merit Award, Catherine Anne Godwin Graduate Award, and Canadian Association of Foodservice Professional (CAFP) Student Award have contributed towards the research process.

Thirdly, I would like to thank my parents for supporting me, and for helping me achieve my professional and personal goals. It has been an interesting and insightful journey to achieving my Master of Science Applied Human Nutrition, and I am grateful to have the encouragement of my family and friends. To my cousin, Deanna, I would like to dedicate this to you for inspiring me with your passion for life and love of learning.

Finally, I would like to recognize and thank my fellow lab group for your support and help along the way, and for the volunteers who were actively involved in the study sessions.

Table of Contents

Acknowledgements	2
List of Tables	7
List of Figures	8
List of Abbreviations	9
Chapter 1: Introduction	11
Chapter 2: Literature Review	13
2.1 Childhood Obesity in Canada	13
2.2 Recommendations for Management of Overweight and Obese Children and Youth	13
2.3 Energy Homeostasis	14
2.4 Food Consumption Patterns in Children and Youth	15
2.4.1 Meal and Snack Patterns among Children and Youth.....	16
2.4.2 Mean Food Intake in Adolescents During Meals	17
2.5 Pulses and their Role in Satiety and Food Intake	18
2.5.1 Overview of Nutritional Composition and Functional Value of Pulses	19
2.5.2 Pulses, Protein Quality and Complementary Proteins	21
2.5.3 Structural, Functional Characteristics of Dietary Fiber in Pulses	22
2.6 Pulse Consumption and Human Studies – Adults and Children	23
2.6.1 Non-oilseed Pulses – Navy Beans	24
2.6.2 Non-oilseed Pulses – Yellow Peas	24
2.7 Rice, Rice Pulse Combination and Satiety	25
2.8 Pulse Consumption. Satiety, Satiation, Appetite, and Body Weight	27
2.9 Pulse Consumption and Cardiovascular Disease	30
2.10 Pulse Consumption, Diabetes, and Blood Glucose Levels	30
2.11 Pulse Recommendations by Health Professionals	31
Chapter 3: Rationale, Hypothesis, and Objectives	33
3.1 Rationale	33
3.2 Objectives	33

3.3 Research Questions	33
3.3 Hypothesis.....	34
Chapter 4: Methods and Procedures	35
4.1 Participants.....	35
4.1.1 Recruitment and Screening	35
4.1.2 Sample Calculation	36
4.2 Ethics.....	36
4.3 Study Design.....	37
4.4 Dietary Treatments.....	37
4.5 Methods for Measuring Satiation, Satiety, and Energy Intake	38
4.5.1 Health Canada Satiety Guidelines	38
4.5.2 Visual Analogue Scale	39
4.5.3 Subjective Appetite	40
4.5.4 Gastrointestinal Comfort	40
4.5.5 Sensory Characteristics of the Treatments	40
4.6 Study Protocol.....	41
4.7 Food Intake	43
4.8 Data Analysis	44
Chapter 5: Results	45
5.1 Subject Characteristics.....	45
5.2 Food and Water Intake.....	45
5.2.1 Food and Water Intake at <i>ad libitum</i> Pizza Meal	45
5.2.2 Cumulative Food and Water Intake	46
5.3 Subjective Appetite Scores	48
5.3.1 Average Appetite.....	48
5.3.2 Desire to Eat	49
5.3.3 Hunger	50
5.3.4 Fullness.....	51

5.3.5 Prospective Food Consumption	52
5.4 Subjective Physical Comfort Scores	53
5.4.1 Nausea	53
5.4.2 Stomach Discomfort.....	53
5.4.3 Wellness	53
5.4.4 Gas.....	54
5.4.5 Diarrhea.....	54
5.4.6 Average Physical Comfort.....	54
5.5 Palatability of Treatments and Pizza Meal	55
5.5.1 Taste	55
5.5.2 Mouthfeel	55
5.5.3 Flavor	55
5.5.4 Sweetness	55
5.5.5 Treatment Pleasantness	56
5.5.6 Pizza Pleasantness.....	56
5.6 Relations among Dependent Variables.....	56
Chapter 6: Discussion	58
6.1 Subjective Appetite and Food Intake.....	58
6.2 Food Intake at <i>ad libitum</i> Pizza Meal	60
6.3 Overweight/Obesity and Satiety, Leptin, and Ghrelin.....	61
6.4 Palatability and Physical Comfort	63
6.5 Factors Influencing Satiety and Food Intake	63
6.6 Glycaemia and Satiety	65
6.7 Summary	65
6.8 Limitations and Strengths	66
6.9 Practical Implications.....	68
Chapter 7: Future Directions	69
Chapter 8: Conclusion	71

References	72
Appendices	80
Appendix 1a Recruitment Letter for Parents	107
Appendix 1b Study Information Sheet and Parent’s Authorization Form (Consent Form)	109
Appendix 1c Children’s Assent form	118
Appendix 2 Telephone Screening Questionnaire	119
Appendix 3a Puberty Questionnaire	122
Appendix 3b Tanner Staging	123
Appendix 3c Menstrual Cycle Questionnaire	126
Appendix 4 Physical Activity Questionnaire	128
Appendix 5 Dutch Eating Habits Questionnaire	129
Appendix 6 Recent Food Intake and Activity Questionnaire	131
Appendix 7a Visual Analogue Scale: Motivation to Eat	132
Appendix 7b Visual Analogue Scale: Physical Comfort	133
Appendix 7c Visual Analogue Scale: Pleasantness	134
Appendix 8a Peryam and Kroll Hedonic Scale	135
Appendix 8b Hedonic Scale: Mouthfeel	136
Appendix 8c Hedonic Scale: Flavor	137
Appendix 8d Visual Analogue Scale: Sweetness	138
Appendix 9 Advertisement	139
Appendix 10 TCPS2: Core Certificate	140

List of Tables

Table 5.1 Participant Baseline Characteristics	80
Table 5.2 Age, Sex and Weight of Study Participants	80
Table 5.3a Energy of Food Intake at the <i>ad libitum</i> Pizza Meal.....	81
Table 5.3b Cumulative Energy of Food Intake	81
Table 5.3c Weight of Food Intake at the <i>ad libitum</i> Pizza Meal	82
Table 5.3d Cumulative Weight of Food Intake	82
Table 5.3e Water Intake at the <i>ad libitum</i> Pizza Meal.....	83
Table 5.3f Cumulative Water Intake	83
Table 5.3g Cumulative Food and Water Intake.....	83
Table 5.4 Nutritional Composition of Dietary Treatments.....	84
Table 5.5 Nutritional Composition of Pizza Meal.....	84
Table 5.6 Food and Water Intake at the <i>ad libitum</i> Pizza Meal Categorized by Sex	85
Table 5.7 Food and Water Intake at the <i>ad libitum</i> Pizza Meal Categorized by Weight Status....	86
Table 5.8 Effect of Session on Food Intake at the <i>ad libitum</i> Pizza Meal	87
Table 5.9a Subjective Average Appetite Scores over 2 Hours in all.....	88
Table 5.9b Subjective Average Appetite Scores over 2 Hours in lighter-to-normal weight	88
Table 5.9c Subjective Average Appetite Scores over 2 Hours in heavier weight	89
Table 5.10 Gastrointestinal Comfort Scores over 2 Hours	89
Table 5.11 Overall Mean Palatability of the Treatments	90
Table 5.12 Overall Mean Pleasantness of the Treatments and Pizza Meal	90
Table 5.13 Correlations of Dependent Variables with Food Intake	91

List of Figures

Figure 5.1 Food Intake at the <i>ad libitum</i> Pizza Meal	92
Figure 5.2 Cumulative Food Intake	93
Figure 5.3 Water Intake at the <i>ad libitum</i> Pizza Meal and Cumulatively	95
Figure 5.4 Subjective Average Appetite Scores over 2 Hours	96
Figure 5.5 Absolute Subjective Average Appetite Scores over 2 Hours	97
Figure 5.6 Gastrointestinal Comfort Ratings over 2 Hours	100
Figure 5.7 Absolute Gastrointestinal Comfort Scores over 2 Hours	101
Figure 5.8 Palatability of Treatments.....	104
Figure 5.9 Overall Mean Pleasantness of the Treatments and Pizza Meal	106

List of Abbreviations

A

ANOVA	Analysis of Variance
AA	Average Appetite
APC	Average Physical Comfort

B

BP	Blood Pressure
BG	Blood Glucose
BMI	Body Mass Index
BMICAT	Body Mass Index Category (Body Weight Status)

C

CDA	Canadian Diabetes Association (Diabetes Canada)
CFG	Canada's Food Guide to Healthy Living
CCHS	Canadian Community Health Survey
CCK	Cholecystokinin
CHD	Coronary Heart Disease
CON	Control
CVD	Cardiovascular Disease

D

DEBQ	Dutch Eating Behavior Questionnaire
DTE	Desire to Eat

E

EAA	Essential Amino Acids
-----	-----------------------

F

FAO	Food and Agriculture Organization
FI	Food Intake

G

GI	Glycemic Index
G	Grams

H

HD	High Density Lipoprotein Cholesterol
----	--------------------------------------

K

Kcal	Kilocalories
------	--------------

L	
LDL	Low-Density Lipoprotein Cholesterol
N	
NB	Navy Beans
NHANES	National Health and Examination Survey
P	
PDCAAS	Protein Digestibility-Corrected Amino Acid Score
PPG	Postprandial Glucose
PPI	Postprandial Insulin
S	
SCFA	Short Chain Fatty Acids
SD	Standard Deviation
SEM	Standard Error of the Mean
T	
TC	Total Cholesterol
T2DM	Type 2 Diabetes
TG	Triglycerides
U	
USDA	United States Department of Agriculture
V	
VAS	Visual Analogue Scale
W	
WHO	World Health Organization
Y	
YP	Yellow Peas

Chapter 1: Introduction

Currently, the world is experiencing an increase of obesity and related chronic illnesses such as type 2 diabetes (1). One possible approach to curb the obesity epidemic is to identify and recommend foods that could reduce energy intake by inducing satiation, which is the process of terminating and eating less during the meal, and increase satiety, which is the process of extending the time and reducing food intake at the next meal (2, 3). Hence, one of the strategies of chronic disease prevention is diet and diet modification. Many nutritional components and functional attributes of fruits and vegetables, specifically non-oilseed pulses (beans, peas, and lentils) may be responsible for their protective effect against the risk for development of chronic disease (4). Pulses have a unique nutritional composition thought to assist in weight control, including high fiber, complex carbohydrates and low glycemic load, vegetable protein, folate, antioxidants and phytochemicals, in addition to having low fat and no cholesterol (4). There is substantial evidence suggesting that nutrients contained in pulses are associated with reducing the risk of obesity, diabetes, cardiovascular diseases (5-11).

Although epidemiological data suggest that the regular consumption of pulses is associated with improved body weight control (12), there are no reports regarding the effect of whole pulse consumption on short-term subjective appetite and food intake in children. The proposed study recruited school aged children to answer the following research questions: 1) Will the intake of cooked pulses result in a reduced subjective appetite and short-term food intake? 2) How will children perceive sensory characteristics of the mixed meal with or without added cooked whole pulses? 3) Do whole cooked pulses added to a mixed meal cause any gastrointestinal discomfort symptoms in the children?

Based on the evidence from epidemiological studies showing the link between pulse consumption and healthier body weight, it has been hypothesized that the consumption of whole pulses added to a mixed meal (rice with tomato based sauce) will lead to reduced appetite and short-term energy intake compared to a pulse-free mixed meal (rice with tomato based sauce) of the same energy density (kcal/g) in children.

The significance of the proposed research was to gain insight on the effects of pulse consumption on subjective appetite and food intake in children as well as their sensory perception and gastrointestinal comfort level as perceived by children. The knowledge acquired from this investigation was aimed at improving the nutrient intake and eating habits of children and adolescents.

Chapter 2: Literature Review

2.1 Childhood Obesity in Canada

The prevalence of overweight and obesity has risen steadily over the past three decades, which has the potential to lead to serious health outcomes (1). This has had a significant impact on Canadian children and youth where 15% aged 11 to 16 years were overweight and 4.6% were obese in 2002 (13). As a result of an unhealthy lifestyle during childhood, overweight and obese children have the increased likelihood of remaining so into adulthood (1, 14). In turn, childhood overweight and obesity have the potential of developing chronic metabolic illnesses at an earlier age such as CVD, and T2DM (1, 14). The 2009 to 2011 CCHS provided the most recent BMI data for children and adolescents, and based on the most recent WHO classification, approximately one third (31.5%) aged 5 to 17 years were overweight (19.8%) or obese (11.7%) (15). Well documented health risks associated with overweight and obesity and economic costs of these co-morbidities (1, 16), when coupled to the propensity of remaining overweight and or obese through to adulthood, make childhood obesity a public health concern (14, 17, 18). One study showed direct total costs attributable to overweight and obesity in Canada were \$6.0 Billion in 2006, with 66% due to obesity (16). Moreover, Maritime Provinces have shown higher prevalence of overweight and obesity (17, 19). Nova Scotia children and youth are at a combined rate of 32% of overweight and obese, and represent one of the highest in Canada (17).

2.2 Recommendations for Management of Overweight and Obesity in Children and Youth

The Canadian Task Force on Preventative Health Care has provided recommendations for growth monitoring and prevention of overweight and obesity in healthy weight children and adolescents aged 17 years and younger in primary care settings, and gave insight to health care providers on the effectiveness of interventions (20). The guideline recommended that growth monitoring be done at appropriate visits to identify children and youth with growth disturbances, including overweight and obesity (20). However, since the effectiveness of long-term primary-care focused interventions is indefinite, the guideline recommended that primary care practitioners do not routinely offer structured interventions aimed at prevention of overweight and obesity (20). Lastly, for the management of overweight and obesity, behavioral

interventions in children and youth aged 2 to 17 years was recommended, while pharmacological interventions or referral to surgical interventions were not recommended due to potential harms and lack of data showing effectiveness (20).

2.3 Energy Homeostasis

An imbalance between the energy content of food intake and energy expenditure is associated with change in body weight; a fundamental principle of nutrition and metabolism (21). Food composition has an important role in satiety and satiation. Macronutrients have differing effects, for instance it has been suggested that protein has a greater effect than carbohydrate, which has a greater effect than fat (21). Satiety and satiation depend upon different factors such as physiological and molecular mechanisms (21). Palatability and pleasantness of foods influences satiation, but not on subsequent satiety according to de Graaf and others (22). Distension of the gastrointestinal tract is but one satiation mechanism that is communicated to the brain, in addition to peptides secreted by the gut, which interact with receptors principally located in the hind-brain (21). The hormone ghrelin, an orexigenic (appetite stimulating) gastric peptide has also been linked to satiety. Hence, there are many environmental factors that contribute to food consumption including cognitive and sensory (liking and wanting food) stimuli, in addition to physiology (21).

Many peripheral signals can have an influence on feeding behaviors and body weight regulation, therefore it is important to recognize that short-term and long-term food intake and energy balance are regulated through separate, but collaborative mechanisms (23). Energy density and mechano- and chemoreceptors signaling in the presence of food in the gastrointestinal tract are factors that contribute to satiety during the postprandial period (23). Blood glucose levels elicit meal initiation and termination through regulating activity of hypothalamic neurons. Short-term regulation of food intake involves nutrients (amino acids and fatty acids), in addition to gastrointestinal peptide hormones such as CCK (23). Long-term regulators (insulin, leptin, and ghrelin also interact to help maintain energy homeostasis by regulating food intake and energy expenditure (23). For example, insulin and leptin are involved in modulating expression of hypothalamic neuropeptides that regulate body weight and feeding

behaviors (23). Decreased production of insulin and leptin may lead to increased energy intake and contribute to weight gain and obesity, especially when the diet consists of long-term and high consumption of fats and fructose (23). Thus, short-term and long-term mechanisms work in concert to ensure that energy balance that includes energy intake and energy expenditure is maintained (23).

2.4 Food Consumption Patterns in Children and Youth

Children nationwide are not meeting the minimum Canada's Food Guide recommended servings for the Vegetables and Fruit, Milk Products, and Grain Products food groups (13, 17, 24). According to a province wide study, 79% of grade 5 students consumed less than the five recommended daily servings of Vegetables and Fruits, in comparison to the country with 64% (19). Children in Nova Scotia have been reported to consume 25% of their daily calories from the Other Foods category, sugar, fats and oils, contained in their food choices (24, 25). A high intake of nutrient-poor foods, particularly high-sugar beverages is a concern for Canadian youth (26). Overall adherence to the Canada's Food Guide to Healthy Eating was low among Nova Scotia students in grades 7 to 11 (27). Fewer servings from vegetables and fruits, in addition to grain products and milk products were shown in at risk overweight and obese students (27). Moreover, findings by St. John and colleagues revealed that the rates of overweight in Nova Scotia students were double those reported by the 2004 CCHS (27). The vast majority of Nova Scotia students in grades 7 and 11 did not meet minimum recommendations for fiber (96% to 98%), or vegetable and fruit servings (83.3% to 90.7%) (25).

Energy expenditure and energy intake are components of the overweight status, and this study will address one of the modifiable factors, which is dietary intake (19). Hence, continued efforts are needed to develop innovative strategies to ensure healthy eating patterns in youth. The current low levels of consumption of pulses combined with their availability as a locally grown food form a strong rationale for Canadians to increase their pulse intake (28-30).

One possible approach to curb the obesity epidemic is to identify and recommend foods that could reduce energy intake by inducing satiety (process that leads to the inhibition of further eating, decline in hunger, and increase in fullness after eating) and increase satiation (process

that leads to termination of eating; therefore control of meal size) (2, 29). Pulses represent an example of a food that is relatively inexpensive, easy to prepare, and nutrient dense.

2.4.1 Meal and Snack Patterns among Children and Youth

Poor eating habits include inadequate intake of fruit, vegetables, milk, and eating too many high-calorie snacks and both have a role in childhood obesity (31). Grain products provided the highest percentage (31%) of daily calories, followed by “other foods” (22%), which provides limited nutritional value (31). Snacks provided 27% of daily calories, which is more than the calories consumed at breakfast (18%) and lunch (24%), but not dinner (31%) (31). For Canadians older than the age of 4 years, more than 41% of daily snack calories are derived from other foods such as chips, chocolate bars, soft drinks, fruit beverages, sugars, syrups, preserves, fats, and oils (31). To prevent childhood obesity, successful interventions need to include the combination of family and school-based programs, nutrition education and dietary change, physical activity, family participation and counseling (31).

When looking at the secular trends in meal and snack patterns among adolescents from 1999 to 2010, the mean frequencies of breakfast and lunch increased modestly in the overall population (32). The mean frequencies of breakfast increased from 3.7 to 4.2 days per week, and lunch increased from 5.6 to 5.8 days per week (32). There were small to modest decreases in the mean number of snacks consumed on school days (4.3 to 3.8 snacks per day) and vacation/weekend days (5.2 to 4.9 snacks per day) (32). The mean number of snacks consumed on school days (4.3 to 3.5 snacks per day) and vacation/weekend days (5.3 to 4.6 snacks per days) decreased notably among adolescents in middle school grades (32). However, no changes in mean number of snacks consumed were observed among adolescents in high school on school days (4.2 to 4.0 snacks per day) and vacation/weekend days (5.1 to 5.1 snacks per day) (32). Moreover, there was no change in the proportion of adolescents who reported frequent consumption of snacks prepared away from home (32). There was a secular decrease in energy-dense, nutrient-poor food/drink consumption (32). Results suggest that there have not been increases in meal skipping, or the consumption of nutrient-poor, energy-dense snacks. However, only 40.7% of adolescents in 2010 reported consuming each main meal on most or all days of a

week, and the mean intake of nutrient-poor, energy-dense snacks was about three daily servings (32). Moreover, there were disparities of meal and snack patterns that persisted over time among subgroups that are most vulnerable to poor nutrition and the development to obesity (32).

In a study by Patel et al. (2013) it was found that an afternoon snack of raisins lowered cumulative food intake in young children (33). Snacks were given in 500 ml clear containers (about 210 kcal) provided 65 g raisins, 301 g grapes, 45 g cookies, or 38 g potato chips. Participants were provided one container initially, and additional containers of snacks were available upon request during the 15-minute interval (33). The *ad libitum* consumption of an after-school snack of raisins had the potential of reducing overall snack intake prior to dinner, similar to grapes when compared to other snacks such as potato chips in children aged 8 to 11 years (33).

2.4.2 Mean Food Intake of Adolescents during Meals

The study participants by Woodruff and colleagues included 1068 grade 7 students at the mean age 12.3 years (52% males) from 26 schools in Windsor, Essex County, Ontario (34). The purpose of the study was to determine the associations among the frequency and caloric consumption of meals/snacks and family dinners (34). The findings revealed positive association of family meal frequency and diet quality among children and adolescents. For example, the frequency of family meals has been associated with healthier food intake and behaviors, and increased fruits and vegetables (35-38). The mean caloric intake of breakfast for males was 426.7 (\pm 236.9), and females was 346.3 (\pm 194.5) (34). The mean caloric intake for morning snack for males was 219.2 (\pm 203.8), while for females was 157.6 (\pm 125.2) (34). The mean caloric intake of lunch for males was 573.1 (\pm 328.9), whereas for females was 487.3 (\pm 263.1) (34). The mean caloric intake of afternoon snack was 241.0 (\pm 200.9) for males, while for females was 185.0 (\pm 146.7) (34). The mean intake of dinner for males was 756.6 (\pm 412.6), whereas for females was 617.5 (\pm 355.6) (34). Finally, the evening snack was 268.5 (\pm 256.3), and 210.3 (\pm 189.9) calories for males and females, respectively (34). Those who ate dinner with family members consumed 4.88 (\pm 1.1) meals/snacks per day compared with 4.40 (\pm 1.3) and 4.40 (\pm 1.3) times/day for consuming dinner alone or with friends, respectively ($p=0.006$) (34).

On average students in Ontario consumed 189 kcal for breakfast, 530 kcal for lunch, and 688 kcal for dinner, and 214 kcal for snacks.

Hoppu et al. (2010) evaluated food and nutrient intake during the school day among Finnish secondary school students in twelve schools in three cities in Finland (39). The study included a total of 1469 grade 7 students at mean age 13.8 years from twelve schools in three cities in Finland (39). Mean breakfast caloric intake was 274 (\pm 135) for males, and for females was 311 (\pm 137) (39). The mean caloric intake of lunch for males was 403 (\pm 173), whereas for females was 303 (\pm 131) (39). Mean dinner intake was 475 (\pm 234) for males, while females were 553 (\pm 200) (39). The school lunch provided approximately 20% of daily energy intake, while the recommended daily energy intake level is one-third according to 2008 dietary guidelines for school meals by the National Nutrition Council in Finland (39). Free lunch meals are provided daily to students in primary school (grades 1-9), secondary and vocational schools in Finland (39). The school lunch was nutritionally superior to the other daily meals (39). In contrast, lunch meals may not be provided by schools and thus food choices are made more freely in places such as in Canada. Snacks provided 41% of the daily energy, whereby mean daily snack intake of males and females was 832 (\pm 426) and 671 (\pm 340) calories, respectively (39). On average students in Finland consumed 293 kcal for breakfast, 353 kcal for lunch, and 514 kcal for dinner.

2.5 Pulses and their Role in Satiety and Food Intake

The pods or fruits of plants in the botanical family *Fabaceae*, or *Leguminosae* are commonly referred to as legumes (7). Pulses are edible seeds of legumes or pod-bearing plants including beans, lentils, chickpeas, and peas (40). A pulse is a type of legume that is harvested for their oil, and are also called grain legumes or pulse grains according to the FAO (7, 41). Additionally, the term “pulses” is limited to crops harvested solely for dry grain, which excludes crops harvested green for food, for example green beans and green peas are classified as vegetable crops (41). Crops used mainly for oil extraction, for example soy beans and ground nuts, and leguminous crops such as seeds of clover and alfalfa that are used for sowing purposes are also excluded (41). Pulses contain approximately twice the amount in protein to grains, are

high in fiber, and low in fat and glycemic carbohydrate (29). Pulses are commonly consumed with high-carbohydrate foods such as rice, pasta, and bread as a meal (42).

Canada is the producer of over a dozen types of beans (*Phaseolus vulgaris*) and sells the crops both domestically and globally (40). The white pea bean (navy bean) is Canada's largest bean crop (40). The largest bean growing areas in Canada are found in provinces of Manitoba and Ontario; however, they are also grown in Alberta, Quebec and Saskatchewan (40). Furthermore, Canada is the world's largest producer and exporter of peas, primarily yellow and green, which are also the largest pulse crop grown (40). Peas are grown mostly in provinces of Manitoba, Saskatchewan, and Alberta (40). Split and whole peas are available and are exported, also in other forms such as pea flour, starch, protein and fiber fractions (40).

2.5.1 Overview of Nutritional Composition and Functional Value of Pulses

The key nutrients found in pulses include: complex carbohydrates (fiber and starch fractions including resistant or slowly digested starch), oligosaccharides, vegetable protein, folate, phytochemicals, B vitamins, and minerals such as potassium and iron (40). It is the relative proportions of nutrients for instance fiber and protein, and the composition of these components for which determines the nutritional value of pulses (12). Moreover, although it is unclear as to which of the nutrient components exert the greatest effect on satiety, both are likely to act in concert to influence satiety, regulate energy intake, and control body weight (12). A serving of pulses (½ cup cooked dried pulses) contains 2-4 g of fiber and 7-8 g of protein (12).

Pulses contain 14-32 g/100 g of fiber, where 55-88% is insoluble and the remaining portion is soluble (43). Soluble viscous fibers (e.g. oats) can aid in increasing satiety by slowing the transit time of food and absorption dietary constituents including glucose, which can help with blood glucose control. Pulses have a low GI, which provide for slow release of energy and increased satiety, both important for weight loss and maintenance (7, 15). Insoluble fibers (e.g. wheat) can also aid in satiety and reduced caloric consumption through their intestinal bulking effects (44). Fiber, resistant starch, and phytate aid in the reduction, or slowing of starch digestibility, leading to decreased energy availability and reduced glycemic response (12).

Polysaccharide, oligosaccharide, and resistant starch are the main non-digestible carbohydrates found in the plant cell wall of pulses and are fermented by gut bacteria into SCFAs (12). Resistant starch are carbohydrates that are not absorbed in the small intestine because of their inability to be affected by certain gut enzymes, and like fiber, they have similar physiological effects and health benefits (28). Thorne, Thompson and Jenkins (1983) reported that pulses contain 30-40% of amylose starch, which is 5-10% more amylose starch compared to that of cereals (45). Pulses, when cooked, act as resistant starch due to the amylose content and thus slow digestion and absorption (46, 47). Amylose have long linear chains that tend to re-associate or retrograde upon cooling following gelatinization which reduces or slows their digestion (7). Pulse starches generally have a higher content of amylose compared with cereal and tuber starches (7).

Oligosaccharides are fibers that are non-digestible and have the ability to stimulate the growth or activation of “good microbiota” (bifidobacteria), thereby having a prebiotic effect (28). SCFA are produced when oligosaccharides are fermented by certain bifidobacteria, which can be oxidized and used as energy in preference to glucose and possibly suppress hepatic glucose production (7). In turn, this can help with balance of glucose metabolism, satiety and reduction of energy intake (28).

Pulses consists of 17-35% protein and provide a variety of amino acids (48). One study demonstrated that weight maintenance diets that are high in protein promote satiety, weight loss and reduced energy intake (49). Dietary protein may induce satiety and promote weight loss by increasing energy expenditure through its effects on diet-induced thermogenesis (3).

Pulses also contain phytochemicals such as polyphenols, which have been shown to inhibit the sodium dependent glucose transporter (SGLT1) on the brush border of the small intestine, and thus slow and partially prevent glucose absorption (50). Also, pulses contain enzyme inhibitors including trypsin, chymotrypsin, and amylase inhibitors, which may prevent the digestion of carbohydrates and proteins in pulses, and result in less energy absorption; however, cooking pulses may reduce the levels of the enzyme inhibitors, hence overall enzymatic effect (46).

Satiety is influenced through hormone modulation in the intestine and stimulation of satiety receptors in the brain following pulse intake. Reverri et al. (2017) found that incorporating whole black beans into a meal has acute beneficial metabolic and GI hormone response in adults with metabolic syndrome; preferred over the addition of equivalent amounts of fiber from a supplement (51). Findings showed the black bean meal produced significantly higher postprandial CCK concentration in comparison to the added fiber (psyllium powder) meal and no fiber meal control (51). CCK, a gut hormone secreted in response to fat and protein, helps to slow gastric emptying and increase satiety, and high levels have been reported after bean consumption (52). The peptides in beans have shown potent *in vitro* CCK stimulating activity, hence consumption of pulses may lead to up-regulation of the CCK brain receptors may enhance satiety (53).

2.5.2 Pulses, Protein Quality and Complementary Proteins

The nutritional value and the manner in which dietary protein exert physiological effects are dependent upon protein quality and quantity (12, 54). Protein quality describes the characteristics of protein in relation to their metabolic functions (12), where amino acid composition is the major determinant (55). A method for protein quality assessment is the PDCAAS, and is used to predict individual amino acid digestibility (55). A complete protein provides all the EAAs, for instance histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine (12). Protein from the meat, poultry, fish, eggs, and dairy products are considered complete proteins. However, proteins from plant sources such as pulses, vegetables, nuts, grains and seeds are low or deficient in EAA (55). Although resulting PDCAAS values for most pulses alone may not achieve a protein claim under the current Food Labeling Regulations, combining pulses with other plant-based protein sources such as cereal grains can produce a more complete protein (54). However, foods containing a combination of plant protein sources can produce improved protein quality due to their complementary amino acid profiles (54). The protein in pulses is higher in lysine and lower in sulphur amino acids, whereas cereal grains such as rice are lower in lysine and higher in sulphur amino acids (cysteine, methionine, tryptophan) (54). Thus, the addition of lentil, black bean or

pea to either wheat or rice increases the overall PDCAAS values ranging from 0.43 and 0.64 in the individual pulse or cereal to 0.71 and 0.75 in the blends (54).

2.5.3 Structural and Functional Characteristics of Dietary Fiber in Pulses

Knowledge of the role of dietary fiber in promotion of health and the prevention disease has gained much interest and attention, and so too has pulses (4). The health benefits noted can be explained partially to the composition and behavior of non-starch polysaccharides within the cellular walls of pulses (4). Previous studies have demonstrated that pulses are a significant source of dietary fiber (43). The total dietary fiber of in dried peas range from 14 to 26%, whereas navy beans range from 23 to 32% (4). There are four types of fiber contained within pulses, including long chain soluble and insoluble polysaccharides, galacto-oligosaccharides, and resistant starch (4). While soluble fiber is associated with reducing post-prandial blood glucose and cholesterol levels, insoluble fiber is generally known to act as a bulking agent and is linked with laxation (4). Furthermore, fiber can function as a prebiotic, thus providing food for gut microorganisms (4). Brummer et al. (2015) suggested that the cellular wall of pulses regulates starch gelatinization and can reduce enzymatic hydrolysis, leading to lowered glycemic response attributed to pulses. The rigidity of the cellular wall impeded access of the starch granules by digestive enzymes (4, 56). When the cell walls are ruptured, as during pulse processing, enzymes are more prone to starch hydrolysis (4). Moreover, the integrity of cell walls in whole pulses after cooking remains partially crystalline during cooking, therefore are prevented from degradation by digestive enzymes (4). Anguah et al. (2014) found that blending lentils increased appetite by approximately 6%, but not glycemic response in comparison to whole lentils, whereas α -galactosidase did not (57). Blending pulses disrupts their physical structure, which may allow for more rapid digestion and absorption (57). Thus, the processing conditions have important implications when pulse products are consumed, particularly on appetite.

Pulse purées are included in many baked products, and preferred consistency can be adjusted with water accordingly (58). Pulses may also be cooked by boiling on the stove top. Of note, pulses double or triple in volume during cooking, thus it is recommended that a large enough saucepan be used (58). Cooking times vary with the type and age of the pulses (58).

Moreover, dry beans, whole peas, and chickpeas must be soaked before cooking (58). However, to reduce the digestive discomfort that may occur from pulse consumption, it is recommended that the soaking water be changed once or twice during the soaking period, and not use the soaking liquid to cook pulses (58). Canned pulses are convenient since they are pre-cooked and ready-to-use, and it is recommended to drain and rinse canned beans before use to remove excess sodium, and to help with prevention of digestive discomfort (58).

2.6 Pulse Consumption and Human Studies – Adults and Children

Studies have identified many health benefits with consumption of pulses. There have been epidemiological studies that have associated pulse consumption with reduced risk of obesity and becoming overweight in both adults and children (59-61). Pulses consumed alone have revealed an association between pulse intake and reduced risk of being overweight and obese in both men (13%) and women (14%) in Rio de Janeiro (61). The NHANES 1999-2002 data showed that pulse consumption was associated with reduced waist circumference, body weight, and reduced risk of obesity compared to individuals who do not consume pulses among U.S. adults (60). In children aged 12 to 19 years, it was also found that pulse intake was associated with reduced waist circumference, body weight, and risk of being overweight in ages 4 to 19 year old (59). Epidemiological studies with pulses have been shown to reduce body weight, waist circumference, and the risk of being overweight and obese when consumed alone (60), or when included in a dietary pattern (61).

Short term studies have demonstrated that when pulses are consumed alone, have low GI, reduced glycemic response (62, 63), and suppressed appetite when compared to control (62). Moreover, consumption of canned pulses also reduced waist circumference and improved glycemic control in an 8-week study (11). When consumed as a mixed meal, pulses similarly lower BG, reduce FI in comparison to a pulse-free meal (64, 65). Although pulses when eaten alone, or consumed as a mixed meal increased satiety and reduced glycemic response in comparison to the control, they do not always result in a reduction in energy at the subsequent meal (64-66). There is some indication that pulses may help to increase satiety (in the short

term), and weight loss during intentional energy restriction (over a few weeks) according to the few studies that have been conducted (7).

Hence, intervention studies have shown low-glycemic and appetite-suppressing properties of pulses in adults (11, 42, 62, 64-68); however, it is currently not known whether whole pulses have the same properties when consumed by children.

2.6.1 Non-oilseed Pulses - Navy Beans

The *Phaseolus vulgaris* species include: kidney beans, haricot beans, pinto beans, and navy beans (7). Findings by Luhovyy et al. (2015) demonstrated that consuming 5 cups per week of ready-to-eat commercially available navy beans for 4 weeks reduces metabolic risk factors associated with obesity, thus providing a strategy in dietetic practice (66). For example, bean consumption results revealed that waist circumference reduced by 2.5 cm in females and 2.1 cm in males (66). Also, the effect of beans on pulse rate, TC and LDL were sex dependent (66). In males, pulse rate, TC and LDL were decreased by 6.5%, 11.5%, and 18%, respectively, while in females, pulse rate increased by 9.6%, and TC and LDL were relatively unchanged (66). A meta-analysis (10 randomized clinical trials, minimum duration of 3 weeks) by Bazzano (2011) revealed beneficial effect of a pulse-rich diet by reducing TC and LDL, thus supporting these findings (69). Wong et al. (2009) found that the short-term effect of navy bean consumption in young men on subjective appetite and food intake at a meal 2 hours later and cumulative food intake was determined by energy content rather than composition, processing, recipe, or variety (62). Mollard et al. (2012) demonstrated in adult males that the addition of pulses to a high-glycemic meal contributes to early satiation, the reduction of blood glucose both following the meal and again after a later meal depending on the pulse type (65). Mollard et al. (2012) showed that frequent consumption of pulses in overweight and obese adults, for 8 weeks reduced metabolic syndrome risk factors (11). Hence, there has been literature showing the health benefits of navy bean and pulse consumption.

2.6.2 Non-oilseed Pulses - Yellow Peas

Health benefits associated with pulse consumption have been well documented; however, the components within pulses that may be responsible for their effects, have not been examined

in great detail (42). Hence, Smith et al. (2012) investigated isolated fiber and protein fractions of yellow peas to determine if these components are responsible for the beneficial effects of whole pulses such as an appetite suppression and reduced glycemic response (42). Yellow pea (*Pisum sativum*) consumption is extremely low in countries where rates of overweight and obesity are highest such as in North American and European, despite being the least expensive and most abundant non-oilseed pulse (42, 67). Smith et al. (2012) found that protein (rather than fiber) is the component responsible for the short-term effects of yellow peas, glycemic regulation, and food intake; however, its second meal effects disappeared by 2 hours post-consumption in young men (42). Mollard et al. (2014) showed that yellow pea protein and hull fiber in combination may be used in blood glucose control in young men, and have similar effect to canned yellow peas (67). Thus, there has been research on yellow pea and pulse consumption and their resulting health benefits.

2.7 Rice, Rice-Pulse Combination, and Satiety

Rice is a dietary staple food for more than half of the world's population, especially in Asian countries (70). Thus, white rice is a major contributor to dietary glycemic load, an index reflecting the acute blood glucose raising potential of foods (71). Since a reduction in post prandial glycemic and insulinemic responses is seen as a beneficial dietary change in chronic metabolic diseases such as T2DM, it would be useful to determine the range of PPG and PPI response to rice and the primary intrinsic and processing factors known to affect such responses (70). Boers et al. (2015) found that there are three main factors that explain most of the variation in glycemic and insulinemic responses to rice (70). They include: inherent starch characteristics (amylose:amylopectin ratio, and rice cultivar), post-harvest processing (particularly parboiling), and consumer processing such as cooking, storage and heating (70). For example, a lower PPG response to rice can be achieved when amylose content is high (more resistant starch content), minimizing cooking times or pressure parboiled, and cooling before consumption (70).

The study by Luo and Kennedy (2015) assessed the rice consumption pattern and its association with selected measures of health, diet and nutritional status in the U.S. children and adolescent population (72). Using the NHANES 2007-2008, findings showed that most children

and adolescents in the U.S. did not consume rice as part of their regular diet, and that ethnicities that were more likely to be rice consumers included non-Hispanic white and Asian/mixed children and adolescents (72). Rice consumers ate less total fat and saturated fat from their diet (72). High rice consumers had significantly higher micronutrient intake including folate, iron, vitamin B6, thiamin, niacin, vitamin C, magnesium and copper (72).

Another study assessed energy intake, hunger, and satiety scores for six breakfast items commonly consumed in India, with adult females (73). Energy intake hunger and satiety scores were assessed for one rice-based, three wheat-based and a rice-pulse fermented preparation, and compared with white bread as the reference (73). The highest satiety score was associated with fermented cereal-pulse preparation, while the lowest was associated with the white bread standard. Results showed that fiber content, energy density, and cooked weight of the food items positively influenced satiety scores (73). Findings suggest that consumption of food items that are high in protein and fiber, with greater water/volume lead to lower energy density, and may be effective in delaying the return of hunger (73).

A study by Mohan et al. (2014) compared the effects of brown rice, white rice, and brown rice with legumes on blood glucose and insulin responses among overweight South Asian population (74). GI values for popular Indian white rice varieties, in addition to short-grain rice are in the range 70-77 (75) in comparison with whole grains such as brown rice, and legumes, which have GI values ranging from 50-87, and 10-70 (76), respectively. The glycemic response was 19.8% lower in the brown rice group compared to the white rice group (74). The brown rice with legumes group further reduced the glycemic response by 20.9% in comparison to the white rice group (74). The fasting insulin was 57% lower for the brown rice group, and 54% lower for the brown rice with legumes group (74). The glycemic and insulinemic responses to the brown rice and brown rice with legumes diets were not significantly different (74). Hence, the consumption of brown rice with and or without legumes in place of white rice may help in the reduction of 24-hour glucose and fasting insulin responses among overweight South Asians (74).

Similarly, Thompson et al. (2012) demonstrated that pinto, dark red kidney beans with rice reduced the glycemic response in comparison to rice alone. Net postprandial glucose values

were significantly lower for the three bean and rice treatments in contrast to the rice control at 90, 120, and 150 minutes (77).

Furthermore, Mattei et al. (2011) found that increasing the ratio of beans to rice, or reducing the intake of white rice by substituting beans, may lower cardiometabolic risk factors. Significant trends for higher HDL cholesterol, lower BP, and TGs were observed for 1:3, 1:2, 1:1, and 2:1 ratio of beans to white rice (78).

2.8 Pulse Consumption, Satiety, Satiation, Appetite and Body Weight

Effective strategies are needed for both losing and maintaining healthy body weight. Fruits and vegetables are low in energy density because of their high water and low-fat content (79). Hence, addition of fruits and vegetables to the diet reduces overall energy density, which can affect satiety (79). To study satiety, a fixed amount of defined food (preload) is consumed, while hunger and fullness are rated after consumption, and measured over a time interval (79). Studies testing the effects of fruit and vegetable intake on satiety have shown that a defined preload (constant macronutrient and energy content) high in fiber and water content and low energy density may promote satiety and decrease energy intake at a subsequent meal as measured by ratings of hunger and fullness (79-82).

The energy density of foods also affects satiation, which is the process of terminating a meal (79). Satiation is studied by measuring intake when foods are freely available, thus satiation is enhanced by lowering energy density of available foods (79). Addition of fruits and vegetables may help with weight management, which can reduce the overall energy density and allow for consumption of adequate portions, while reducing caloric intake (79). Studies where energy density was reduced with the addition of fruits and vegetables showed that participants consume a consistent amount of food per day and there was a reduction in daily energy intake as a result of decreasing energy density; however, a reduction in intake was not associated with increase in hunger (79-82).

An additional dietary modification to reduce the energy density of the diet and improve satiation and satiety control is the incorporation of pulses. A review by McCrory and colleagues (2010) stated that there is evidence that pulses may help to increase satiety over the short term

and weight loss associated with energy restriction in adults (7). Short term studies (mostly single meal studies), revealed reduced hunger and increased satiety 2-4 hours following pulse intake when meals were controlled for energy, but not when controlled for available carbohydrate (7). Hence, the effect of pulses on satiety may be mediated by available carbohydrates amount or composition (7). In a few observational studies studying the association between pulse consumption and weight status, adults with lower BMI consumed a greater amount of pulses in their diet (7). Four out the five intervention studies that tested the effectiveness of whole pulses on weight loss during intentional caloric restriction (7, 45, 82-85) reported significant effects on body weight from pulse treatments in comparison to non-pulse controls (7). The intervention studies were 6-8 weeks long, with varied pulse treatments from eating rice and beans twice a day to incorporating mixed pulses (approximately 3 to 5 cups/week), and indicated 8 to 18 lbs. weight loss (7). The intervention studies with pulse consumption and body weight without energy restriction showed a lack of effect of pulses on body weight, and is consistent with the suggestion that an increase in fruit and vegetable intake will have a modest effect on body weight loss unless advice on reducing energy intake is provided simultaneously (7).

A recent systematic review and meta-analysis of 21 randomized controlled trials by Kim and colleagues (2016) showed an overall significant weight reduction of -0.34 kg (95% CI: -0.63, -0.04 kg; P=0.03) in diets with dietary pulses (median intake 132 g/d or ~1 serving/d) compared to diets without a dietary pulse intervention over 6 weeks in adults (86). Thus, inclusion of dietary pulses in the diet may be a beneficial weight loss strategy as it can result in modest weight loss even in diets that are not intentionally calorie restricted (86). A clinical study by Turner and colleagues (2013) examined the effects and acceptability of two high-fiber hypocaloric diets (1400 kcal) and provided 25-35 g fiber, but differing in sources of fiber, they included beans compared to fruits, vegetables and whole grains (1.5 cups beans/day, or fruits, vegetables and whole grains) (87). Mean weight loss was 1.4 kg (SD=1.5; P<0.001), energy density and self-reported hunger decreased (P's<0.01), and self-reported fullness increased (P<0.05) (87). Both diets were rated as potentially acceptable up to and as long as 6 months,

significantly increased fiber intake by 75%, increased satiation, and reduced hunger, thus supported weight loss strategy with increasing fiber with dietary sources such as beans (87).

Another systematic review and meta-analysis of nine acute feeding trials regarding dietary pulses, satiety and food intake by Li et al. (2014) (88) indicated that consumption of dietary pulses may increase acute satiety, but again may not manifest in a detectable decrease in second meal food intake (88).

According to Mitchell et al. (2009) there has been considerable research on the consumption of pulses and their health benefits, yet consumption levels in the U.S. are relatively low (89). The results of their study suggested that consumption of ½ cup of pulses resulted in higher intake of fiber, protein, folate, zinc, iron, and magnesium while lowering intakes of total fat and saturated fat in diets (89). Consuming ½ cup cooked pulses can be considered as a vegetable or as 2 oz. equivalents from the Meat and Bean group (89). It was shown that between 1% to 48% of Americans (depending on age and gender) have been meeting the recommendations for total fruit and vegetable intake (89). Mean intakes of vegetable subgroups have been below recommended levels except for the starchy vegetable subgroup, which included pulses (89).

Guenther et al. (2006) stated that only 40% of Americans ate on average of five or more ½ cup servings of fruits and vegetables per day, the amount recommended by the 5 A Day program (90). Generally, Americans need to consume more fruits and vegetables, especially dark green and orange vegetables and legumes (90). Mean intake of dark green and orange vegetables, and legumes are less than one third of recommended amounts (90).

As in other countries, Canadians too generally fall short of meeting recommended daily guidelines for fruit and vegetable intake (24, 91, 92). The Food Guide recommends 6 servings per day for youth aged 9-13, 7 servings for girls aged 14-18, and 8 servings for boys aged 14-18 years (93). In 2015, 31.5% of Canadians aged 12 and older, about 9 million people, reported that they had consumed fruits and vegetables 5 or more times per day (94). The proportion of residents who reported eating fruits and vegetables at least 5 times daily, lower than the national average (31.5%), were five provinces including Nova Scotia (25.3%) (94). Food frequency data

from the 2015 Canadian Community Health Survey (CCHS) showed that youth aged 12-19 years, 30.3% of boys and 32.3% of girls reported consuming fruits and vegetable at least 5 times per day. In addition, Mudryj et al. (2012) reported that 13% of Canadians consumed pulses, with the highest consumption in Asian populations (30).

2.9 Pulse Consumption and Cardiovascular Diseases

Obesity is one of the major risk factors for non-communicable diseases such as CVDs, and despite advances in prevention and treatment, CVD remains a public health problem worldwide (95). CVD is the leading cause of deaths and accounts for approximately 30% of global deaths (96).

Research has shown that regular intake of pulses (dry beans, peas, chickpeas, and lentils) may reduce the risk of cardiovascular disease (97). Pulse consumption has been demonstrated to improve blood profile (reduce lipid, TC, LDL cholesterol, TGs, and increasing HDL) and decrease body weight (10). A meta-analysis evaluating data from 10 randomized clinical trials representing 268 participants (18-78 years old) found that consumption of pulses reduced TC levels by 11.8 mg/dL (5.5%) and LDL by 8 mg/dL (6.6%) when compared to control diets (9, 97). This meta-analysis provided evidence that non-oilseed pulse consumption reduces serum TC and LDL, and may lower the risk of CVC (97). Moreover, foods that were replaced iso-calorically by dietary pulses in another study significantly lowered systolic (-2.25 mm Hg, 95% CI -4.22 to -0.28, P=0.03) and mean arterial BP (-0.75 mm Hg, 95% CI, -1.44 to -0.06, P=0.03), but not significant for diastolic BP (-0.71 mm Hg, 95% CI -1.74 to 0.31, P=0.17) (98).

A systematic review and meta-analysis of 26 randomized controlled trials on the effects of dietary pulse intake on established therapeutic lipid targets for cardiovascular risk reduction and findings suggest dietary pulse intake significantly reduces LDL cholesterol levels (5). The dietary pulse intake with median dose of 130 g/d (~ 1 serving daily), significantly reduced LDL cholesterol levels in comparison to the control according to Ha et al. (2014) (5).

2.10 Pulse Consumption, Diabetes and Blood Glucose Levels

The prevalence of diabetes has also increased rapidly along with obesity and CVDs, particularly rates of T2DM are increasing in younger age groups (95). A large portion of this

increase has occurred in developing countries because of population aging, lack of physical activity and obesity (95). A feasible approach to the prevention of diabetes has been through lifestyle interventions (95). This knowledge when translated into practice, could mean saving lives, improving quality of life, and avoiding further health care expenditures (95).

Research has shown that pulse consumption may be beneficial in the management of BG levels (99). GI studies revealed that pulses had a significantly lower GI than the control (100-102). Additionally, post prandial studies comparing pulses or pulse products to controls found significant reductions in postprandial glucose compared to the control (63, 103-105). Similarly, Jenkins et al. (2012) demonstrated that incorporation of pulses as part of a low GI-diet improved both glycemic control and reduced calculated CHD risk score in T2DM (6). Moreover, a meta-analysis of 41 randomized controlled long term experimental trials by Sievenpiper and colleagues (2009) demonstrated that pulse consumption alone, or in low-GI or high fiber diets improved markers of longer term glycemic control in humans (9).

Ramdath, Renwick, and Duncan (2016) recently reviewed results from acute feeding trials and stated that postprandial blood glucose response was significantly attenuated by a single pulse serving of between three-quarters and one cup, and long-term pulse intake of five cups per week resulted in consistent improvements in glycemic control (106). Also, regular consumption of about two-thirds of a cup per day could help in the management of dyslipidemia in individuals with T2DM (106).

2.11 Pulse Recommendation by Health Professionals

Pulse consumption has been recommended by many health organizations to maintain optimal health and prevention of chronic diseases (diabetes, cardiovascular diseases and cancer) (97, 99). The 2007 CFG suggested having meat alternatives (beans, lentils, and tofu) often, and that other meat alternatives such as lentils can help to minimize the amount of saturated fat in the diet (93). The 2007 CFG categorized foods into the groups based on usage, thus pulses are found in the Meat and Alternatives group, where a 175 ml ($\frac{3}{4}$ cup) serving is equivalent to one serving (93).

The 2013 Diabetes Canada (CDA) Guidelines (107) also reported that individuals with diabetes should follow the healthy diet recommended by the CFG; regularly choosing beans and other meal alternatives such as lentils to minimize the amount of saturated fat in the diet (93).

Another recommendation from the 2013 CDA Guidelines (107) stated that foods should be low in energy density to promote satiety, and prevent overconsumption to help with the achievement and maintenance of body weight, thus ensuring adequate intake of carbohydrates, fiber, protein and other nutrients. Thus, research suggested that pulses may increase satiety over short term, with the potential for weight loss over long term (7).

The Heart and Stroke Foundation of Canada recommended that a heart-healthy diet should include foods that are high in fiber, and that soluble fiber may help lower cholesterol and control blood glucose levels (108). The best sources of soluble fiber included oatmeal and oat bran, legumes such as dried beans, peas, lentils, and pectin-rich fruits (108).

Pulses are also incorporated in both the Meat and Beans group as well as the Vegetable group in the USDA's My Plate food guidance system based on their nutritional profile where ½ cup of pulses acts as a two ounce equivalent in the Meat and Beans Group, and alternatively as one serving in the Vegetable group (109).

The 2015 Dietary Guidelines recommends a legume serving size of ½ cup (~ 90 g), and for a Healthy U.S. Style Eating pattern and a Healthy Mediterranean-Style Eating Pattern, 1 ½ cups per week based on a 2000 kcal diet (110). The Data from the National Health and Nutrition Examination Survey 1999-2000 showed that adults are consuming average 0.1-0.3 servings of legumes per day, which is about $\leq 1/3$ than the recommendation (90). Of the estimated 30% of adults who do consume pulses, only 40-45% of them achieve at least the recommended (111).

As shown by the literature in adults, increasing consumption of pulses, and striving to achieve the recommended dietary intakes may help in weight control, and in diet related chronic illnesses, for example T2DM and CVDs. Pulse consumption is beneficial to a healthful diet strategy and is recommended by the CFG and USDA My Plate guidelines, in addition to other organizations. However, currently there is no data showing the effect of the consumption of meals with added pulses on satiety and short-term food intake in children.

Chapter 3: Rationale, Hypothesis and Objectives

3.1 Rationale

Pulses are reported to have significant short-term physiological benefits (42). Pulses are also commonly consumed with high carbohydrate available foods such as rice and pasta (65). Epidemiological data indicate that the regular consumption of pulses is associated with improved body weight control (12). However, there are no reports regarding the effect of whole pulse consumption in a mixed meal on satiety and short-term subjective appetite and food intake in children, in addition to their health benefits. Current low levels of consumption of pulses, combined with their availability as a locally grown food form a strong rationale for Canadians to increase their pulse intake (29, 60, 89, 111).

The significance of the proposed research was the increased consumption of whole pulses by children led to improved dietary intake, aimed at the reduction of obesity and related metabolic disorders. This may be achieved by incorporating more fiber and protein, while reducing total fat and sugar in the diet.

3.2 Objectives

The objectives were as follows: 1) To determine the effects of cooked whole navy beans and yellow peas added to mixed meal on subjective appetite, satiety, and short-term, food intake in children. 2) To investigate palatability (pleasantness) and sensory properties (sweetness, flavor and texture) of cooked whole pulses, and 3) To evaluate their effect on gastro-intestinal comfort level in children (nausea, stomach discomfort and diarrhea).

3.3 Research Questions

The proposed project recruited school-age children to answer the following research questions: 1) Will the intake of cooked beans and peas result in reduced short-term appetite and food intake of a subsequent meal provided two hours later? 2) How will children perceive sensory characteristics of the mixed meal with or without added cooked whole pulses? 3) Do whole cooked pulses added to a mixed meal cause any gastrointestinal discomfort symptoms in the children?

3.4 Hypothesis

It was hypothesized that the consumption of a meal (300 kcal), in which rice was partially replaced (44% energy) with whole pulses will lead to reduced appetite (increased satiety) and short-term energy intake, compared to a pulse-free control meal (rice) of the same energy density (kcal/g) and weight in children. Moreover, cooked whole pulses added to a meal will be well tolerated, have acceptable palatability, without gastrointestinal discomfort.

Chapter 4: Methods and Procedures

4.1 Participants

4.1.1 Recruitment and Screening

Thirty-three healthy (13 boys and 20 girls) children aged 12-14 years, were recruited for this study in the Halifax area through advertisements (**Appendix 9**), Halifax Kijiji website (<http://halifaxjiji.ca/f-community-volunteers-W0QOCatIdZ3>) and by the word of mouth. Small card sized flyers were distributed in public areas, including libraries, and community centers, while large flyers were posted at Mount Saint Vincent University and Dalhousie University.

The sample size (n=24) was determined, with power analysis from a previous study on pulses and appetite with children (112). This considers the attrition rate of 20%, and is based on the sample size calculation ($\alpha = 0.05$, $\beta = 0.8$, to detect the effect size 10%). To participate, children must have been born at full term (≥ 37 and ≤ 42 weeks) within the normal weight category range. The children's BMI was assessed according to the WHO Growth Charts for Canada (113). The rationale for using children of this age was based on current and previous experience and the lack of acute intervention studies showing the effect of pulses on food intake for this cohort. Participants were excluded from this study if they have food sensitivities or allergies, dietary restrictions, health, learning, emotional or behavioral problems, or if they were receiving medication.

After the children's parents initiated contact with our research group by phone or by email, we provided the recruitment letter (**Appendix 1a**) for more study detail, and determined children's eligibility by using a Telephone Screening Questionnaire (**Appendix 2**). The study was conducted at the Mount Saint Vincent University, Department of Applied Human Nutrition, Appetite Lab Evaristus 301. Participants who met the study requirements attended one screening session where informed consent was obtained from a parent (**Appendix 1b**) and assent (**Appendix 1c**) was obtained from the child. Participants' body weight (kg) was measured with Tanita Body Composition Analyzer TBF-300A, Tanita Corporation of America Inc. while subjects wear light clothing using reference weight 0.5 kg (114), and height (cm) were recorded from a stadiometer (Tanita HR-200, Tanita Corporation of America Inc.). The children were

told that the purpose of the pulse study was to evaluate beans and peas, and examine children's food preferences. The pubertal stage will be assessed with the Puberty Questionnaire (**Appendix 3a**), Tanner Staging Assessment (**Appendix 3b**) and Menstrual Cycle Questionnaire (**Appendix 3c**) which will be demonstrated to parents first and if they agree, then to children. Parents will have a choice to answer pubertal stage questionnaires for children or not to answer at all. The reason for using these questionnaires is justified by the fact that the energy intake regulation varies on different stages of the puberty, as it was recently shown (112, 115). The children will be asked to fill out a Physical Activity Questionnaire (**Appendix 4**) and a Dutch Eating Behavior Questionnaire (**Appendix 5**) that will be used for the secondary data analyses. Children were familiarized with the visual analogue scale (VAS) questionnaires (**Appendices 7a-c, 8a-d**) employed in the study and the parent and child were given a tour of the facility to minimize apprehension during the first test visit. The children were given the treatments in a randomized order per the Latin Squares Row-Column design. Eligible participants attended three laboratory visits on either Saturday or Sunday, with a one-week washout period. As a thank you, participants were given a \$20 gift card of their choice (Indigo Bookstore, movie theatre) for completion of each lab sessions, and parents were given \$5 for travel expenses.

4.1.2 Sample Calculation

In order for the study to be adequately powered to demonstrate a significant effect on the primary outcome(s) measured, the sample size calculations should be able to detect at least 10% difference in satiety ratings for the primary outcome between the test and control foods for comparative claims with a statistical significance at $p \leq 0.05$ and power (β) of at least 80% (116). It was found that 20 children are needed to detect 10% difference, thus 24 children (includes four anticipated dropouts, 20% attrition rate) was the study's sample size (117).

4.2 Ethics

The protocol for the study was submitted for clearance to the Mount Saint Vincent University Research Ethics Board. Upon clearance, the study commenced, and each child attended one screening and three experimental sessions on the weekend with one week apart

between the sessions. Written and informed consent was obtained from participants and their parents by the research assistant.

4.3 Study Design

One short-term clinical trial was conducted wherein a single blinded, repeated measures, within-subject, balanced crossover design was applied to measure children's energy intake and subjective appetite following consumption of one of three treatments NB, YP or control, subjects were assigned to treatment order using the Latin Squares Row-Column Design.

4.4 Dietary Treatments

The dietary treatments were equalized to the same energy density (300 kcal), and weight (200 g), and consist of white rice with tomato-based sauce in which 44% (by energy) of rice was replaced with cooked: 1) whole navy beans, 2) whole yellow split pea, and 3) rice only (control). The addition of tomato-based sauce and seasoning provided uniform color and flavor in all treatments. The subsequent energy intake was measured two hours later with the pizza meal. The subjective appetite and physical comfort was measured over two hours.

Commercially available dried yellow split peas (Blue Menu, Loblaw's Inc., Canada) and navy beans (Blue Menu, Loblaw's Inc., Canada) were prepared the day of the session according to Pulse Canada guide (58). However, navy beans were soaked for 8 hours prior to treatment preparation (12:00 am to 8:00 am) as in a previous study. The pulse treatments and pulse-free control were made the day of the session and all meals had the same energy density and volume adjusted through the addition of water. The pulses were added to replace 44% energy of rice serving. To equalize the energy density (kcal/g), varying amounts of water were added to all treatments. The formulation was as follows: 93.6 g (132.0 kcal) of navy bean, or 85.9 g (132.0 kcal) of yellow pea added to 66.3 g (118.8 kcal) of rice. The pulse-free control contained 100% rice (140.0 g, 250.8 kcal) (No Name medium grain Calrose, Loblaw's Inc., Canada). The rice was cooked prior in vegetable broth (Campbell Company of Canada, Toronto, Canada). The flavor of the treatments was adjusted with tomato-based Rosée sauce (Classico, International Gourmet Companies, Canada).

Table 1 Nutritional Composition of Dietary Treatments (per 200 g)

Cooked Treatments	CON¹	NB¹	YP¹
Weight, g	200.0	200.0	200.0
Protein, g	5.8	11.7	10.9
Fat, g	4.3	5.0	4.9
Carbohydrate, g	61.4	56.6	55.9
Fiber, g	0.0	7.4	4.0
Energy, kcal	300.0	300.0	300.0

¹CON, rice and tomato-based sauce, NB, whole navy beans with rice and tomato-based sauce, YP, split yellow peas with rice and tomato-based sauce

The pulse-free control consisted of 61.4 g available carbohydrate, 5.8 g protein, and 4.3 g fat. The navy bean treatment consisted of 56.6 g available carbohydrate, 7.4 g dietary fiber, 11.7 protein, and 5.0 g fat. The yellow pea treatment consisted of 55.9 g available carbohydrate, 4.0 g dietary fiber, 10.9 g protein, and 4.9 g fat. The nutrient composition of the dietary treatments is shown above and in **Table 5.4**. For the pulse treatments, 93.6 g of navy bean, and 85.9 g of yellow pea (President's Choice, Blue Menu, Toronto, ON, Canada) were added to the total 200 g treatment meal. The pulse addition accounted for 132 kcal or 44% of 300 kcal of the treatment meal.

Participants were able to choose from Pepperoni or Cheese (McCain's Deep 'N Delicious Mini Pizzas) pizzas for the ad libitum pizza meals, and were consumed consistently for the three study sessions. The brand name changed to Dr. Oetker Mini Pizzas, but continued to be produced at the same manufacturing facility, and were used starting at subject n=19. The pizza nutrient compositions are included in **Table 5.5**.

4.5 Methods for Measuring Satiating, Satiety, and Energy Intake

4.5.1 Health Canada Satiety Guidelines

Cross-over, within subject study designs are preferred according to the Health Canada draft guidance document (116). Participants were blinded to the treatment and time blinded to prevent influence of when the next meal should occur and associated subjective sensations of satiety; however, the researcher was not blinded to the preloads due to food preparation

requirement beforehand. It is also difficult to establish a minimum number of hours, for example non-comparative claims about the duration of an effect on subjective satiety measure as there are intrinsic (energy density, volume and macronutrient content) and extrinsic (environmental and social cues) factors. Based on the Health Canada draft guidance document, to merit a claim, the duration of an effect of foods on subjective satiety measures should be at least 3 hours for a snack, or 4 hours for a meal for non-comparative studies (116).

When the subjective average appetite ratings was graphed against time (min) in a previous study with mixed meals containing pureed pulse consumption on satiation and satiety and short-term food intake in children, the time that the subjective appetite returned to baseline was at approximately 70 min (115). With whole pulse consumption, satiety maybe increased sooner due to increased palatability (118).

Health Canada Satiety Guidelines on Satiety recommend 3 hours between preload and test meal for snacks, 4 hour between for meals for non-comparative claims about duration of an effect on subjective satiety measures (116). However, this study is a comparative study. It was therefore suggested that the pizza test meal be incorporated at 2 hours instead of 3 hours. Hence, the pizza meal was provided 2 hours after the test meal.

Satiation and satiety are processes that affect eating behavior and are assessed by a combination of objective energy intake and subjective appetite-related sensory ratings measures (116). Satiation measures the study participant's *ad libitum* consumption of the food that is explored under controlled conditions to minimize environmental or cognitive confounders, and organoleptic food properties on the termination of the eating occasion and amount of food that is eaten (116). Satiety measures the duration of changes in subjective ratings of appetite-related sensations with or without measurement of energy intake at a subsequent meal, and this process was examined in this study (116).

4.5.2 Visual Analogue Scale (VAS)

A validated method for measuring subjective states of motivation to eat before and in response to meals is the VAS (**Appendices 7, 8**) (119, 120). VAS consists of questionnaires that assess sensory characteristics of subjective appetite (116). The standard VAS questionnaires

have an anchored 100 mm horizontal line where each end represents opposing extremes of a specific scale, for example “not hungry at all” to “extremely hungry” (116). The study participants were instructed to draw a mark on the line that corresponds to how they are feeling at that moment (116). The subjective sensation is quantified by measuring the distance from the left end of the line to the mark (116).

4.5.3 Subjective Appetite

VAS for subjective appetite assessed the following characteristics: desire to eat (DTE), hunger (H), fullness (F), and prospective food consumption (PFC). The average appetite score was calculated using (121):

$$\text{Average Appetite Score} = [DTE + H(100-F) + PFC]/4$$

4.5.4 Gastrointestinal Comfort

Gastrointestinal comfort levels were also investigated, for instance subjective feelings of nausea (N), stomach discomfort (SD), wellness (W), flatulence (F), and diarrhea (D) were reported. The average physical comfort was calculated using (121):

$$\text{Average Physical Comfort} = [(100-N) + (100-SD) + W + (100-F) + (100-D)]/5$$

4.5.5 Sensory characteristics of the Treatments

The sensory characteristics of the treatment include the following: pleasantness and sweetness using VAS, taste using the Peryham and Kroll hedonic scale, in addition to mouthfeel and flavor using the 5-point hedonic scale.

Also, energy (caloric intake) in studies that assessed satiety/satiation effects was measured through observation of food consumed *ad libitum* (116). The intake of the test food alone or as part of a meal measures satiety as in this study, whereas energy intake at a test meal is measured at pre-determined time after the preload measures satiation. Generally, the preload (treatment) is either the test food(s) (pulse meal), or the control food (pulse-free meal) for comparative claim (116).

4.6 Study Protocol

Following a 12 hour overnight fast, children consumed a standardized breakfast (340 kcal) in the morning (8:00 am) and a standardized snack (100 kcal) (10:00 am), both provided beforehand by the research group, prior to arriving at the laboratory (11:00 am) on the session day. The standardized snack consisted of one granola bar (26 g, 100 kcal) (Blue Menu Chewy Cranberry Apple, President's Choice, Loblaws Inc., Toronto, ON), and one small bottle of water (330 mL) (Nestlé Pure Life, Nestlé Waters Canada, Guelph, ON). The standardized breakfast included Honey Nut Cheerios (26 g, 100 kcal) (General Mills, Toronto ON, Canada), Baxter's 2% milk (250 ml, 130 kcal) (Saputo, Dartmouth, NS, Canada), and orange juice (236 ml, 110 kcal) (Tropicana Products Inc., Bradenton, FL, USA), was used in a previous study (112). The rationale for the controlled intake during the day was to account for variability in energy intake of the children.

Upon arrival, participants completed Recent Food Intake and Activity Questionnaire (**Appendix 6**) assessing their sleep habits and stress, and their compliance with the study protocol such as fasting and physical activity instructions. Those whose answers indicated non-compliance with the study protocol, feelings of illness, atypical fatigue, stress or significant deviations from their usual patterns were asked to reschedule the study session.

After completing a recent food intake and activity questionnaire, children were asked to consume one of the treatments (12:00 pm). Participants were escorted to the taste panel room, asked to consume the randomized treatment (within 10 minutes) in the individual cubicles, return to the examination room and complete validated VAS questionnaires assessing palatability and sensory properties of the treatments, motivation to eat and physical comfort levels (42, 62, 64, 65, 119, 120). The researcher began timing at the first bite (0 min). The commercially available dried navy beans and yellow peas were prepared the day of the session at the facility. Navy beans were pre-soaked 8 hours before being cooked, whereas yellow peas did not require pre-soaking (58). The rice was cooked separately with vegetable broth in a rice cooker the morning of the session. The pulses were combined with the seasoned rice to produce the pulse treatments, while the pulse-free control treatment contained seasoned-only rice. The pulse treatments and

pulse-free treatment also contained a tomato-based sauce for flavor and uniformity. The pulse and pulse-free meal were re-heated on high (100% power) for 2 min in a microwave oven (Panasonic NN-CD989B, 1100-Watt) at the facility immediately before being served in a microwavable glass bowl with lid. One 250 mL cup (250 g) of water was included with the treatment.

Children completed VAS questionnaires (baseline) prior to consumption of a treatment (time 0 min) and at 15, 30, 45, 60, 90, 120, 150 min after. They were instructed to read and place an “X” along the 100-mm line corresponding to their feelings of subjective appetite and physical comfort. Motivation-to-eat VAS measures subjective appetite and consists of four questions: 1) How strong is your desire to eat? (“Very weak” to “Very strong”); 2) How hungry do you feel? (“Not hungry at all” to “As hungry as I’ve ever felt”); 3) How full do you feel? (“Not full at all” to “Very full”); and 4) How much food do you think you can eat? (prospective food consumption (PFC)) (“Nothing at all” to “A large amount”). Physical comfort was assessed by “How well do you feel?” (“Not well at all” to “Very well”). Pleasantness was assessed by “How pleasant have you found the food” (“Not pleasant at all” to “Very pleasant”), while sweetness of the food will be assessed by “How sweet have you found the food” (“Not sweet at all” to “Very sweet”). In-between, children were free to read, color, play games, or be engaged with educational activities and arts and crafts provided by our study group. To measure *ad libitum* food intake, children were asked to return to the taste panel room two hours later (2:00 pm) where they were served with a pizza meal, and instructed to eat until comfortably full (within 15 minutes). During *ad libitum* food and water intake with pizza meal two hours later, subjects were provided with a 500-ml bottle of natural spring water (Nestlé Pure Life®).

4.7 Food Intake

The post-meal palatability, subjective appetite, and physical comfort were measured with VAS questionnaires at 150 min, ending the session at 2:30 pm. One of two varieties Pepperoni, and Three Cheese of Deep 'N Delicious pizza (McCain Foods, Florenceville, NB, Canada) was offered as the pizza test meal per participant's preference, which was determined at screening, and the same choices were provided at all three sessions. Each cooked pizza (10 min at 425°F and cut in quarters) were weighed before serving. Each tray contained 2 pizzas and participants were instructed that fresh pizzas trays would replace the previous trays at 7 min intervals until participants declined further trays. This type of pizzas provides uniform energy content due to their lack of a thick outer crust, thus eliminating the possibility of participants eating only the more energy dense center. Food intake with the *ad libitum* pizza meal, and water were measured based on the mass of food and bottled water before and leftover food after the meal, and the mass (g) were converted in energy (kcal). The manufacturers' nutritional information was used to calculate energy intake in kcal. The two varieties of McCain's mini pizza averaged 9.5 g of protein, 5.0 g of fat, 23.0 g of carbohydrate, and 215 kcal/100 g. Nutritional composition of all other ingredients was based on information provided by manufacturers (**Table 5.5**).

4.8 Data Analysis

Statistical analyses of the data were performed using SAS version 9.3 (Statistical Analysis Systems; SAS Institute, Inc., Cary, N.C., USA). The results were reported as standard error of the mean (SEM). All ANOVAs included session as a repeated measure to control for within-subject variability. One-way repeated measures ANOVA was used to determine the effect of treatment on food intake at the ad libitum pizza meal, cumulative food intake, and all components of subjective appetite and physical comfort. The effect of age, weight status, sex, and food intake was also analyzed using two-way repeated measures ANOVA. Tukey-Kramer post-hoc test was used to describe the differences between the treatments. The statistical significance was set at $P < 0.05$. Pearson correlation coefficients were calculated to determine the relationship between the dependent variables and food intake. The tests performed by SAS included: Testing the effect of treatment, time, session, and sex. Additionally, time by treatment interaction, sex by treatment interaction, and session by treatment interaction was conducted.

Chapter 5: Results

5.1 Subject Characteristics

The total number of subjects that were recruited and completed the study was thirty-three (13 boys and 20 girls) (**Table 5.1**). The average BMI percentile was 55.2 ± 30.0 (normal weight). There were twenty-five subjects who were between the 3rd and less than 85th (normal weight), who were categorized as lighter-to-normal weight. There were six subjects who were between 85th and 97th (over weight), and two who were greater than 97th (obese) age- and sex-specific BMI percentiles, who were categorized as heavier weight. On average, subjects rated their restrained, emotional, and external eating behavioral scores (2.3 ± 0.5) as “rarely”, indicating they these behaviors would be less likely to be displayed. The average age for the subjects was 13.3 ± 1.0 years.

5.2 Food and Water Intake at *ad libitum* Pizza Meal

5.2.1 Food and Water Intake at *ad libitum* Pizza Meal

There was no treatment effect on energy ($P=0.4$) (**Table 5.3a**, **Figure 5.1b**) and weight intake ($P=0.3$) (**Table 5.3c**, **Figure 5.1a**) at the pizza meal, nor was there was a treatment effect on water intake ($P=0.4$) (**Table 5.3e**, **Figure 5.3a**) during the *ad libitum* pizza meal for all subjects. In lighter-to-normal weight subjects, there was no treatment effect on energy (kcal) ($P=0.7$) (**Table 5.3a**) and weight intake (g) ($P=0.9$) (**Table 5.3c**) with a pizza meal, nor was there was a treatment effect on water intake ($P=0.4$) (**Table 5.3e**) during the *ad libitum* pizza meal. There was no treatment effect on energy (kcal) ($P=0.2$) (**Table 5.3a**) and weight intake (g) ($P=0.1$) (**Table 5.3c**) with a pizza meal, nor was there was a treatment effect on water intake ($P=0.3$) (**Table 5.3e**) during the *ad libitum* pizza meal for heavier weight subjects.

There was no session effect on energy ($P=0.4$) and weight intake ($P=0.4$) at the pizza meal; however, there was a session effect on water intake ($P=0.003$) during the *ad libitum* pizza meal (**Table 5.8**). There was a significant difference on water intake between sessions 1 and 2 ($P=0.007$), and between sessions 1 and 3 ($P=0.002$) revealed by post-hoc analysis.

There was no effect of age on energy ($P=0.3$) and weight intake ($P=0.7$) at the pizza meal. There was no effect of age on water intake ($P=0.4$) during the *ad libitum* pizza meal.

There was no effect of sex on energy ($P=0.7$) and weight intake ($P=0.7$) at the pizza meal. There was no effect of sex on water intake ($P=0.9$) during the ad libitum pizza meal (**Table 5.6**).

There was no effect of weight status (BMICAT) on energy ($P=0.1$) and weight intake ($P=0.1$) at the pizza meal. However, there was an effect of weight status on water intake ($P=0.009$) during the ad libitum pizza meal (**Table 5.7**), where the heavier subjects drank significantly more water compared to lighter-to-normal subjects. When analyzing the treatments between groups, post-hoc analysis showed that there was a significant difference in water intake during the pulse-free controls ($P=0.002$), and during the navy bean treatments ($P=0.009$) where the heavier subjects drank more compared to lighter-to-normal subjects. When analyzing the treatments among groups, there was also a significant difference of water intake among the heavier weight subjects ($P=0.03$), where more was consumed during the control compared to yellow pea treatment.

There was no interaction between the treatment and session, treatment and age, treatment and sex or treatment and BMICAT on energy, weight and water intake during the pizza meal.

5.2.2 Cumulative Food and Water Intake

There was no treatment effect on cumulative energy ($P=0.6$) (**Table 5.3b, Figure 5.2b**), cumulative weight intake ($P=0.4$) (**Table 5.3d, Figure 5.2a**) at the pizza meal, and cumulative weight intake at the pizza meal plus water ($P=0.5$) (**Table 5.3g, Figure 5.2c**), nor was there a treatment effect on cumulative water intake ($P=0.4$) (**Table 5.3f, Figure 5.3b**) during the *ad libitum* pizza meal for all subjects. There was no treatment effect on cumulative energy ($P=0.7$) (**Table 5.3b**), cumulative weight intake ($P=0.9$) (**Table 5.3d**) at the pizza meal, and cumulative weight intake at the pizza meal plus water ($P=0.8$) (**Table 5.3g**), nor was there a treatment effect on cumulative water intake ($P=0.4$) (**Table 5.3f**) during the *ad libitum* pizza meal for lighter-to-normal weight subjects. There was no treatment effect on cumulative energy ($P=0.5$) (**Table 5.3b**), cumulative weight intake ($P=0.3$) (**Table 5.3d**) at the pizza meal, and cumulative weight intake at the pizza meal plus water ($P=0.7$) (**Table 5.3g**), nor was there a treatment effect on cumulative water intake ($P=0.3$) (**Table 5.3f**) during the *ad libitum* pizza meal for heavier weight subjects.

There was no session effect on cumulative energy ($P=0.3$), cumulative weight intake ($P=0.3$) at the pizza meal, and cumulative weight intake at the pizza meal plus water ($P=0.07$); however, there was a session effect with cumulative water intake ($P=0.003$) during the *ad libitum* pizza meal. There was a significant difference on cumulative water intake between sessions 1 and 2 ($P=0.007$), and between sessions 1 and 3 ($P=0.002$) as per post-hoc analysis.

There was no effect of age on cumulative energy ($P=0.7$), cumulative weight intake ($P=0.2$) at the pizza meal, and cumulative weight intake plus water ($P=0.2$). There was no effect of age on cumulative water intake ($P=0.4$) during the *ad libitum* pizza meal.

There was no effect of sex on cumulative energy ($P=0.8$), cumulative weight intake ($P=0.7$) at the pizza meal, and cumulative weight intake plus water ($P=0.8$). There was no effect of sex on cumulative water intake ($P=0.9$) during the *ad libitum* pizza meal (**Table 5.6**).

There was no effect of weight status (BMICAT) on cumulative energy ($P=0.2$) and cumulative weight ($P=0.2$) intake at the pizza meal. There was a significant effect of weight status on cumulative weight plus water ($P=0.02$) and cumulative water intake ($P=0.009$) during the *ad libitum pizza* meal (**Table 5.7**). The post-hoc analysis indicated that there was a significant difference on cumulative water intake between the pulse-free controls of the lighter-to-normal weight subjects and the heavier weight subjects ($P=0.002$), and between the navy bean treatments of the lighter-to-normal weight subjects and heavier subjects ($P=0.009$), where water intake was significantly higher in the heavier group. There was also a significant difference on cumulative water intake among the heavier weight subjects ($P=0.03$), where there was significantly higher water intake with the pulse-free control compared to the yellow pea treatment.

Additionally, there was a significant difference on cumulative weight intake at the pizza meal plus water of the pulse-free controls ($P=0.02$), and between the navy bean treatments ($P=0.02$), where food and water intake was significantly higher among the heavier group compared to the lighter-to-normal group as per post-hoc test.

There was no interaction between the treatment and session, treatment and age, treatment and sex or treatment and BMICAT on cumulative energy, weight and water intake during the pizza meal.

5.3 Subjective Appetite Scores

5.3.1 Average Appetite (AA)

There was an effect of treatment ($P=0.04$), an effect of time ($P<0.0001$), and treatment and sex ($P<0.0001$), and treatment and time ($P=0.04$) on subjective average appetite ratings. There was no effect of session ($P=0.08$), age ($P=0.8$), sex ($P=0.5$), BMICAT ($P=0.4$), the interaction between treatment and session ($P=0.2$), treatment and age ($P=0.3$), or treatment and BMICAT ($P=0.4$) on subjective feeling of AA (**Table 5.9a**) in all participants.

The post hoc test showed that there was a significantly lower rating of AA with the control compared to NB ($P<0.0001$), a significantly lower rating of AA with the control compared to YP ($P<0.0001$), and a significantly higher rating of AA with NB compared to YP ($P<0.001$) in all participants.

When comparing the effect of treatment on subjective appetite scores at each time point, at times 30 minutes ($P=0.020$), 45 minutes ($P=0.03$), 60 minutes ($P=0.03$), and 90 minutes ($P=0.009$), the navy bean treatment subjective average appetite score was significantly higher than the pulse-free control (**Figure 5.5**) in all participants, as revealed by post-hoc analysis. At times 60 minutes ($P=0.03$), and 90 minutes ($P=0.02$), the yellow pea treatment subjective average appetite score was significantly higher than the pulse-free control (**Figure 5.5**) in all.

There was an effect of time ($P<0.0001$), and treatment and time ($P=0.01$) on subjective average appetite ratings in lighter-to-normal weight participants (**Table 5.9b**). There was no effect of treatment ($P=0.08$), session ($P=0.14$), treatment and session ($P=0.094$), sex ($P=0.58$), treatment and sex ($P=0.14$), BMI ($P=0.89$), treatment and BMI ($P=0.16$). The post hoc test showed significantly lower rating of AA with control compared to NB at times 30 minutes ($P=0.031$), 45 minutes ($P=0.032$), and 60 minutes ($P=0.035$) in lighter-to-normal weight participants.

There was an effect of time on subjective average appetite scores ($P < 0.0001$) in heavier participants (**Table 5.9c**). There was no effect of treatment ($P = 0.36$), session ($P = 0.34$), treatment and session ($P = 0.46$), sex ($P = 0.07$), treatment and sex ($P = 0.35$), and treatment and time ($P = 0.93$). The post hoc test did not show significance at specific time points in heavier weight.

5.3.2 *Desire to Eat (DTE)*

There was an effect of time ($P < 0.0001$), session ($P < 0.0001$), sex ($P = 0.03$), and BMICAT ($P < 0.0001$) on the subjective feeling of DTE (**Table 5.9a**) in all participants. There was an effect on the interaction between treatment and session ($P < 0.0001$), treatment and sex ($P < 0.0001$), treatment and BMICAT ($P < 0.0001$), and treatment and time ($P = 0.002$) on DTE scores. There was no effect of treatment ($P = 0.07$), age ($P = 0.6$), or treatment and age ($P = 0.2$) on subjective feeling of DTE.

At times 30 minutes ($P = 0.003$), 45 minutes ($P = 0.006$), and 60 minutes ($P = 0.04$), the navy bean treatment desire to eat score was significantly higher compared to the pulse-free control (**Figure 5.5**) in all participants, as per post-hoc analysis. At times 30 minutes ($P = 0.04$) and 45 minutes ($P = 0.04$), the yellow pea treatment was significantly higher in comparison to the pulse-free control, and at time 150 minutes ($P = 0.03$), the pulse-free control was significantly higher compared to the yellow pea treatment (**Figure 5.5**) in all.

The post hoc test revealed that session 2 had a significantly higher DTE score compared to session 1 ($P < 0.0001$), session 3 had a significantly higher DTE score compared to session 1 ($P = 0.01$), and session 2 had a significantly higher DTE score compared to session 3 ($P = 0.004$).

There was an effect of treatment and session ($P = 0.023$), treatment and sex ($P = 0.023$), treatment and BMI ($P = 0.05$), time ($P < 0.0001$), treatment and time ($P = 0.01$) on subjective feelings of DTE in lighter-to-normal weight participants (**Table 5.9b**). There was no effect of treatment ($P = 0.10$), session ($P = 0.14$), sex ($P = 0.48$), and BMI ($P = 0.89$). The post hoc test revealed significantly lower control DTE scores compared to the navy bean treatment at times 30 minutes ($P = 0.0065$), 45 minutes ($P = 0.011$), and 60 minutes ($P = 0.05$) in lighter-to normal weight participants.

There was an effect of sex ($P=0.025$), and time ($P<0.0001$) on subjective feelings of DTE scores in heavier participants (**Table 5.9c**). There was no effect of treatment ($P=0.52$), session ($P=0.76$), treatment and session ($P=0.28$), treatment and sex ($P=0.51$), and treatment and time ($P=0.53$) on DTE ratings. The post hoc test did not reveal significance at each time point in heavier weight.

5.3.3 Hunger

There was an effect of treatment ($P=0.03$), and time ($P<0.0001$), session ($P=0.0002$), and BMICAT ($P<0.0001$) on the subjective feeling of hunger ratings (**Table 5.9a**) in all participants. There was an effect on the interaction between treatment and session ($P<0.0001$), treatment and BMICAT ($P=0.01$), and treatment and time ($P<0.0001$) on hunger scores. There was no effect of age ($P=0.7$), sex ($P=0.6$), the interaction between treatment and age ($P=0.2$), or treatment and sex ($P=1.0$) on hunger scores in all.

The post hoc test showed that the control had a significantly lower HUN score compared to YP ($P=0.006$), and NB had a significantly higher HUN rating compared to YP ($P=0.02$).

At times 30 minutes ($P=0.02$), 45 minutes ($P=0.04$), 90 minutes ($P=0.002$), and 120 minutes ($P=0.04$), the navy bean treatment HUN scores were significantly higher in comparison to the pulse-free control (**Figure 5.5**) in all participants, as post hoc-analysis indicated. At time 90 minutes ($P=0.01$), the yellow pea treatment hunger score was significantly higher compared to the pulse-free control (**Figure 5.5**). At time 30 minutes ($P=0.02$), the navy bean treatment hunger score was significantly higher than that of the yellow pea treatment (**Figure 5.5**) for all.

The post hoc test revealed that session 2 had a significantly higher hunger score compared to session 1 ($P<0.0001$), and session 3 had a significantly higher hunger score compared to session 1 ($P=0.007$) for all participants.

There was an effect of treatment and session ($P=0.031$), time ($P<0.0001$), and treatment and time ($P=0.0001$) on HUN ratings in lighter-to-normal weight participants (**Table 5.9b**). There was no effect of treatment ($P=0.10$), session ($P=0.15$), BMI ($P=0.89$), treatment and BMI ($P=0.16$) on HUN ratings. The post hoc test showed significantly higher HUN scores for the navy bean treatment in comparison to the yellow pea treatment at 30 minutes ($P=0.025$). At

times 60 ($P=0.039$) and 90 ($P=0.010$) minutes the HUN score ratings for the control was significantly lower than the navy bean treatment in lighter-to-normal weight participants.

There was an effect of treatment and session ($P=0.036$), and time ($P<0.0001$) on hunger ratings in heavier weight participants (**Table 5.9c**). There was no effect of treatment ($P=0.35$), session ($P=0.78$), sex ($P=0.25$), treatment and sex ($P=0.15$), treatment and time ($P=0.91$). The post hoc test did not indicate significant differences between treatments at each time point in heavier weight.

5.5.4 Fullness

There was an effect of time ($P<0.0001$), session ($P=0.05$), and BMICAT ($P<0.0001$) on subjective feelings of fullness ratings in all participants (**Table 5.9a**). There was an effect on the interaction between treatment and BMICAT ($P<0.0001$), and treatment and time ($P=0.01$) on fullness scores. There was no effect of treatment ($P=0.1$), age ($P=0.9$), sex ($P=0.1$), the interaction between treatment and session ($P=0.2$), treatment and age ($P=0.4$), or treatment and sex ($P=0.3$) on fullness scores in all.

At times 90 minutes ($P=0.01$), the pulse-free control fullness scores were significantly higher than the navy bean treatment (**Figure 5.5**) in all participants, as indicated by post-hoc analysis. At times 60 minutes ($P=0.01$) and 90 minutes ($P=0.03$), the pulse-free control fullness scores were significantly higher in comparison to the yellow pea treatment (**Figure 5.5**).

The post hoc test showed that session 3 had significantly higher FULL ratings compared to session 1 ($P=0.02$).

There was an effect of time ($P<0.0001$), and treatment and time ($P=0.008$) on FULL scores in lighter-to-normal participants (**Table 5.9b**). There was no effect on treatment ($P=0.31$), session ($P=0.14$), treatment and session ($P=0.38$), sex ($P=0.31$), treatment and sex ($P=0.61$), BMI ($P=0.79$), and treatment and BMI ($P=0.39$). The post hoc test showed that at time 90 minutes ($P=0.039$), the control treatment FULL scores were significantly lower in comparison to navy bean treatment FULL scores in lighter-to-normal weight.

There was an effect of time ($P<0.0001$) on FULL ratings in heavier weight participants (**Table 5.9b**). There was no effect of treatment ($P=0.31$), session ($P=0.26$), treatment and

session ($P=0.56$), sex ($P=0.26$), treatment and sex ($P=0.47$), and treatment and time ($P=0.92$). The post hoc test did not indicate significantly different treatments at each time point in heavier weight.

5.3.5 Prospective Food Consumption (PFC)

There was an effect of time ($P<0.0001$), session ($P=0.0003$), and sex ($P=0.002$) on subjective feeling of PFC in all participants (**Table 5.9a**). There was an effect on the interaction between treatment and session ($P<0.0001$), treatment and sex ($P=0.008$), treatment and BMICAT ($P=0.0004$) on PFC scores. There was no effect of treatment ($P=0.07$), age ($P=0.8$), BMICAT ($P=0.7$), the interaction between treatment and age ($P=0.2$), or treatment and time ($P=0.3$) on PFC scores.

At times 60 minutes ($P=0.03$), and 90 minutes ($P=0.03$), the navy bean treatment prospective food consumption scores were significantly higher in comparison to the pulse-free control (**Figure 5.5**) in all participants, as shown by post-hoc analysis. At times 45 minutes ($P=0.05$), 60 minutes ($P=0.02$), and 90 minutes ($P=0.01$), the yellow pea treatment prospective food consumption scores were significantly higher compared to the pulse-free control (**Figure 5.5**) in all.

The post hoc test showed that session 2 had a significantly higher PFC rating in comparison to session 1 ($P<0.0001$), and session 2 had a significantly higher PFC rating in comparison to session 3 ($P=0.002$).

There was an effect on session ($P=0.049$), and time ($P<0.0001$) on PFC scores in lighter-to-normal weight participants (**Table 5.9b**). There was no effect of treatment ($P=0.11$), treatment and session ($P=0.14$), sex ($P=0.67$), treatment and sex ($P=0.063$), BMI ($P=0.58$), treatment and BMI ($P=0.094$), and treatment and time ($P=0.45$). The post hoc test revealed at time 60 minutes ($P=0.026$) that the control treatment PFC scores were significantly lower than navy bean treatment PFC scores in lighter-to-normal weight.

There was an effect of sex ($P=0.020$), and time ($P<0.0001$) on PFC scores in heavier weight participants (**Table 5.9c**). There was no effect of treatment ($P=0.53$), session ($P=0.11$), treatment and session ($P=0.68$), treatment and sex ($P=0.48$), and treatment and time ($P=0.93$).

The post hoc test did not reveal significantly different treatments at each time point in heavier weight.

5.4 Subjective Physical Comfort

5.4.1 Nausea

There was an effect of age ($P=0.008$) on subjective feeling of nausea in all participants. There was an effect of the interaction between treatment and sex ($P=0.05$), and treatment and BMICAT ($P=0.04$) on ratings of nausea. There was no effect of treatment ($P=0.4$), session ($P=0.4$), sex ($P=0.09$), BMICAT ($P=0.2$), time ($P=0.07$), the interaction between treatment and session ($P=0.09$), treatment and age ($P=0.2$), or treatment and time ($P=0.5$) on nausea scores (**Table 5.10**).

5.4.2 Stomach Discomfort

There was an effect of session ($P=0.006$), and an effect of BMICAT ($P=0.0006$), and time ($P=0.02$) on the subjective feeling of stomach discomfort in all subjects. There was an effect of the interaction between treatment and session ($P=0.01$), treatment and BMICAT ($P=0.001$), and treatment and time ($P=0.002$) on stomach discomfort scores. There was no effect of treatment ($P=0.3$), age ($P=0.2$), sex ($P=0.08$), the interaction between treatment and age ($P=0.1$), or treatment and sex ($P=0.09$) on stomach discomfort scores (**Table 5.10**).

At times 60 minutes ($P=0.05$), and 90 minutes ($P=0.03$), the navy bean treatment stomach discomfort scores were significantly higher in comparison to the pulse-free control (**Figure 5.7**) as post-hoc analysis presented in all.

The post hoc test revealed that session 1 had a significantly higher STO rating compared to session 2 ($P=0.01$), and session 1 had a significantly higher STO rating compared to session 3 ($P=0.003$).

5.4.3 Wellness

There was an effect of session ($P=0.0003$), an effect of age ($P=0.008$), and sex ($P=0.008$), on subjective feeling of wellness in all participants. There was a significant effect on the interaction between treatment and age ($P=0.04$), and treatment and sex ($P=0.02$) on subjective ratings of wellness. There was no effect on treatment ($P=0.9$), BMICAT ($P=0.8$), time ($P=0.2$),

the interaction between treatment and session ($P=0.8$), treatment and BMICAT ($P=1.0$), or treatment and time ($P=0.6$) on wellness scores (**Table 5.10**).

The post hoc test revealed that session 3 had a significantly higher WELL score in comparison to session 1 ($P<0.0001$), and session 3 had a significantly higher WELL score in comparison to session 2 ($P=0.01$).

5.4.4 Gas

There was an effect of session ($P=0.0005$), and time ($P=0.04$) on subjective feeling of gas in all subjects. There was an effect of the interaction between treatment and BMICAT ($P=0.004$) on ratings of gas. There was no effect of treatment ($P=0.5$), age ($P=0.9$), sex ($P=0.1$), BMICAT ($P=0.5$), treatment and session ($P=0.8$), the interaction between treatment and age ($P=0.06$), treatment and sex ($P=0.07$), or treatment and time ($P=0.1$) on gas scores (**Table 5.10**).

The post hoc test showed that session 1 had a significantly higher subjective feeling of gas compared to session 3 ($P<0.0001$), and session 2 had a significantly higher subjective feeling of gas compared to session 3 ($P=0.01$).

5.4.5 Diarrhea

There was an effect of session ($P=0.02$), and BMICAT ($P<0.0001$) on subjective feeling of diarrhea in all subjects. There was an effect on the interaction between treatment and sex ($P=0.01$), and treatment and BMICAT ($P=0.007$) on ratings of diarrhea. There was no effect of treatment ($P=0.8$), age ($P=0.06$), sex ($P=0.1$), time ($P=0.8$), the interaction between treatment and session ($P=0.2$), treatment and age ($P=0.3$), or treatment and time ($P=0.4$) on diarrhea scores (**Table 5.10**).

The post hoc test showed that session 1 had a significantly higher subjective feeling of diarrhea in comparison to session 3 ($P=0.006$).

5.4.6 Average Physical Comfort (APC)

There was an effect of session ($P=0.0007$), BMICAT ($P=0.05$), and time ($P=0.01$) on subjective average physical comfort level in all participants. There was an effect of the interaction between treatment and BMICAT ($P<0.0001$) on the subjective ratings of average physical comfort. There was no effect of treatment ($P=0.4$), age ($P=0.08$), sex ($P=0.1$), the

interaction between treatment and session ($P=0.3$), treatment and age ($P=0.06$), treatment and sex ($P=0.1$), or treatment and time ($P=0.1$) on the subjective average physical comfort scores (**Table 5.10**).

The post hoc test revealed that session 3 had a significantly higher APC rating in comparison to session 1 ($P=0.0002$), and session 3 had a significantly higher APC rating in comparison to session 2 ($P=0.04$).

5.5 Palatability of Treatments and Pizza Meal

Taste

There was no effect of treatment ($P=0.4$), session ($P=0.08$), age ($P=0.7$), sex ($P=0.4$), BMICAT ($P=0.7$), the interaction between treatment and session ($P=0.8$), treatment and age ($P=0.8$), treatment and sex ($P=0.9$), and treatment and BMICAT ($P=0.4$) on taste score at the treatment meal (**Table 5.11**) in all participants.

Mouthfeel

There was no effect of treatment ($P=0.1$), session ($P=0.1$), age ($P=0.9$), sex ($P=1.0$), BMICAT ($P=0.4$), the interaction between treatment and session ($P=0.5$), treatment and age ($P=1.0$), treatment and sex ($P=0.5$), or treatment and BMICAT ($P=0.3$) on mouthfeel score at the treatment meal (**Table 5.11**) in all participants.

Flavor

There was no effect of treatment ($P=0.7$), session ($P=1.0$), age ($P=1.0$), sex ($P=0.5$), BMICAT ($P=0.09$), the interaction between treatment and session ($P=0.8$), treatment and age ($P=0.08$), treatment and sex ($P=0.7$), or treatment and BMICAT ($P=0.6$) on flavor score at the treatment meal (**Table 5.11**) in all participants.

Sweetness

There was no effect of treatment ($P=0.3$), session ($P=0.3$), age ($P=0.8$), sex ($P=0.4$), BMICAT ($P=0.1$), the interaction between treatment and session ($P=0.3$), treatment and age ($P=0.4$), treatment and sex ($P=0.8$), or treatment and BMICAT ($P=0.9$) on sweetness score at the treatment meal (**Table 5.11**) in all participants.

Treatment Pleasantness

There was no effect of treatment ($P=0.6$), session ($P=0.1$), age ($P=0.5$), sex ($P=0.8$), BMICAT ($P=1.0$), the interaction between treatment and session ($P=0.6$), treatment and age ($P=0.9$), treatment and sex ($P=0.8$), treatment and BMICAT ($P=0.2$) on the rating of treatment pleasantness at the treatment meal (**Table 5.12**) in all participants.

Pizza Pleasantness

There was no effect of treatment ($P=0.7$), session ($P=0.08$), age ($P=0.7$), sex ($P=0.3$), BMICAT ($P=0.5$), the interaction between treatment and session ($P=0.6$), treatment and age ($P=0.8$), treatment and sex ($P=0.4$), or treatment and BMICAT ($P=0.6$) on the rating of pizza pleasantness at the pizza meal (**Table 5.12**) in all participants.

5.6 Relations among Dependent Variables

Average appetite ($r=0.02$, $P=0.82$), desire to eat ($r=0.02$, $P=0.89$), hunger ($r=0.05$, $P=0.60$), fullness ($r=-0.01$, $P=0.95$), and prospective food intake ($r=0.02$, $P=0.85$) had positive, but no linear correlation with food intake (**Table 5.13**), and were not significant.

Wellness ($r=0.22$, $P=0.031$), and average physical comfort ($r=0.22$, $P=0.027$) had weak positive correlation with food intake (**Table 5.13**), and were significant. Nausea ($r=-0.15$, $P=0.13$), stomach discomfort ($r=-0.15$, $P=0.13$), gas ($r=-0.15$, $P=0.14$), and diarrhea ($r=-0.11$, $P=0.28$) had negative, but no linear correlation with food intake (**Table 5.13**), and were not significant.

Taste ($r=-0.12$, $P=0.25$), flavor ($r=-0.11$, $P=0.27$), mouthfeel ($r=-0.11$, $P=0.28$), and sweetness ($r=-0.13$, $P=0.21$) had negative, but no linear correlation with food intake (**Table 5.13**), and were not significant.

Pleasantness of the treatments ($r=-0.10$, $P=0.34$) had negative, but no linear correlation with food intake, and was not significant. However, pleasantness of the pizza meal ($r=0.31$, $P=0.0015$) had positive, weak linear correlation with food intake (**Table 5.13**), and was significant.

Hence, there were no correlations with subjective average appetite measurements and subsequent food intake two hours later, and the sensory parameters of the treatment do not affect subsequent food intake two hours later. However, there was a weak positive correlation with average comfort with food intake, which means that as average comfort scores increased, food intake also increased.

Summary

Results obtained from all, and both lighter-to-normal weight and heavier children indicated that there were no differences between the treatments on subsequent food intake (g or kcal) with pizza meal two hours later, or on cumulative energy intake (energy of the treatment and pizza meal) with added navy beans or yellow peas in comparison to the pulse-free control. This indicates that the addition of whole pulses to foods with lower energy density compared to pulses, such as rice, did not decrease subsequent energy intake, calories from pizza consumed over two hours, and cumulative short-term energy intake (total calories consumed over two hours); however, there was improved intake of dietary fiber and protein.

Chapter 6: Discussion

6.1 Subjective Appetite and Food Intake

Findings in this study do not support the hypothesis that the adding of whole pulses to a mixed meal reduces subjective appetite (increase satiety) and short-term food intake in 12-14-year-old children. Analysis of subjective appetite measures showed significantly lower average appetite scores after the consumption of the pulse-free control compared to the navy bean treatment ($P=0.04$), whereby NB average appetite ratings were 17.8% higher in comparison to the pulse-free control in all subjects. Also, there were significantly lower hunger scores after consumption of the control compared to the navy bean treatment ($P=0.03$), whereby NB hunger ratings were 21.1% higher compared to the pulse-free control. However, there were no significant differences in desire to eat, fullness, and prospective food consumption (**Table 5.9a, Figure 5.5**) in all participants. There were no significant differences in subjective average appetite, desire to eat, fullness, and prospective food consumption in lighter-to-normal participants (**Table 5.9b**), and in heavier weight participants (**Table 5.9c**). Additionally, there were no significant differences on energy at the *ad libitum* pizza meal between the treatments in all, lighter-to-normal, and heavier weight participants (**Table 5.3a**).

Studies that have examined the effects of pulse consumption on satiety and food intake have produced mixed results. Although there were no significant increases in satiety in this study with children, there were significant increases in satiety with the consumption of meals containing pulses reported in other studies with adults (62, 64).

There was a significant effect of time on all subjective appetite measures, and there was an observed increase in the pre-meal period and decreased significantly after the test meal at 120 min, except for fullness, which increased at 120 min, thus confirming the validity of VAS tool as a measurement of subjective measurement in children (**Table 5.9a, Figure 5.5**).

Canada's Food Guide recommend daily intake of pulses is $\frac{3}{4}$ cup (175 mL), while the 2015 U.S. Dietary Guidelines suggests $\frac{1}{2}$ cup (125 mL) daily legume serving size and recommends 1 $\frac{1}{2}$ cups (375 mL) per week of legumes (2000 kcal diet) (110). The amount of navy bean and yellow pea that were used in the study were 93.6 g (110.0 mL) and 85.6 g (97.5

mL), respectively. The total energy of the pulse meal was 300.0 kcal, where pulses represented 132.0 kcal, rice was 118.8 kcal, rosée sauce was 26.3 kcal and butter was 22.9 kcal. Navy bean consists of 7.4 g fiber and 11.7 g protein, yellow pea consists of 4.0 g fiber, and 10.9 g protein, and pulse free control 0.0 g fiber, and 5.8 g protein (**Table 5.4**). Thus, the amount of pulses provided in this study was less than one ½ cup (125 mL) serving of the recommended amount as per Canada's Food Guide. The pulse component was 44% of energy of the treatment meal, determined and represented the average food intake at the treatment in preliminary studies, and reflect the amount of food children would consume on average (112).

Fiber and protein are components found in pulses that have been shown to reduce food intake in the short term in some studies. The high fiber content in pulses has been shown to increase satiety (87, 88), and enhance gastric distension, slow gastric emptying from the gelling effect of viscous soluble fibers (122). Turner et al. (2013) had subjects consume minimum 25 g (1.5 cups) fiber per day from beans, which reduced hunger (87). Moreover, fermentable fiber is digested in the colon by bacteria, which releases short chain fatty acids (SCFA) that may be used for energy, thus sparing protein and glucose (7). SCFA may suppress hepatic glucose production, and SCFA propionate may also stimulate satiety (7). In resistant starch, the amylose and external branches of amylopectin gelatinize when heated, but re-associate or retrograde upon cooling, thereby becoming resistant to digestion (7). Like fiber, protein also influences satiety. Dietary protein may stimulate gut hormones to increase satiety, and protein-starch interactions may further prevent digestibility by limiting enzyme accessibility to the starch (7, 12). Dietary protein may increase energy expenditure and induce satiety through diet-induced thermogenesis, in addition to reduced energy intake (3, 49, 123). Smith et al. (2012) found that 20 g pea protein reduced subsequent food intake (42). The current investigation, both fiber (7.4 g in NB, 4.0 g in YP) and protein (11.7 g in NB and 10.9 g in YP) amounts in the pulse treatments (**Table 5.4**) were greater than the pulse-free control (0.0 g fiber and 5.8 g protein), but less than the studies mentioned, results did not demonstrate reduced appetite (increased satiety) and short-term food intake. Mollard et al. (2014) showed that both fiber and protein had a greater response in reducing pre-prandial blood glucose compared to fiber alone (67).

There was no difference in food intake between treatments. There was no positive correlation between average appetite, desire to eat, hunger, fullness and prospective food consumption, and subsequent food intake, suggesting that the satiating properties of pulses within the mixed meal cannot explain or predict subsequent food intake, and that other factors influence satiety and food intake. There was no negative correlation between nausea, stomach discomfort, gas, and diarrhea with food intake, hence average physical comfort levels cannot predict subsequent food intake. However, there was a positive weak correlation with wellness, and average physical comfort with food intake (**Table 5.13**). There were no negative correlations with the palatability characteristics and pleasantness of the treatments. However, pizza pleasantness had a weak positive correlation with food intake (**Table 5.13**).

6.2 Food Intake at *ad libitum* Pizza Meal (Subsequent Food Intake)

This study was the first to assess *ad libitum* food intake using 44% energy of whole cooked navy bean and yellow split pea in mixed meals in children aged 12-14 years, and other literature findings had differing methodologies, study designs and sampling consisted mainly of adults. Thus, comparison of findings with other literature was difficult.

There was no effect of treatment at *ad libitum* food intake with the test pizza meal 120 min after treatment in all participants ($P=0.4$). There was no effect of treatment by participants' age or session, no treatment by age or treatment by session interaction at *ad libitum* food intake with test pizza meal. There was no effect of treatment at *ad libitum* food intake at the pizza meal 120 min after the treatment among lighter-to-normal participants ($P=0.7$) or heavier participants ($P=0.2$). Similarly, there was no effect of treatment on cumulative food intake (kcal treatment + kcal pizza) over two hours in all participants ($P=0.6$). There was no effect of treatment on cumulative food intake over 120 min in lighter-to-normal participants ($P=0.7$), or heavier participants ($P=0.5$). The results of *ad libitum* intake at pizza test meal are summarized in Tables 5.3a, 5.3b, and Figures 5.1, and 5.2. The pulse amounts may not have been sufficient to initiate a satiating effect. Future studies may investigate higher amounts such as a ½ cup pulse amount to determine the effect of satiety and short-term food intake, in addition to sensory properties in children and adolescents. An alternative explanation may include participants' hunger scale

were based more on external cues such as time of day, number of hunger scale questionnaires completed, boredom, rather than on actual biological hunger signals (124). Obese individuals respond more to external cues of hunger than non-obese (125).

These findings aligned with Li et al. (2014) (88) review and meta-analyses of dietary pulses, satiety and food intake. The systematic review and meta-analysis (88) showed that dietary pulse meals as compared to iso-caloric non-pulse meals increased satiety in healthy adults. However, dietary pulse meals did not significantly affect or decreased second meal food intake (88). Findings by Mollard et al. (2012) also did not demonstrate significant differences in food intake at the pizza meal following *ad libitum* treatment meal consumption with pulses in adult males (65). On the other hand, significant decreases in food intake have been reported in some adult studies after the consumption of pulse-containing meals (42, 62, 64). The proposed mechanisms on food intake regulation by dietary pulses are related to digestive resistance of key components such as carbohydrates (fiber, starches and oligosaccharides), in addition to protein and phytochemicals interactions (88). Bioactive compounds also affect digestion and satiety signals, and the low-moderate energy density of dietary pulses contribute to their resistance (88).

6.3 Overweight/Obese and Satiety, Leptin, and Ghrelin

Food intake when categorized by weight status (Table 5.8) showed that there were no differences among lighter-to-normal participants ($P=0.1$) and heavier participants ($P=0.1$). Similarly, there were no differences in cumulative food intake among lighter-to-normal participants ($P=0.2$) and heavier participants ($P=0.2$). However, water intake categorized by weight status (Table 5.8) revealed significant differences among lighter-to-normal participants ($P=0.009$) and heavier participants ($P=0.009$), where heavier participants had significantly higher water intake at the *ad libitum* pizza meal. Similarly, there was a significant difference in cumulative water intake (treatment water intake + *ad libitum* pizza meal water intake) among lighter-to-normal participants ($P=0.009$) and heavier participants ($P=0.009$), where heavier participants had higher overall water intake.

The sensation of fullness is enhanced by increased gastric distension and a slowed rate of gastric emptying into the intestine, which result from the gelling effect of viscous soluble fibers

(126). One study assessed the onset of satiety using the water-load test in normal-weight and obese children and adolescents, and found that obese children and adolescents need to ingest greater volumes to feel full (127). The need for greater gastric volumes to perceive satiety may lead to the consumption of larger portion size, hence overeating (127). The management of portion size is one factor that can have an influence on overall energy intake, and consequently body weight (127).

Many peripheral signals contribute to the regulation of food intake and energy homeostasis (23). Short term signals such as CCK and GI stretch receptors from the GI tract are involved in promoting sensations of satiety that lead to meal termination (23). Long term signals such as leptin and insulin are produced and circulate in proportion to energy intake and body adiposity (23). Moreover, long term signals determine the sensitivity of the brain to satiety producing effects of the short-term signals from the GI tracts (23). GI peptide hormones such as CCK and ghrelin can also inhibit food intake in the short-term and their physiological role in food regulation (23).

Data from Tschop and colleagues (2001) indicated that ghrelin plasma levels were significantly lower in obese subjects compared to age-matched lean control subjects (128). Down regulation of ghrelin in obese subjects may be a consequence of elevated insulin or leptin (negative correlation), and represent a physiological adaptation to the positive energy balance associated with obesity (128).

Leptin is the primary signal from energy stores that exerts negative feedback effects on energy intake (129). However, individuals with diet induced obesity develop leptin resistance, characterized by high circulating leptin levels and decreased leptin sensitivity (129). The protein hormone leptin is important in the homeostatic regulation of body weight, hence treatment with exogenous leptin may have an influence on weight loss (130). Findings from Heymsfield and colleagues (1999) revealed a dose response relationship with weight and fat loss with subcutaneous recombinant leptin injections (130).

6.4 Palatability and Physical Comfort

Palatability and gastrointestinal comfort level data revealed no differences among the pulse treatments in comparison to the pulse-free control. Pulse intake was both edible and tolerable as children indicated similar high taste and average physical comfort ratings of pulse treatments compared with the pulse-free control. A study by Contento et al. (2006) with American adolescents aged 11 to 18 years indicated that the primary food choice criteria were taste, familiarity or habit, health, dieting and “fillingness” (131). Palatability and taste are important factors that could determine pulse intake into the diet (7). Gellar, Rovner and Nansel (2009) showed variability in acceptability of whole grains and legumes among youth with type 1 diabetes and the importance of addressing acceptability when designing nutrition interventions to improve consumption of these foods (132). Additionally, results by Veenstra et al. (2009) demonstrated that moderate pulse consumption was well tolerated with negligible perceived changes in flatulence and overall gastrointestinal function when incorporated into the diet of healthy male adults (133). However, tolerance decreases when pulse consumption reaches higher levels. Repeated exposure could improve familiarity and increase likelihood of regular pulse consumption (7, 134).

The results for this study support the hypothesis that cooked whole navy beans and yellow pea added to a meal will have acceptable palatability. Findings did not reveal significant differences in the rating of taste, mouthfeel, sweetness, and pleasantness among treatments and pizza meal (**Table 5.11, 5.12**). Similarly, the results for this study support the hypothesis that cooked whole navy beans and yellow pea added to a meal will have tolerable physical comfort rating as there were no differences scores of nausea, stomach discomfort, wellness, flatulence, diarrhea, and average physical comfort. (**Table 5.11, Figure 5.7**).

6.5 Factors Influencing Food Intake

There are many factors in our food environment that influence our ability to make healthy food choices and to follow a healthy pattern of eating (31). With pulse consumption, specific factors include physiological effects such as digestion, cultural factors such as vegetarianism or veganism, and knowledge and skills on how to incorporate them into the diet (7). In general,

food available at home, school, in stores and restaurants, social influences and food marketing have a major impact on our choices, and make healthy eating a challenge for many (31). Eating more energy dense, high caloric foods, eating more meals outside of the home, eating more pre-prepared meals, less physical activity, and having a more sedentary lifestyle (spending more time watching television and using computers) are contributing factors to childhood obesity (135). Poor eating habits, eating at school, and eating in front of the television are associated with excess weight and obesity in children, whereas eating together with family and physical activity have an opposite, protective effect against obesity as studies have shown (31). Familial factors, availability of foods at home, schools and fast-food restaurants can significantly influence children's eating habits, in addition to potential influences by television and media (136). However, in teenagers there is a broader range of factors that can influence food choices. Neumark-Sztainer and colleagues (1999) (137) suggested that hunger, food cravings, appeal of food, time considerations of family members, convenience, availability, parental influence on eating behaviors (including religion, culture, race, ethnicity, and beliefs), benefits of eating food such as health, situational-specific factors, mood, body image, habits, cost, and media are factors that have an impact on adolescent food choices. Thus, parents are in need of practical information about choosing and preparing foods that balances many factors such as taste, nutrition, time, convenience, and cost effective for their children and adolescents (31). Developmental factors in adolescence can lead them susceptible to marketing strategies. Adolescents are cognitively more vulnerable and tend to be more impulsive, prefer immediate gratification, have strong emotional response and are more susceptible to peer influence (138, 139). During this stage of development, adolescents are establishing their own identity and independence, want to "fit in", have great spending power, in addition to having their cognitive vulnerabilities, make them receptive to and easy targets for media messaging (138, 139). Most caloric intake also occurs during adolescence, and declines as we age (24). However, an obesogenic environment challenges early patterns of eating and may lead to poor and unhealthy food choices that remain until adulthood.

6.6 Glycaemia and Satiety

Carbohydrates are thought to regulate satiety and food intake through their blood glucose effect, whereby foods with low glycemic index are associated with greater satiety than foods with a high glycemic index (121, 140). Ingestion of rapidly digestible, high glycemic index carbohydrates, followed by rapid increases in blood glucose may increase satiety in the short-term, while consumption of low glycemic index carbohydrates, which are slowly digested, and absorbed may be more effective at sustaining long term satiety (121, 140). These findings follow the glucostatic hypothesis in the study by Mayer (1953) that increases in blood glucose result in increased satiety and decreased consumption (141), and may have a role in weight loss and maintenance. Hallschmid et al. (2012) data indicated that brain insulin acts as a relevant satiety signal during the postprandial period, reducing the intake of highly palatable food and impacting peripheral glucose homeostasis (142).

This study's findings, though non-significant, indicated that the subsequent food intake was slightly lower with the pulse-free control containing rice (high glycemic index) only, in comparison to the navy bean and yellow pea treatments (low-glycemic index) with rice, and concurs with the glucostatic hypothesis in all participants. Future studies with participant blood glucose levels could further substantiate the glucostatic hypothesis.

6.7 Summary

Findings in this study do not support the hypothesis that the consumption of whole pulses suppressed subjective appetite (increased satiety) and reduced short term food intake. However, whole pulse addition to mixed meals were both edible and tolerable as children had similar taste and average physical comfort ratings that were relatively high with the pulse treatments in comparison to the pulse-free control.

Many factors such as physiological, environmental, sociological, and cognitive influence the regulation of food intake. Furthermore, appetite studies consist of differing methodologies and outcomes, thus results were inconclusive. Stronger evidence is necessary on the development of recommendations for pulse consumption associated with satiety health claims,

and should follow methodologies outlined in Health Canada's Satiety Health Claims Guidance Document (116).

6.8 Limitations and Strengths

One limitation for this study was the number of the children recruited, which can influence the generalizability of the data to the population. The external validity of the findings is limited by the small number of participants; there were a total of 33 children that consisted of 25 NW, 6 OW, and 2 OB. Additionally, there were disproportionately more girls than boys present in the sample, for example in the total sample there were 20 girls and 13 boys. Of the 20 girls, 6 were pre-menarche while 14 were in the menarche stage, and pubertal stage may influence food intake both physically and psychologically. The gender imbalance of the children reduces the generalizability of the data. The three study sessions were conducted in a controlled laboratory environment, and this does not take into consideration the eating habits and or food intake that occurs under usual and "normal" every day conditions. As acceptability, may be influenced by race, ethnicity, and cultural factors, the study did not involve sufficient subjects of varying races or ethnicity to address these concerns. Another limitation of the study could be the length of time for measurement of satiety, which was two hours. Fiber types may vary in ideal dose and time maximum effectiveness and may not have been sufficiently tested. A systematic review by Clark and Slavin (2013) suggested that ending VAS collection 3-15 hours after the fiber treatment may be the ideal time frame to see changes in satiety in adults (143); however, the current investigation measured satiety two hours after the pulse meal in children. Moreover, the greatest reduction in food intake was observed when *ad libitum* meals were administered 4-5 hours after fiber ingestion (143). Different fiber types may have effects on satiety at different times due to their viscosity, or fermentability in which fibers may reduce the rate gastric emptying, or elicit their satiety enhancing effects in the large intestine (83). Although BG measurements were not collected, it would have been interesting to observe the relationship between BG, food intake and subjective appetite in the children. Finally, there are limitations intrinsic to the measurement of satiety and food intake as VAS scales, although a useful and validated tool, are subjective and open to interpretation. Nonetheless, the limitations do not

counter with the satiety methodologies recommended in Health Canada's Satiety Guide Document (116).

Session effect was a confounding variable, included in the model for data analysis, and is a concern for within-subjects designs as the order in which the conditions are presented may influence the study outcome (144). Researchers reduce session or order effects by counterbalancing, which is a systematic way of varying the order of conditions so that each condition is presented equally in each ordinal position (144). The control, NB, and YP treatments were counterbalanced in a Latin Square design and randomized in sets of three. Subjects were assigned to their condition order in the order that they were screened into the study. Each treatment occurred once, and the quasi-random treatment ordering scheme resulted in approximately equal number of treatment replications. Hence, the balanced presentation ensured every possible order was presented an equal number of times. However, despite employing this design, session effects were not eliminated entirely. Researchers use a variety of methods to reduce or control session or order effects, for example practice effects may be reduced by providing a warm-up exercise before the experiment starts (144).

To the author's knowledge, this was one of the first studies with children that investigated the effect of whole pulse consumption and short-term satiety and food intake, evaluated how children perceived sensory characteristics of the mixed meal with or without pulses, and determined if pulses added to a mixed meal caused gastrointestinal discomfort symptoms in children. This study allowed for awareness and the introduction of whole pulse consumption, and highlighted the addition of whole pulses to a meal as a practical way to increase fiber, protein, and other nutrients into the diet.

6.9 Practical Implications

The findings of this study showed that although the addition of cooked whole pulses did not increase satiety and decrease short-term food intake, they are well tolerated and have acceptable palatability when added to a mixed meal of rice with sauce in children. Adding pulses to a mixed meal increased fiber (4-7 g), protein (5-6 g), and nutrients. Moreover, pulses may be recommended as an ingredient to be added to different types of foods such as rice, pasta, or mashed potatoes. Consumption of vegetable and fruit, and fiber intake are low in Canada and the U.S. in both children and adults. However, findings from Gellar, Rovner, and Nansel (2009) suggested that current low consumption and acceptability may be related less to an unwillingness to eat foods such as pulses and more to their competition with highly accessible and palatable refined carbohydrate foods, in addition to familiarity (132). Less common legume containing foods such as three bean salad and lentil soup were less acceptable compared to baked beans, a more commonly consumed legume was more acceptable to youth in this study (132). As such, substitution of dietary pulses for low-fiber, high glycemic index (GI) foods can have a beneficial effect in the diet, and merit additional attention. Successful interventions include a multifaceted approach to prevent childhood obesity where strategies involve family, school, community, media and all levels of the government (31). Patterns of eating by children that do not follow food guide recommendations to fulfill nutrient needs and consuming high-calorie, low-nutrient foods suggest poor eating habits in children (31). When counseling patients on nutrition, practitioners should focus on helping patients increase their exposure to pulses, and enhance their ability to identify and how to incorporate these foods in their current environment (132). For example, a diet history can be used to inform suggestions for substitution of pulses for highly processed foods in the current diet (132). Youths may need to be offered a variety of different foods to allow them to select the pulses that are more acceptable to them (132). Of note, modified diets include behavioral change and flexibility when attempting to increase intake of new or infrequently consumed foods, thus multiple exposures are often required for new foods to become acceptable (132).

Chapter 7: Future Directions

The prevalence of metabolic conditions such as CVD, diabetes and obesity demonstrate the need for approaches that address the link between these chronic illnesses and the knowledge translation of research that supports and encourages behavioral modifications that could decrease associated risk factors. Hence, healthy dietary patterns and interventions represent a reasonable and cost-effective strategy that could assist with the prevention and management of chronic illnesses associated with lifestyle and behavior.

Health Canada's Healthy Eating Strategy was launched October 2016 to improve the food environment through complementary initiatives, including strengthening food labels and claims, improving nutrition quality in foods, revising Canada's Food Guide, and restricting marketing to children. The main objective of restricting marketing of unhealthy food and beverages to children is to reduce the exposure of children to these advertisements, which have an influence food preferences and choices resulting in the over consumption of unhealthy food, as such can lead to poor health outcomes. Consultations with Canadians and stakeholders are necessary to determine what specific forms of advertising will be restricted.

Although overall pulse consumption has been low in the both Canada and the U.S., engaging the public with food skills, for instance learning to soak, rinse, boil, freezing, along with suggesting ways to incorporate pulses into their meals, will assist in increasing pulse consumption (145). In turn, will have long term positive impacts on nutrition and health, and sustainable impacts on the environment by reducing the carbon footprint associated with animal-based proteins (145). A recent study by Kristensen et al. (2016) (146) found that vegetable-based meals (beans/peas) had favorable appetite sensations in comparison to animal-based (pork/veal) with similar protein and energy content. Additionally, a vegetable-based meal with low protein content was as satiating and palatable as an animal-based meal with higher protein content, and potentially aid in weight loss (146).

A key outcome of International Year of the Pulse (IYP) was to create global attention to inform about the nutritional value of pulses. Messages about pulses being healthy, sustainable, and affordable food option reached billions of consumers, researchers and political leaders. The

many projects related to the IYP enabled the pulse industry to engage with many stakeholders including schools, universities, health care organizations, governments and NGO (133). As the global pulse industry continues toward a 10% increase in pulse consumption and production by 2020, the stakeholders will assist with dissemination of pulses and pulse consumption (133).

Pulses are incorporated into many food products as functional ingredients. For instance, pulses are now utilized in ground flour, or fractionated into fiber for bakery products, pasta, breakfast cereals, chips and snack bars. Moreover, pulses can be extruded and used as meat substitutes and in snack products. For example, beans can be gently dehydrated, milled, pre-cooked and reconstituted into snacks to add nutrients (protein, fiber, vitamins and minerals), and enhance the nutrient profile without changing sensory attributes such as taste. Altering the starch structure of the pulse flour may lead to application of new commercial products, such as gluten free products for individuals with Celiac disease or gluten sensitivities. Moreover, further studies are warranted to strengthen the available evidence and address the following question: What is the minimum effective dose of pulses required to attenuate satiety significantly in children and adolescents? The amount of pulse consumed may be increased to ½ cup to investigate the effect on satiety, subsequent short-term food intake, palatability and gastrointestinal comfort in children and adolescents. Future research may also include other types of pulses such as red and or green lentils, combinations, or a longer study with more sessions.

Chapter 8: Conclusion

Mixed meals containing whole cooked pulses did not lead to reduced appetite and short-term food intake in children; however, had acceptable palatability, were tolerable, without gastrointestinal discomfort, and improved the overall nutrient profile. This study presented an effective and practical approach to improving dietary intake of fiber, protein, and nutrients by incorporating pulses.

References

1. (WHO) WHO. Population-based approaches to childhood obesity prevention. Geneva, Switzerland: WHO; 2012. p. 11-52.
2. Blundell J, de Graaf C, Hulshof T, Jebb S, Livingstone B, Lluch A, et al. Appetite control: methodological aspects of the evaluation of foods. *Obes Rev*. 2010;11(3):251-70.
3. Rebello CJ, Liu AG, Greenway FL, Dhurandhar NV. Dietary strategies to increase satiety. *Adv Food Nutr Res*. 2013;69:105-82.
4. Brummer YK, M.; Tosh, S. M. Structural and functional characteristics of dietary fibre in beans, lentils, peas and chickpeas. *Food Research International*. 2015;37:117-25.
5. Ha V, Sievenpiper JL, de Souza RJ, Jayalath VH, Mirrahimi A, Agarwal A, et al. Effect of dietary pulse intake on established therapeutic lipid targets for cardiovascular risk reduction: a systematic review and meta-analysis of randomized controlled trials. *CMAJ*. 2014;186(8):E252-62.
6. Jenkins DJ, Kendall CW, Augustin LS, Mitchell S, Sahye-Pudaruth S, Blanco Mejia S, et al. Effect of legumes as part of a low glycemic index diet on glycemic control and cardiovascular risk factors in type 2 diabetes mellitus: a randomized controlled trial. *Arch Intern Med*. 2012;172(21):1653-60.
7. McCrory MA, Hamaker BR, Lovejoy JC, Eichelsdoerfer PE. Pulse consumption, satiety, and weight management. *Adv Nutr*. 2010;1(1):17-30.
8. Rebello CJ, Greenway FL, Finley JW. Whole grains and pulses: a comparison of the nutritional and health benefits. *J Agric Food Chem*. 2014;62(29):7029-49.
9. Sievenpiper JL, Kendall CW, Esfahani A, Wong JM, Carleton AJ, Jiang HY, et al. Effect of non-oil-seed pulses on glycaemic control: a systematic review and meta-analysis of randomised controlled experimental trials in people with and without diabetes. *Diabetologia*. 2009;52(8):1479-95.
10. Anderson JW, Major AW. Pulses and lipaemia, short- and long-term effect: potential in the prevention of cardiovascular disease. *Br J Nutr*. 2002;88 Suppl 3:S263-71.
11. Mollard RC, Luhovyy BL, Panahi S, Nunez M, Hanley A, Anderson GH. Regular consumption of pulses for 8 weeks reduces metabolic syndrome risk factors in overweight and obese adults. *Br J Nutr*. 2012;108 Suppl 1:S111-22.
12. Rebello CJ, Greenway FL, Finley JW. A review of the nutritional value of legumes and their effects on obesity and its related co-morbidities. *Obes Rev*. 2014;15(5):392-407.
13. Janssen I, Katzmarzyk PT, Boyce WF, King MA, Pickett W. Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *J Adolesc Health*. 2004;35(5):360-7.
14. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med*. 1997;337(13):869-73.
15. Roberts KC, Shields M, de Groh M, Aziz A, Gilbert JA. Overweight and obesity in children and adolescents: results from the 2009 to 2011 Canadian Health Measures Survey. *Health Rep*. 2012;23(3):37-41.
16. Anis AH, Zhang W, Bansback N, Guh DP, Amarsi Z, Birmingham CL. Obesity and overweight in Canada: an updated cost-of-illness study. *Obes Rev*. 2010;11(1):31-40.
17. Shields M. Overweight and obesity among children and youth. *Health Rep*. 2006;17(3):27-42.
18. Singh AS, Mulder C, Twisk JW, van Mechelen W, Chinapaw MJ. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev*. 2008;9(5):474-88.
19. Veugelers PJ, Fitzgerald AL. Prevalence of and risk factors for childhood overweight and obesity. *CMAJ*. 2005;173(6):607-13.

20. Canadian Task Force on Preventive Health C. Recommendations for growth monitoring, and prevention and management of overweight and obesity in children and youth in primary care. *CMAJ*. 2015;187(6):411-21.
21. Hall KD, Heymsfield SB, Kemnitz JW, Klein S, Schoeller DA, Speakman JR. Energy balance and its components: implications for body weight regulation. *Am J Clin Nutr*. 2012;95(4):989-94.
22. De Graaf C, De Jong LS, Lambers AC. Palatability affects satiation but not satiety. *Physiol Behav*. 1999;66(4):681-8.
23. Havel PJ. Peripheral signals conveying metabolic information to the brain: short-term and long-term regulation of food intake and energy homeostasis. *Exp Biol Med (Maywood)*. 2001;226(11):963-77.
24. Garriguet D. Canadians' eating habits. *Health Rep*. 2007;18(2):17-32.
25. Wadsworth LA, McHugh TL, Thompson AM, Campagna PD, Durant MA, Murphy RJ, et al. Dietary intake of Nova Scotia youth in grades 7 and 11. *Can J Diet Pract Res*. 2012;73(1):14-20.
26. Phillips S, Jacobs Starkey L, Gray-Donald K. Food habits of Canadians: food sources of nutrients for the adolescent sample. *Can J Diet Pract Res*. 2004;65(2):81-4.
27. St John M, Durant M, Campagna PD, Rehman LA, Thompson AM, Wadsworth LA, et al. Overweight Nova Scotia children and youth: the roles of household income and adherence to Canada's Food Guide to Healthy Eating. *Can J Public Health*. 2008;99(4):301-6.
28. Canada P. Pulses and weight control. In: Canada P, editor.: *Agriculture and Agri-Food Canada*; 2015. p. 1-4.
29. Phillips T, Zello GA, Chilibeck PD, Vandenberg A. Perceived Benefits and Barriers Surrounding Lentil Consumption in Families with Young Children. *Can J Diet Pract Res*. 2015;76(1):3-8.
30. Mudryj AN, Yu N, Hartman TJ, Mitchell DC, Lawrence FR, Aukema HM. Pulse consumption in Canadian adults influences nutrient intakes. *Br J Nutr*. 2012;108 Suppl 1:S27-36.
31. Roblin L. Childhood obesity: food, nutrient, and eating-habit trends and influences. *Appl Physiol Nutr Metab*. 2007;32(4):635-45.
32. Larson N, Story M, Eisenberg ME, Neumark-Sztainer D. Secular Trends in Meal and Snack Patterns among Adolescents from 1999 to 2010. *J Acad Nutr Diet*. 2016;116(2):240-50 e2.
33. Patel BP, Bellissimo N, Luhovyy B, Bennett LJ, Hurton E, Painter JE, et al. An after-school snack of raisins lowers cumulative food intake in young children. *J Food Sci*. 2013;78 Suppl 1:A5-A10.
34. Woodruff SJ, Campbell K, Campbell T, Cole M. The associations of meals and snacks on family meals among a sample of grade 7 students from Southwestern Ontario. *Appetite*. 2014;82:61-6.
35. Fulkerson JA, Friend S, Flattum C, Horning M, Draxten M, Neumark-Sztainer D, et al. Promoting healthful family meals to prevent obesity: HOME Plus, a randomized controlled trial. *Int J Behav Nutr Phys Act*. 2015;12:154.
36. Gillman MW, Rifas-Shiman SL, Frazier AL, Rockett HR, Camargo CA, Jr., Field AE, et al. Family dinner and diet quality among older children and adolescents. *Arch Fam Med*. 2000;9(3):235-40.
37. Neumark-Sztainer D, Wall M, Fulkerson JA, Larson N. Changes in the frequency of family meals from 1999 to 2010 in the homes of adolescents: trends by sociodemographic characteristics. *J Adolesc Health*. 2013;52(2):201-6.
38. Videon TM, Manning CK. Influences on adolescent eating patterns: the importance of family meals. *J Adolesc Health*. 2003;32(5):365-73.
39. Hoppu U, Lehtisalo J, Tapanainen H, Pietinen P. Dietary habits and nutrient intake of Finnish adolescents. *Public Health Nutr*. 2010;13(6A):965-72.
40. Canada P. Pulses are a superfood. In: Canada P, editor.: *Agriculture and Agri-Food Canada*; 2015. p. 1-2.

41. (FAO) FaAOotUN. Definition and classification of commodities: 4. Pulses and derived products: FAO; 1994 [Available from: www.fao.org/es/faodef/fdef/fdef04e.htm].
42. Smith CE, Mollard RC, Luhovyy BL, Anderson GH. The effect of yellow pea protein and fibre on short-term food intake, subjective appetite and glycaemic response in healthy young men. *Br J Nutr*. 2012;108 Suppl 1:S74-80.
43. Tosh SMY, S. Dietary fibre in pulse seeds and fractions: Characterization, functional, attributes, and applications. *Food Research International*. 2010;43:450-60.
44. Saris WH. Glycemic carbohydrate and body weight regulation. *Nutr Rev*. 2003;61(5 Pt 2):S10-6.
45. Thorne MJ, Thompson LU, Jenkins DJ. Factors affecting starch digestibility and the glycemic response with special reference to legumes. *Am J Clin Nutr*. 1983;38(3):481-8.
46. Campos-Vega RL-P, G.; Oomah, B. D. Minor components of pulses and their potential impact on human health. *Food Research International*. 2010;43:461-82.
47. Wursch P, Del Vedovo S, Koellreutter B. Cell structure and starch nature as key determinants of the digestion rate of starch in legume. *Am J Clin Nutr*. 1986;43(1):25-9.
48. Hoover RH, T.; Chung, H. J.; Liu, Q. Composition, molecular structure, properties, and modification of pulse starches: a review *Food Research International*. 2010;43:399-413.
49. Weigle DS, Breen PA, Matthys CC, Callahan HS, Meeuws KE, Burden VR, et al. A high-protein diet induces sustained reductions in appetite, ad libitum caloric intake, and body weight despite compensatory changes in diurnal plasma leptin and ghrelin concentrations. *Am J Clin Nutr*. 2005;82(1):41-8.
50. Kobayashi Y, Suzuki M, Satsu H, Arai S, Hara Y, Suzuki K, et al. Green tea polyphenols inhibit the sodium-dependent glucose transporter of intestinal epithelial cells by a competitive mechanism. *J Agric Food Chem*. 2000;48(11):5618-23.
51. Reverri EJ, Randolph JM, Kappagoda CT, Park E, Edirisinghe I, Burton-Freeman BM. Assessing beans as a source of intrinsic fiber on satiety in men and women with metabolic syndrome. *Appetite*. 2017;118:75-81.
52. Boye JZ, F.; Pletch, A. Pulse proteins: Processing, characterization, functional properties and applications in food and feed. *Food Research International*. 2010;43:414-31.
53. Sufian MK, Hira T, Asano K, Hara H. Peptides derived from dolicholin, a phaseolin-like protein in country beans (*Dolichos lablab*), potently stimulate cholecystokinin secretion from enteroendocrine STC-1 cells. *J Agric Food Chem*. 2007;55(22):8980-6.
54. Canada P. Protein quality of cooked pulses (PDCAS Method). In: Canada P, editor.: *Agriculture and Agri-Food Canada*; 2015. p. 1-2.
55. Millward DJ, Layman DK, Tome D, Schaafsma G. Protein quality assessment: impact of expanding understanding of protein and amino acid needs for optimal health. *Am J Clin Nutr*. 2008;87(5):1576S-81S.
56. Berg TS, J.; Hardacre, A.; Boland, M. J. The role of cotyledon cell structure during in vitro digestion of starch in navy beans. *Carbohydrate Polymers*. 2012;87:1678-88.
57. Anguah KO, Wonnell BS, Campbell WW, McCabe GP, McCrory MA. A blended- rather than whole-lentil meal with or without alpha-galactosidase mildly increases healthy adults' appetite but not their glycemic response. *J Nutr*. 2014;144(12):1963-9.
58. Canada P. *Guide to cooking beans, chickpeas, lentils and peas*. Winnipeg, MB: Pulse Canada; 2015.
59. Fulgoni VLr, Papanikolaou Y, Fulgoni SA, Kelly RM, Rose SF, . Bean consumption by children is associated with better nutrient intake and lower body weights and waist circumferences. *FASEB J* [Internet]. 2006 June 13, 2015 [cited 2015 June 13, 2015]; 20:[A621 p.].

60. Papanikolaou Y, Fulgoni VL, 3rd. Bean consumption is associated with greater nutrient intake, reduced systolic blood pressure, lower body weight, and a smaller waist circumference in adults: results from the National Health and Nutrition Examination Survey 1999-2002. *J Am Coll Nutr.* 2008;27(5):569-76.
61. Sichieri R. Dietary patterns and their associations with obesity in the Brazilian city of Rio de Janeiro. *Obes Res.* 2002;10(1):42-8.
62. Wong CL, Mollard RC, Zafar TA, Luhovyy BL, Anderson GH. Food intake and satiety following a serving of pulses in young men: effect of processing, recipe, and pulse variety. *J Am Coll Nutr.* 2009;28(5):543-52.
63. Jenkins DJ, Wolever TM, Taylor RH, Barker HM, Fielden H. Exceptionally low blood glucose response to dried beans: comparison with other carbohydrate foods. *Br Med J.* 1980;281(6240):578-80.
64. Mollard RC, Wong CL, Luhovyy BL, Anderson GH. First and second meal effects of pulses on blood glucose, appetite, and food intake at a later meal. *Appl Physiol Nutr Metab.* 2011;36(5):634-42.
65. Mollard RC, Zykus A, Luhovyy BL, Nunez MF, Wong CL, Anderson GH. The acute effects of a pulse-containing meal on glycaemic responses and measures of satiety and satiation within and at a later meal. *Br J Nutr.* 2012;108(3):509-17.
66. Luhovyy BL, Mollard RC, Panahi S, Nunez MF, Cho F, Anderson GH. Canned Navy Bean Consumption Reduces Metabolic Risk Factors Associated with Obesity. *Can J Diet Pract Res.* 2015;76(1):33-7.
67. Mollard RC, Luhovyy BL, Smith C, Anderson GH. Acute effects of pea protein and hull fibre alone and combined on blood glucose, appetite, and food intake in healthy young men - a randomized crossover trial. *Appl Physiol Nutr Metab.* 2014;39(12):1360-5.
68. Mollard RC, Wong CL, Luhovyy BL, Cho F, Anderson GH. Second-meal effects of pulses on blood glucose and subjective appetite following a standardized meal 2 h later. *Appl Physiol Nutr Metab.* 2014;39(7):849-51.
69. Bazzano LA, Thompson AM, Tees MT, Nguyen CH, Winham DM. Non-soy legume consumption lowers cholesterol levels: a meta-analysis of randomized controlled trials. *Nutr Metab Cardiovasc Dis.* 2011;21(2):94-103.
70. Boers HM, Seijen Ten Hoorn J, Mela DJ. A systematic review of the influence of rice characteristics and processing methods on postprandial glycaemic and insulinaemic responses. *Br J Nutr.* 2015;114(7):1035-45.
71. Mohan V, Radhika G, Vijayalakshmi P, Sudha V. Can the diabetes/cardiovascular disease epidemic in India be explained, at least in part, by excess refined grain (rice) intake? *Indian J Med Res.* 2010;131:369-72.
72. Kennedy E, Luo H. Association between rice consumption and selected indicators of dietary and nutritional status using National Health and Nutrition Examination Survey 2007-2008. *Ecol Food Nutr.* 2015;54(3):224-39.
73. Pai S, Ghugre PS, Udipi SA. Satiety from rice-based, wheat-based and rice-pulse combination preparations. *Appetite.* 2005;44(3):263-71.
74. Mohan V, Spiegelman D, Sudha V, Gayathri R, Hong B, Praseena K, et al. Effect of brown rice, white rice, and brown rice with legumes on blood glucose and insulin responses in overweight Asian Indians: a randomized controlled trial. *Diabetes Technol Ther.* 2014;16(5):317-25.
75. Shobana S, Kokila A, Lakshmi Priya N, Subhashini S, Ramya Bai M, Mohan V, et al. Glycaemic index of three Indian rice varieties. *Int J Food Sci Nutr.* 2012;63(2):178-83.
76. Atkinson FS, Foster-Powell K, Brand-Miller JC. International tables of glycemic index and glycemic load values: 2008. *Diabetes Care.* 2008;31(12):2281-3.

77. Thompson SV, Winham DM, Hutchins AM. Bean and rice meals reduce postprandial glycemic response in adults with type 2 diabetes: a cross-over study. *Nutr J.* 2012;11:23.
78. Mattei J, Hu FB, Campos H. A higher ratio of beans to white rice is associated with lower cardiometabolic risk factors in Costa Rican adults. *Am J Clin Nutr.* 2011;94(3):869-76.
79. Tohill BC, Seymour J, Serdula M, Kettel-Khan L, Rolls BJ. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. *Nutr Rev.* 2004;62(10):365-74.
80. Poppitt SD, Prentice AM. Energy density and its role in the control of food intake: evidence from metabolic and community studies. *Appetite.* 1996;26(2):153-74.
81. Rolls BJ, Bell EA. Dietary approaches to the treatment of obesity. *Med Clin North Am.* 2000;84(2):401-18, vi.
82. Yao M, Roberts SB. Dietary energy density and weight regulation. *Nutr Rev.* 2001;59(8 Pt 1):247-58.
83. Howarth NC, Saltzman E, Roberts SB. Dietary fiber and weight regulation. *Nutr Rev.* 2001;59(5):129-39.
84. Jenkins DJ, Jenkins AL. Nutrition principles and diabetes. A role for "lente carbohydrate"? *Diabetes Care.* 1995;18(11):1491-8.
85. Rizkalla SW, Bellisle F, Slama G. Health benefits of low glycaemic index foods, such as pulses, in diabetic patients and healthy individuals. *Br J Nutr.* 2002;88 Suppl 3:S255-62.
86. Kim SJ, de Souza RJ, Choo VL, Ha V, Cozma AI, Chiavaroli L, et al. Effects of dietary pulse consumption on body weight: a systematic review and meta-analysis of randomized controlled trials. *Am J Clin Nutr.* 2016;103(5):1213-23.
87. Turner TF, Nance LM, Strickland WD, Malcolm RJ, Pechon S, O'Neil PM. Dietary adherence and satisfaction with a bean-based high-fiber weight loss diet: a pilot study. *ISRN Obes.* 2013;2013:915415.
88. Li SS, Kendall CW, de Souza RJ, Jayalath VH, Cozma AI, Ha V, et al. Dietary pulses, satiety and food intake: a systematic review and meta-analysis of acute feeding trials. *Obesity (Silver Spring).* 2014;22(8):1773-80.
89. Mitchell DC, Lawrence FR, Hartman TJ, Curran JM. Consumption of dry beans, peas, and lentils could improve diet quality in the US population. *J Am Diet Assoc.* 2009;109(5):909-13.
90. Guenther PMD, K. W.; Reedy, J.; Krebs-Smith, S. M. Most Americans eat much less than recommended amounts of fruits and vegetables. *Journal of the American Dietetic Association.* 2006;106:1371-9.
91. Black JL, Billette JM. Do Canadians meet Canada's Food Guide's recommendations for fruits and vegetables? *Appl Physiol Nutr Metab.* 2013;38(3):234-42.
92. Rossiter MD, Evers SE, Pender AC. Adolescents' diets do not comply with 2007 Canada's food guide recommendations. *Appetite.* 2012;59(3):668-72.
93. Canada H. *Eating Well with Canada's Food Guide.* Ottawa, ON: Health Canada; 2011. p. 1-6.
94. Canada S. *Health Facts Sheets: Fruit and vegetable consumption, 2015.* 2017:1.
95. Bazzano LA, Serdula MK, Liu S. Dietary intake of fruits and vegetables and risk of cardiovascular disease. *Curr Atheroscler Rep.* 2003;5(6):492-9.
96. (WHO) WHO. Cardiovascular disease Factsheet No. 317: WHO; 2015 [updated January 2015]. Available from: <http://www.who.int/mediacentre/factsheets/fs317/en/>.
97. Canada P. Pulses and cardiovascular disease. In: Canada P, editor.: *Agriculture and Agri-Food Canada;* 2015. p. 1-4.

98. Jayalath VH, de Souza RJ, Sievenpiper JL, Ha V, Chiavaroli L, Mirrahimi A, et al. Effect of dietary pulses on blood pressure: a systematic review and meta-analysis of controlled feeding trials. *Am J Hypertens*. 2014;27(1):56-64.
99. Canada P. Pulses and diabetes control. In: Canada P, editor.: *Agriculture and Agri-Food Canada*; 2015. p. 1-4.
100. Jenkins DJAW, T. M.; Jenkins, A. L.; Thorne, M. J.; Lee, R.; Kalmusky, J.; Reichert, R.; Wong, G. S. The glycaemic index of foods tested on diabetic patients: a new basis for carbohydrate exchange favouring the use of legumes. *Diabetologia*. 1983;24:257-64.
101. Wolever TM, Jenkins DJ, Ocana AM, Rao VA, Collier GR. Second-meal effect: low-glycemic-index foods eaten at dinner improve subsequent breakfast glycemic response. *Am J Clin Nutr*. 1988;48(4):1041-7.
102. Wolever TM, Jenkins DJ, Thompson LU, Wong GS, Josse RG. Effect of canning on the blood glucose response to beans in patients with type 2 diabetes. *Hum Nutr Clin Nutr*. 1987;41(2):135-40.
103. Jenkins DJ, Wolever TM, Jenkins AL, Josse RG, Wong GS. The glycaemic response to carbohydrate foods. *Lancet*. 1984;2(8399):388-91.
104. Jenkins DJ, Wolever TM, Jenkins AL, Taylor RH. Dietary fibre, carbohydrate metabolism and diabetes. *Mol Aspects Med*. 1987;9(1):97-112.
105. Jenkins DJ, Wolever TM, Taylor RH, Griffiths C, Krzeminska K, Lawrie JA, et al. Slow release dietary carbohydrate improves second meal tolerance. *Am J Clin Nutr*. 1982;35(6):1339-46.
106. Ramdath D, Renwick S, Duncan AM. The Role of Pulses in the Dietary Management of Diabetes. *Can J Diabetes*. 2016;40(4):355-63.
107. Committee CDACPGE. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(Suppl 1):S1-S212.
108. Foundation HaS. *Fibre* Ottawa, ON: Heart and Stroke Foundation; 2015 [updated April 2011]. Available from: <https://www.heartandstroke.ca/get-healthy/healthy-eating/whole-grains>.
109. Agriculture USDo. ChooseMyPlate.gov All about the protein food groups Washington, D.C. : USDA; 2015 [updated August 19, 2015]. Available from: <https://www.choosemyplate.gov/protein-foods>.
110. Agriculture USDoHaHSAUSDo. 2015-2020 Dietary Guidelines for Americans. 8th Edition. 2015:144.
111. Kimmons J, Gillespie C, Seymour J, Serdula M, Blanck HM. Fruit and vegetable intake among adolescents and adults in the United States: percentage meeting individualized recommendations. *Medscape J Med*. 2009;11(1):26.
112. Yu CJN. The effect of mixed meals with added pureed beans and peas on satiety and food intake in children [Master's]. Halifax, NS: Mount Saint Vincent University; 2015.
113. Shefali R. A Health Professional's Guide for Using the WHO Growth Charts for Canada. Dietitians of Canada and Canadian Paediatric Society: Dietitians of Canada and Canadian Paediatric Society; 2014. p. 1-14.
114. Khan AI, Hawkesworth S, Hawlader MD, El Arifeen S, Moore S, Hills AP, et al. Body composition of Bangladeshi children: comparison and development of leg-to-leg bioelectrical impedance equation. *J Health Popul Nutr*. 2012;30(3):281-90.
115. Pollard D. The effect of ad libitum consumption of mixed meals with added pureed navy beans and yellow peas on satiation, satiety, and short-term food intake in children [Master's]. Halifax, NS: Mount Saint Vincent University; 2015.

116. Canada H. Draft Guidance Document - Satiety Health Claims on Food Ottawa, ON: Health Canada; 2012 [updated September 11, 2012. Available from: <http://www.hc-sc.gc.ca/fn-an/consult/satiety-satiete/document-consultation-eng.php>.
117. Dupont WDP, W. D. . Power and sample size calculations for studies involving linear regression. *Controlled Clinical Trials*. 1998;19(6):589-601.
118. Luhovyy BM, A.; Chiu, T.; Mather, K.; Boachie, R.; Hamilton, A. The sensory characteristics of whole and pureed navy beans: effect of processing. [Abstract]. In press 2015.
119. Bellissimo N, Thomas SG, Pencharz PB, Goode RC, Anderson GH. Reproducibility of short-term food intake and subjective appetite scores after a glucose preload, ventilation threshold, and body composition in boys. *Appl Physiol Nutr Metab*. 2008;33(2):326-37.
120. Flint A, Raben A, Blundell JE, Astrup A. Reproducibility, power and validity of visual analogue scales in assessment of appetite sensations in single test meal studies. *Int J Obes Relat Metab Disord*. 2000;24(1):38-48.
121. Anderson GH, Catherine NL, Woodend DM, Wolever TM. Inverse association between the effect of carbohydrates on blood glucose and subsequent short-term food intake in young men. *Am J Clin Nutr*. 2002;76(5):1023-30.
122. Moran TH, Dailey MJ. Intestinal feedback signaling and satiety. *Physiol Behav*. 2011;105(1):77-81.
123. Lejeune MP, Westerterp KR, Adam TC, Luscombe-Marsh ND, Westerterp-Plantenga MS. Ghrelin and glucagon-like peptide 1 concentrations, 24-h satiety, and energy and substrate metabolism during a high-protein diet and measured in a respiration chamber. *Am J Clin Nutr*. 2006;83(1):89-94.
124. Ball SD, Keller KR, Moyer-Mileur LJ, Ding YW, Donaldson D, Jackson WD. Prolongation of satiety after low versus moderately high glycemic index meals in obese adolescents. *Pediatrics*. 2003;111(3):488-94.
125. Tuomisto T, Tuomisto MT, Hetherington M, Lappalainen R. Reasons for initiation and cessation of eating in obese men and women and the affective consequences of eating in everyday situations. *Appetite*. 1998;30(2):211-22.
126. Slavin J. Fiber and prebiotics: mechanisms and health benefits. *Nutrients*. 2013;5(4):1417-35.
127. Mack I, Sauer H, Weimer K, Dammann D, Zipfel S, Enck P, et al. Obese children and adolescents need increased gastric volumes in order to perceive satiety. *Obesity (Silver Spring)*. 2014;22(10):2123-5.
128. Tschöp M, Weyer C, Tataranni PA, Devanarayan V, Ravussin E, Heiman ML. Circulating ghrelin levels are decreased in human obesity. *Diabetes*. 2001;50(4):707-9.
129. Pan H, Guo J, Su Z. Advances in understanding the interrelations between leptin resistance and obesity. *Physiol Behav*. 2014;130:157-69.
130. Heymsfield SB, Greenberg AS, Fujioka K, Dixon RM, Kushner R, Hunt T, et al. Recombinant leptin for weight loss in obese and lean adults: a randomized, controlled, dose-escalation trial. *JAMA*. 1999;282(16):1568-75.
131. Contento IR, Williams SS, Michela JL, Franklin AB. Understanding the food choice process of adolescents in the context of family and friends. *J Adolesc Health*. 2006;38(5):575-82.
132. L. G, A.J. R, T.R. N. Whole grain and legume acceptability among youths with type 1 diabetes. *Diabetes Educ*. 2009;35(3):422-7.
133. J. C, M. M, R. B, I. W, M. M. Collaboration among sectors to increase pulse consumption. *Ann N Y Acad Sci*. 2017;1392:3-5.
134. Cooke L. The importance of exposure for healthy eating in childhood: a review. *J Hum Nutr Diet*. 2007;20(4):294-301.

135. Anderson PM, Butcher KE. Childhood obesity: trends and potential causes. *Future Child*. 2006;16(1):19-45.
136. Taylor JP, Evers S, McKenna M. Determinants of healthy eating in children and youth. *Can J Public Health*. 2005;96 Suppl 3:S20-6, S2-9.
137. Neumark-Sztainer D, Story M, Perry C, Casey MA. Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. *J Am Diet Assoc*. 1999;99(8):929-37.
138. Harris JL, Brownell KD, Bargh JA. The Food Marketing Defense Model: Integrating Psychological Research to Protect Youth and Inform Public Policy. *Soc Issues Policy Rev*. 2009;3(1):211-71.
139. Harris JL, Graff SK. Protecting young people from junk food advertising: implications of psychological research for First Amendment law. *Am J Public Health*. 2012;102(2):214-22.
140. Arumugam V, Lee JS, Nowak JK, Pohle RJ, Nyrop JE, Leddy JJ, et al. A high-glycemic meal pattern elicited increased subjective appetite sensations in overweight and obese women. *Appetite*. 2008;50(2-3):215-22.
141. Mayer J. Regulation of energy intake and the body weight: the glucostatic theory and the lipostatic hypothesis. *Ann N Y Acad Sci*. 1955;63(1):15-43.
142. Hallschmid M, Higgs S, Thienel M, Ott V, Lehnert H. Postprandial administration of intranasal insulin intensifies satiety and reduces intake of palatable snacks in women. *Diabetes*. 2012;61(4):782-9.
143. Clark MJ, Slavin JL. The effect of fiber on satiety and food intake: a systematic review. *J Am Coll Nutr*. 2013;32(3):200-11.
144. J.J.S, E.B. Z, J.S. Z. *Research methods in psychology*. 2006.
145. Havemeier S, Erickson J, Slavin J. Dietary guidance for pulses: the challenge and opportunity to be part of both the vegetable and protein food groups. *Ann N Y Acad Sci*. 2017;1392(1):58-66.
146. Kristensen MD, Bendtsen NT, Christensen SM, Astrup A, Raben A. Meals based on vegetable protein sources (beans and peas) are more satiating than meals based on animal protein sources (veal and pork) - a randomized cross-over meal test study. *Food Nutr Res*. 2016;60:32634.

Appendices

Tables

Table 5.1 Participant Baseline Characteristics

Subject Characteristics	All (n=33) (Boys=13, Girls=20)	Lighter to Normal Weight (n=25) (Boys=8, Girls=17)	Heavier Weight (n=8) (Boys=5, Girls=3)
Age (years)	13.3 ± 1.0	13.3 ± 1.0	13.3 ± 1.0
BW ¹ (kg)	52.8 ± 12.3	47.6 ± 7.5	69.3 ± 9.4
Height (m)	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1
BMI ² (kg/m ²)	20.3 ± 3.9	18.5 ± 2.1	25.8 ± 3.2
BMI %ile (WHO)	55.2 ± 30.0	43.4 ± 24.2	92.4 ± 5.9
FM ³ (kg)	11.7 ± 7.4	8.6 ± 4.4	21.2 ± 7.2
FFM ⁴ (kg)	39.9 ± 10.2	37.2 ± 9.2	48.1 ± 9.0
TBW ⁵ (kg)	30.2 ± 5.8	28.6 ± 4.6	35.2 ± 6.5
Average Restrained Eating Score	2.2 ± 0.7	2.1 ± 0.7	2.5 ± 0.6
Average Emotional Eating Score	1.8 ± 0.6	1.8 ± 0.6	1.6 ± 0.7
Average External Eating Score	3.0 ± 0.8	3.1 ± 0.8	2.8 ± 0.7
Average DEBQ ⁶	2.3 ± 0.5	2.3 ± 0.5	2.3 ± 0.4

Data are means ± SD, n = 33. ¹BW, Body Weight; ²BMI, Body Mass Index; ³FM, Fat Mass; ⁴FFM, Fat Free Mass; ⁵TBW, Total Body Water; ⁶DEBQ, Dutch Eating Behavior Questionnaire.

Table 5.2 Age, Sex and Weight Status of All Study Participants

Age (years) (mean=13.3)	Number of Participants (n=33)
12	15
13	8
14	10
Sex	
Boys	13
Girls	20
Weight Status	
Lighter to Normal	25
Heavier	8

Food and Water Intake with Pizza Meal at the *ad libitum* pizza meal Two Hours Later

Table 5.3a Food Intake (kcal) at the *ad libitum* pizza meal Two Hours Later

Treatment	Pizza Intake All Participants (n=33)	Pizza Intake Lighter to Normal Participants (n=25)	Pizza Intake Heavier Participants (n=8)
Control	608.8 ± 24.8	607.3 ± 22.3	676.9 ± 93.8
Navy Bean	627.5 ± 40.0	619.7 ± 39.5	770.6 ± 92.0
Yellow Pea	640.7 ± 38.2	586.8 ± 42.4	761.1 ± 44.0
P-Value	0.4	0.7	0.2

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.3b Cumulative Food Intake (kcal) (Treatment and Pizza Meal)

Treatment	Pizza Intake All Participants (n=33)	Pizza Intake Lighter to Normal Participants (n=25)	Pizza Intake Heavier Participants (n=8)
Control	908.8 ± 24.8	907.3 ± 22.3	976.9 ± 93.8
Navy Bean	927.5 ± 46.4	919.7 ± 39.5	1070.6 ± 139.9
Yellow Pea	940.7 ± 38.2	886.8 ± 42.4	1061.1 ± 44.0
P-Value	0.6	0.7	0.5

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.3c Food Intake (g) at the *ad libitum* Pizza Meal Two Hours Later

Treatment	Pizza Intake All Participants (n=33)	Pizza Intake Lighter to Normal Participants (n=25)	Pizza Intake Heavier Participants (n=8)
Control	285.0 ± 12.5	287.1 ± 12.4	306.8 ± 42.1
Navy Bean	318.2 ± 18.4	281.3 ± 20.9	374.1 ± 31.6
Yellow Pea	297.3 ± 18.0	283.7 ± 21.7	345.7 ± 19.8
P-Value	0.3	0.9	0.1

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.3d Cumulative Food Intake (g) (Treatment and Pizza Meal)

Treatment	Pizza Intake All Participants (n=33)	Pizza Intake Lighter to Normal Participants (n=25)	Pizza Intake Heavier Participants (n=8)
Control	485.0 ± 12.5	487.1 ± 12.4	506.8 ± 42.1
Navy Bean	518.2 ± 18.3	481.3 ± 20.9	574.1 ± 32.7
Yellow Pea	497.3 ± 18.0	483.7 ± 21.7	545.7 ± 19.8
P-Value	0.4	0.9	0.3

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.3e Water Intake (mL) at the *ad libitum* Pizza Meal Two Hours Later

Treatment	Water Intake All Participants (n=33)	Water Intake Lighter to Normal Participants (n=25)	Water Intake Heavier Participants (n=8)
Control	255.7 ± 32.4	215.7 ± 34.5	412.3 ± 45.6
Navy Bean	227.9 ± 27.8	168.7 ± 20.6	357.2 ± 62.9
Yellow Pea	227.7 ± 26.3	178.3 ± 16.3	289.8 ± 72.4
P-Value	0.4	0.4	0.3

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.3f Cumulative Water Intake (mL) (Treatment and Pizza Meal)

Treatment	Water Intake All Participants (n=33)	Water Intake Lighter to Normal Participants (n=25)	Water Intake Heavier Participants (n=8)
Control	505.7 ± 32.4	465.7 ± 34.5	662.3 ± 45.6
Navy Bean	477.9 ± 27.8	418.7 ± 20.6	607.2 ± 62.9
Yellow Pea	477.7 ± 26.3	428.3 ± 16.3	539.8 ± 72.4
P-Value	0.4	0.4	0.3

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.3g Cumulative Food and Water Intake (g) at *ad libitum* Pizza Meal

Treatment	Pizza Food & Water Intake All Participants (n=33)	Pizza Food & Water Intake Lighter to Normal Participants (n=25)	Pizza Food & Water Intake Heavier Participants (n=8)
Control	540.7 ± 41.5	502.8 ± 38.6	719.1 ± 58.2
Navy Bean	546.1 ± 40.0	450.0 ± 35.2	731.3 ± 57.3
Yellow Pea	525.0 ± 37.1	462.0 ± 38.0	635.5 ± 98.0
P-Value	0.5	0.8	0.7

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.4 Nutritional Composition of Dietary Treatments

	CON	NB	YP
Energy (kcal)	300.0	300.0	300.0
CHO (g)	61.4	56.6	55.9
Dietary Fiber (g)	0.0	7.4	4.0
Protein (g)	5.8	11.7	10.9
Fat (g)	4.3	5.0	4.9
Weight (dry) (g)	200.0	200.0	200.0

Information obtained from Nutrition Facts Tables (President's Choice No Name Calrose Rice, Loblaws Inc., Toronto, ON, President's Choice Blue Menu Navy Beans, Loblaws, Inc., Toronto, ON, President's Choice Blue Menu Yellow Pea, Loblaws, Inc., Toronto, ON Classico Di Lombardia Rosée Sauce, International Gourmet Specialities Co., Toronto, ON, Atlantic No-Salt Butter, NS)

Table 5.5 Nutrient Composition of Pizza Meal

	McCain's Mini Pizzas Pepperoni (per 87 g)	McCain's Mini Pizzas 3 Cheese (per 81 g)	Dr. Oetker Mini Pizzas Pepperoni (per 87 g)	Dr. Oetker Mini Pizzas 3 Cheese (per 82 g)
Calories (kcal)	180	180	190	190
Fat (g)	5	5	6	6
Sodium (mg)	400	400	490	430
Carbohydrate (g)	23	23	24	24
Fibre (g)	1	1	1	1
Sugar (g)	3	2	2	2
Protein (g)	9	10	9	9

Information obtained from McCain's Deep 'N Delicious Mini Pizzas' and Dr. Oetker Giuseppe Mini Pizzas' Nutrition Facts Table.

Table 5.6 Food and Water Intake at *ad libitum* Pizza Meal Two Hours Later Categorized by Sex

	Sex	CON	NB	YP	P-Value (Treatment)	P-Value (Sex)
Pizza Food Intake (kcal)	Boys (n=13) Girls (n=20)	608.0 ± 42.6 617.7 ± 31.6	700.0 ± 65.7 640.8 ± 51.8	665.9 ± 61.6 637.0 ± 50.3	0.3	0.7
Cumulative Pizza Food Intake (kcal)	Boys (n=13) Girls (n=20)	911.4 ± 42.4 917.0 ± 31.6	959.5 ± 77.1 940.8 ± 60.5	965.9 ± 61.0 932.9 ± 50.0	0.6	0.8
Pizza Food Intake (g)	Boys (n=13) Girls (n=20)	277.9 ± 26.1 290.3 ± 15.1	287.3 ± 36.5 280.1 ± 25.3	272.9 ± 39.2 288.8 ± 26.9	0.1	0.7
Cumulative Pizza Food Intake Solid only (g)	Boys (n=13) Girls (n=20)	479.5 ± 28.7 494.6 ± 21.4	536.0 ± 26.8 498.6 ± 21.1	506.7 ± 26.2 496.3 ± 21.4	0.1	0.7
Water Intake (g)	Boys (n=13) Girls (n=20)	272.0 ± 47.2 245.2 ± 38.1	228.3 ± 47.2 227.7 ± 38.1	219.5 ± 47.2 233.0 ± 38.1	0.4	0.9
Cumulative Water Intake (g)	Boys (n=13) Girls (n=20)	522.0 ± 47.2 495.2 ± 38.1	478.3 ± 47.2 477.7 ± 38.1	469.5 ± 47.2 483.0 ± 38.1	0.4	0.9
Cumulative Pizza Food Intake Solid and water (g)	Boys (n=13) Girls (n=20)	576.6 ± 62.6 545.0 ± 49.8	545.9 ± 63.5 521.4 ± 50.3	526.2 ± 61.7 528.3 ± 50.3	0.4	0.8

Data are means ± SEM, n=33. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.7 Food and Water Intake at *ad libitum* Pizza Meal Two Hours Later Categorized by Weight Status

	Weight Status	CON	NB	YP	P-Value (Treatment)	P-Value (BMICAT)
Pizza Food Intake (kcal)	Lighter to Normal (n=25)	612.2 ± 29.2	628.9 ± 45.8	606.9 ± 42.0	0.1	0.1
	Heavier (n=8)	626.9 ± 51.6	770.6 ± 80.0	784.7 ± 77.3		
Cumulative Pizza Food Intake (kcal)	Lighter to Normal (n=25)	912.2 ± 29.1	928.6 ± 54.4	906.9 ± 42.0	0.2	0.2
	Heavier (n=8)	928.0 ± 51.5	1008.7 ± 94.9	1082.3 ± 77.8		
Pizza Food Intake (g)	Lighter to Normal (n=25)	289.7 ± 14.7	294.3 ± 20.6	283.7 ± 20.0	0.06	0.1
	Heavier (n=8)	283.2 ± 26.1	374.1 ± 36.1	355.0 ± 36.6		
Cumulative Pizza Food Intake Solid only (g)	Lighter to Normal (n=25)	489.6 ± 14.7	494.3 ± 20.7	483.7 ± 20.0	0.08	0.2
	Heavier (n=8)	483.8 ± 26.1	567.0 ± 36.3	555.6 ± 36.6		
Water Intake (g)	Lighter to Normal (n=25)	205.7 ± 31.0	186.5 ± 31.0	207.8 ± 31.0	0.2	0.009
	Heavier (n=8)	412.3 ± 54.8 ^a	357.2 ± 54.8 ^{ab}	289.8 ± 54.8 ^b		
Cumulative Water Intake (g)	Lighter to Normal (n=25)	455.7 ± 31.0	436.5 ± 31.0	457.8 ± 31.0	0.2	0.009
	Heavier (n=8)	662.3 ± 54.8 ^a	607.2 ± 54.8 ^{ab}	539.8 ± 54.8 ^b		
Cumulative Pizza Food Intake Solid and water (g)	Lighter to Normal (n=25)	505.7 ± 42.6	477.7 ± 42.7	491.5 ± 42.2	0.5	0.02
	Heavier (n=8)	719.1 ± 74.6	689.2 ± 76.9	627.4 ± 78.1		

Data are means ± SEM, n=33. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.8 Effect of Session on Food Intake and Water Intake at the *ad libitum* Pizza Meal Two Hours Later

Session	Pizza Food Intake (kcal)	Pizza Food Intake (g)	Water Intake (ml)
1	623.3 ± 35.1	288.5 ± 16.3	279.1 ± 29.8 ^a
2	644.9 ± 59.1	317.6 ± 19.4	220.2 ± 27.5 ^b
3	618.3 ± 45.5	287.0 ± 18.3	212.0 ± 28.4 ^b
P-Value (Session)	0.4	0.4	0.003

Data are means ± SEM, n=33. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Subjective Average Appetite

Table 5.9a Subjective Average Appetite Scores over Two Hours - All

Treatments	CON	NB	YP	P-Value (Treatment)	P-Value (Time)
Average Appetite (mm)	42.7 ± 1.5 ^a	50.3 ± 1.7 ^b	48.0 ± 1.6 ^{ab}	0.04	<0.0001
Desire to Eat (mm)	41.4 ± 1.7	49.0 ± 1.9	46.5 ± 1.8	0.07	<0.0001
Hunger (mm)	38.8 ± 1.6 ^a	47.0 ± 1.8 ^b	41.9 ± 1.8 ^{ab}	0.03	<0.0001
Fullness (mm)	53.7 ± 1.8	47.0 ± 1.9	47.4 ± 1.9	0.11	<0.0001
Prospective Food Consumption (mm)	44.6 ± 1.7	51.0 ± 1.8	51.1 ± 1.6	0.07	<0.0001

Data are means ± SEM, n=33. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.9b Subjective Average Appetite Scores over Two Hours - Lighter to Normal Weight

Treatments	CON	NB	YP	P-Value (Treatment)	P-Value (Time)
Average Appetite (mm)	42.6 ± 1.8	50.1 ± 2.0	46.9 ± 1.9	0.08	<0.0001
Desire to Eat (mm)	41.3 ± 2.0	49.7 ± 2.2	45.5 ± 2.1	0.10	<0.0001
Hunger (mm)	38.7 ± 1.9	46.6 ± 2.1	41.4 ± 2.0	0.10	<0.0001
Fullness (mm)	53.6 ± 2.1	48.1 ± 2.2	49.0 ± 2.2	0.31	<0.0001
Prospective Food Consumption (mm)	43.5 ± 2.0	50.8 ± 2.1	49.4 ± 1.9	0.11	<0.0001

Data are means ± SEM, n=25. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.9c Subjective Average Appetite Scores over Two Hours – Heavier Weight

Treatments	CON	NB	YP	P-Value (Treatment)	P-Value (Time)
Average Appetite (mm)	43.6 ± 3.1	50.8 ± 3.2	51.6 ± 3.1	0.36	<0.0001
Desire to Eat (mm)	41.9 ± 3.2	46.9 ± 3.6	49.4 ± 3.5	0.52	<0.0001
Hunger (mm)	39.2 ± 3.0	48.1 ± 3.2	43.2 ± 3.4	0.35	<0.0001
Fullness (mm)	54.0 ± 3.5	43.7 ± 3.7	42.5 ± 3.8	0.31	<0.0001
Prospective Food Consumption (mm)	48.4 ± 3.2	51.6 ± 3.3	56.2 ± 3.1	0.53	<0.0001

Data are means ± SEM, n=8. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Subjective Physical Comfort

Table 5.10 Gastrointestinal Comfort Scores over Two Hours

Treatments	CON	NB	YP	P-Value (Treatment)	P-Value (Time)
Nausea (mm)	3.4 ± 0.4	4.5 ± 0.6	4.2 ± 0.6	0.4	0.07
Stomach Discomfort (mm)	4.3 ± 0.5	5.7 ± 0.6	4.7 ± 0.6	0.3	0.02
Wellness (mm)	87.5 ± 1.1	87.8 ± 1.0	88.4 ± 1.1	0.9	0.2
Flatulence (mm)	2.5 ± 0.2	3.2 ± 0.4	3.2 ± 0.5	0.5	0.04
Diarrhea (mm)	1.3 ± 0.1	1.3 ± 0.1	1.5 ± 0.2	0.8	0.8
Average Physical Comfort (mm)	95.3 ± 0.3	94.4 ± 0.5	95.0 ± 0.4	0.4	0.01

Data are means ± SEM, n=33. Two-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Palatability

Table 5.11 Overall Mean of Palatability of the Treatments

Treatments	CON	NB	YP	P-Value
Taste (1-9)	7.2 ± 0.2	6.9 ± 0.2	7.2 ± 0.2	0.4
Mouthfeel (1-5)	3.9 ± 0.1	3.6 ± 0.1	3.8 ± 0.1	0.1
Flavor (1-5)	2.7 ± 0.1	2.8 ± 0.1	2.7 ± 0.1	0.7
Sweetness (mm)	35.2 ± 4.0	34.4 ± 4.5	41.3 ± 4.9	0.3

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

Table 5.12 Overall Mean of Pleasantness of the Treatments and Pizza Meal

Treatments	CON	NB	YP	P-Value
Treatment pleasantness (mm)	74.8 ± 3.3	72.2 ± 4.3	75.8 ± 3.7	0.6
Pizza pleasantness (mm)	86.9 ± 3.0	85.8 ± 3.1	84.0 ± 3.5	0.7

Data are means ± SEM, n=33. One-way ANOVA with a Tukey Kramer post-hoc test. Values with different superscripts are statistically different (P<0.05).

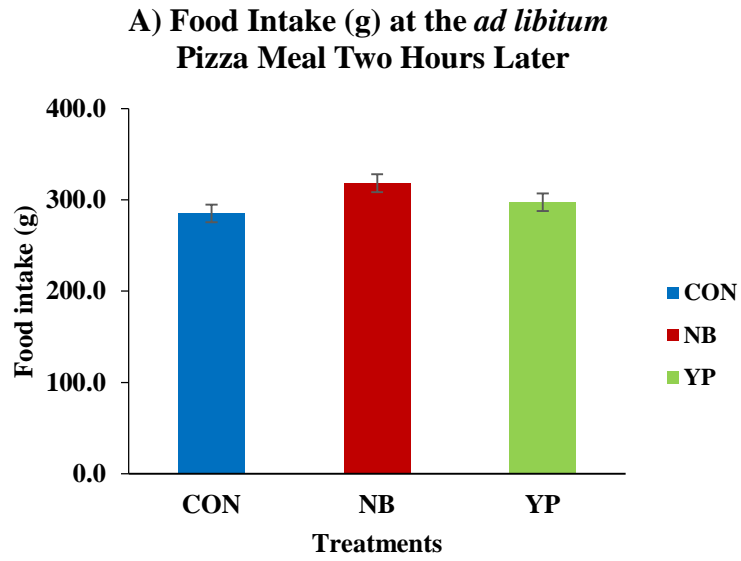
Correlations

Table 5.13 Correlations of Dependent Variables with Food Intake

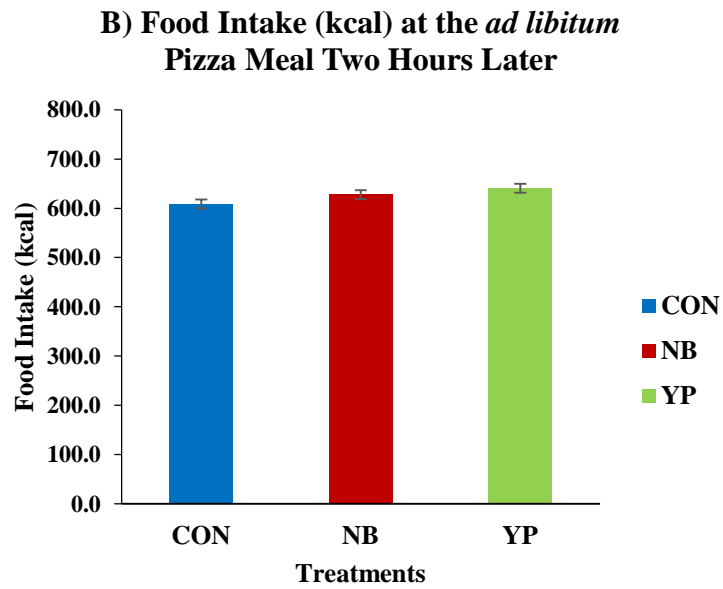
Variables	Food Intake Correlation (r)	P-Value
Average Appetite	0.02	0.82
Desire to Eat	0.01	0.89
Hunger	0.05	0.60
Fullness	0.01	0.95
Prospective Food Consumption	0.02	0.85
Nausea	-0.15	0.13
Stomach Discomfort	-0.15	0.13
Wellness	0.22	0.031*
Gas	-0.15	0.14
Diarrhea	-0.11	0.28
Average Physical Comfort	0.22	0.027*
Taste of Treatment	-0.12	0.25
Mouthfeel of Treatment	-0.11	0.28
Flavor of Treatment	-0.11	0.27
Sweetness of Treatment	-0.13	0.21
Pleasantness of Treatment	-0.10	0.34
Pleasantness of Pizza	0.31	0.0015*

Pearson Correlation Coefficients (r). *Indicates significance (<0.05)

Figure 5.1 Food Intake at the *ad libitum* Pizza Meal Two Hours Later



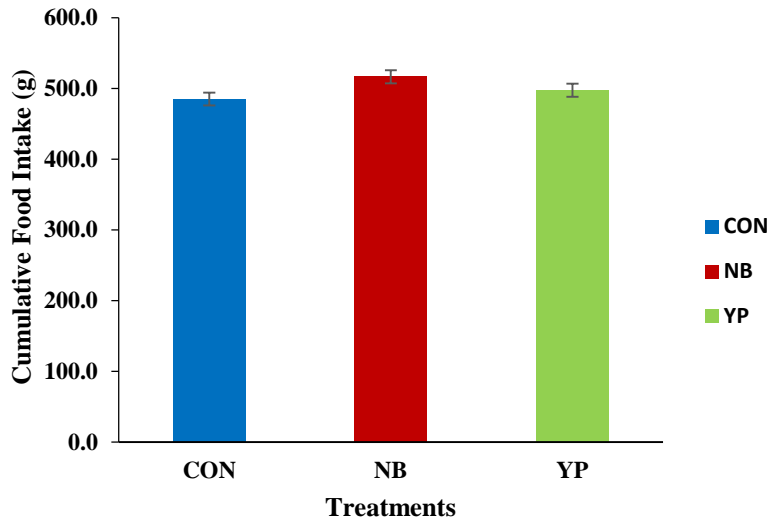
Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.



Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

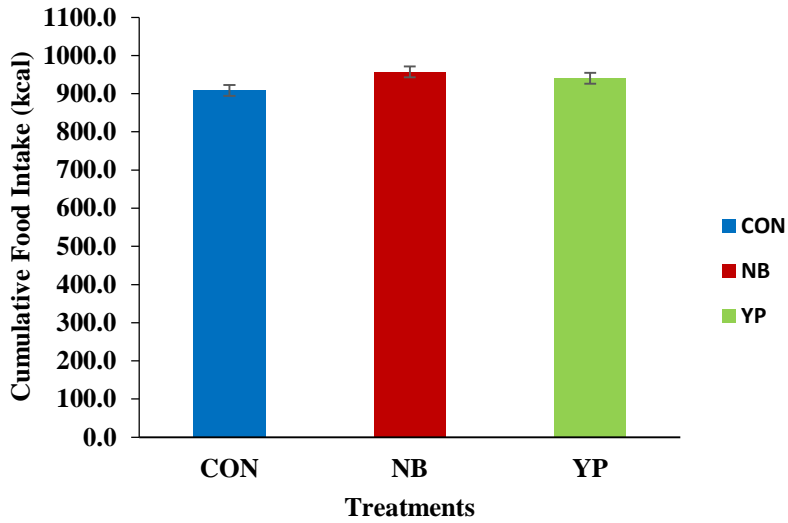
Figure 5.2 Cumulative Food Intake (Treatment and Pizza Meal)

A) Cumulative Food Intake (g)



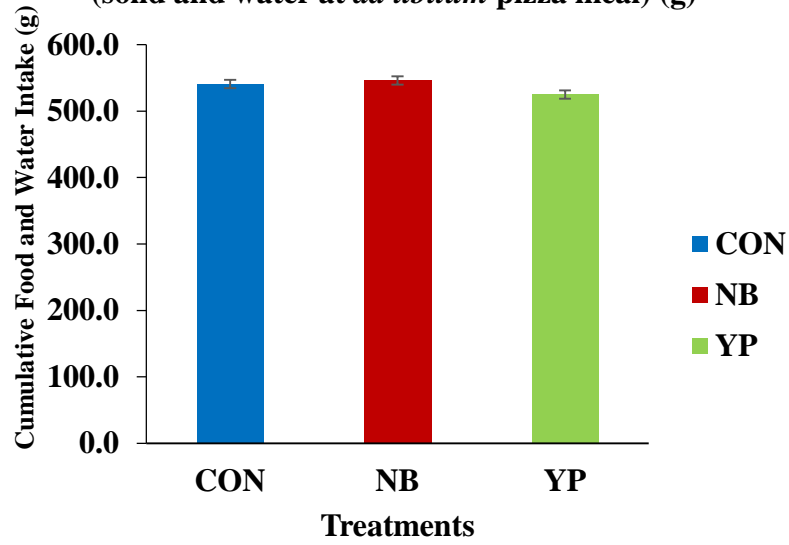
Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

B) Cumulative Food Intake (kcal)



Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

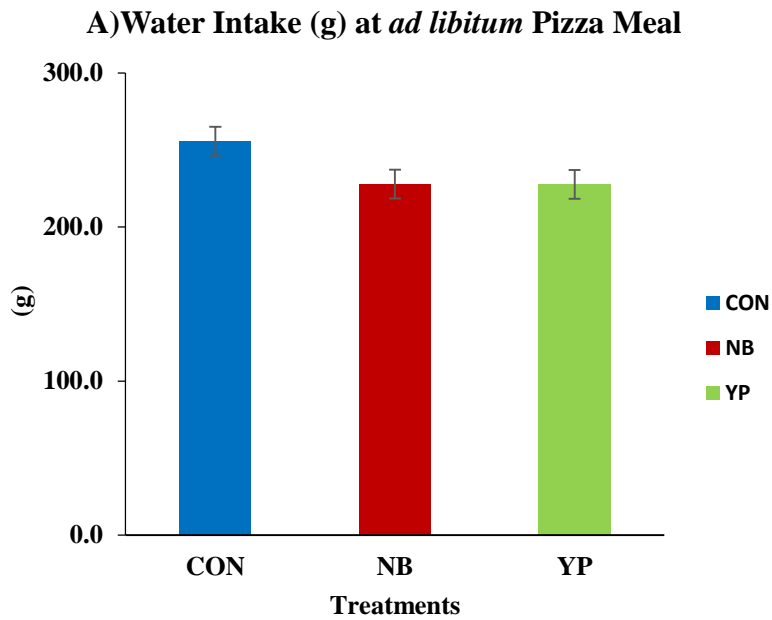
**C) Cumulative Food and Water Intake
(solid and water at *ad libitum* pizza meal) (g)**



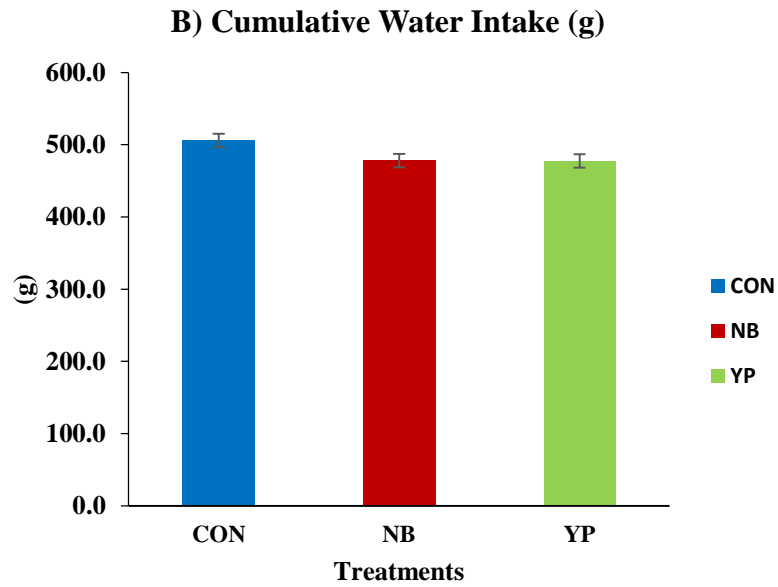
Means \pm SEM, n=33

One-way ANOVA with Tukey Kramer post-hoc test.

Figure 5.3 Water Intake at the *ad libitum* Pizza Meal and Cumulatively

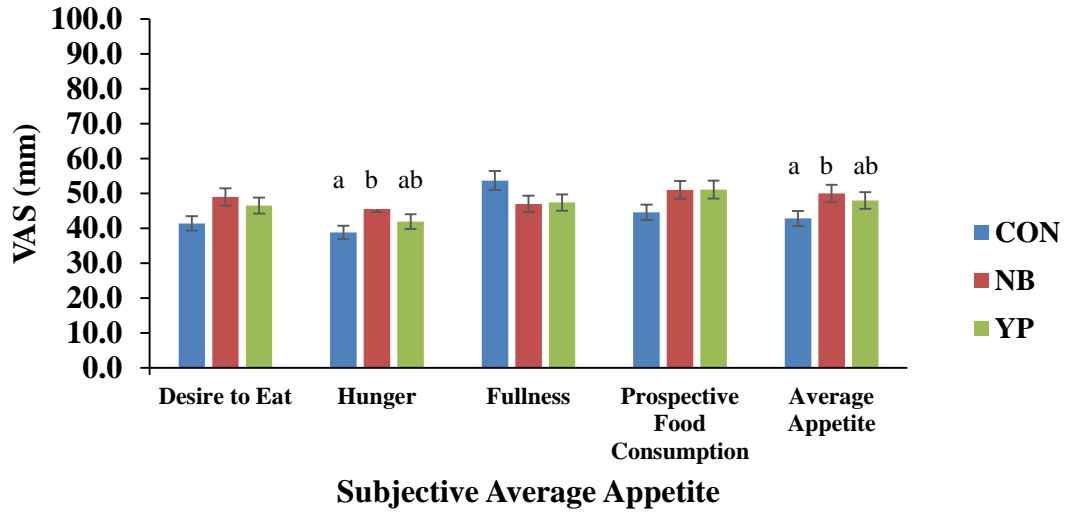


Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.



Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

Figure 5.4 Subjective Average Appetite Scores over Two Hours
Subjective Average Appetite Ratings over Two Hours

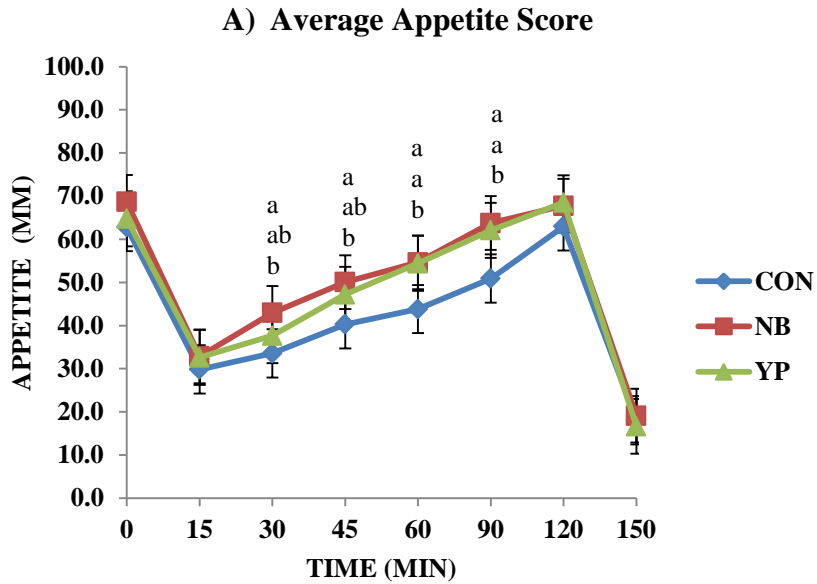


Means ± SEM, n=33

Two-way ANOVA with a Tukey Kramer post-hoc test.

Bars are different subscript letters are significantly different (p<0.05).

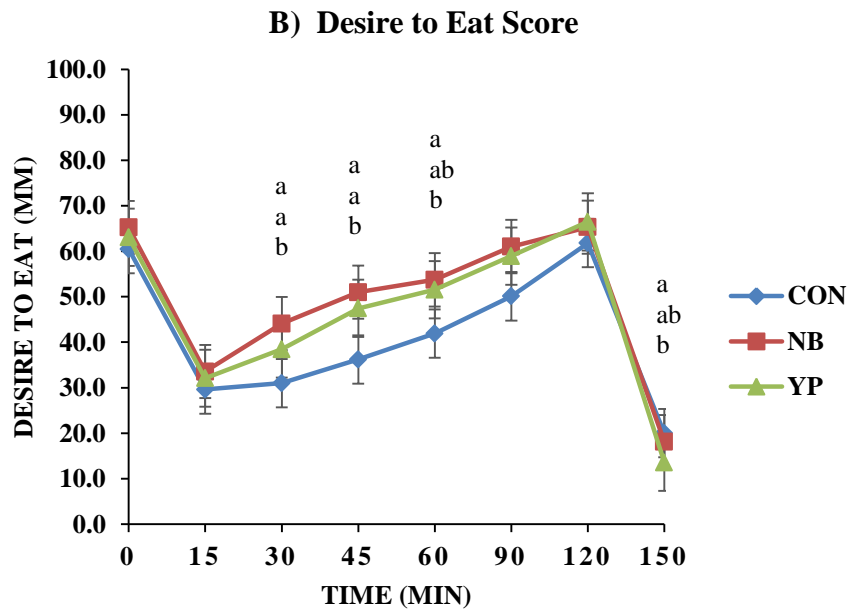
Figure 5.5 Absolute Subjective Average Appetite Score over Two Hours



Means \pm SEM, n=33

Two-way ANOVA with Tukey Kramer post-hoc test.

Values with different subscript letters are significantly different ($p < 0.05$).

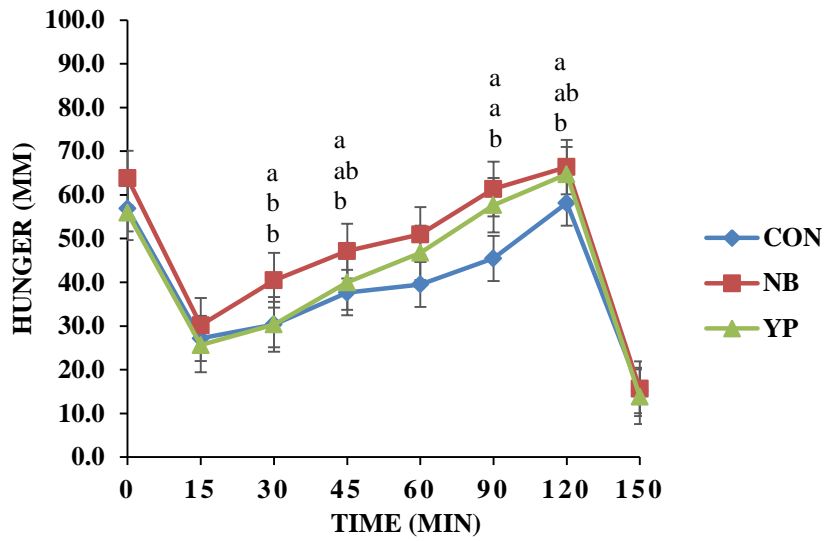


Means \pm SEM, n=33

Two-way ANOVA with Tukey Kramer post-hoc test.

Values with different subscript letters are significantly different ($p < 0.05$).

C) Hunger Score

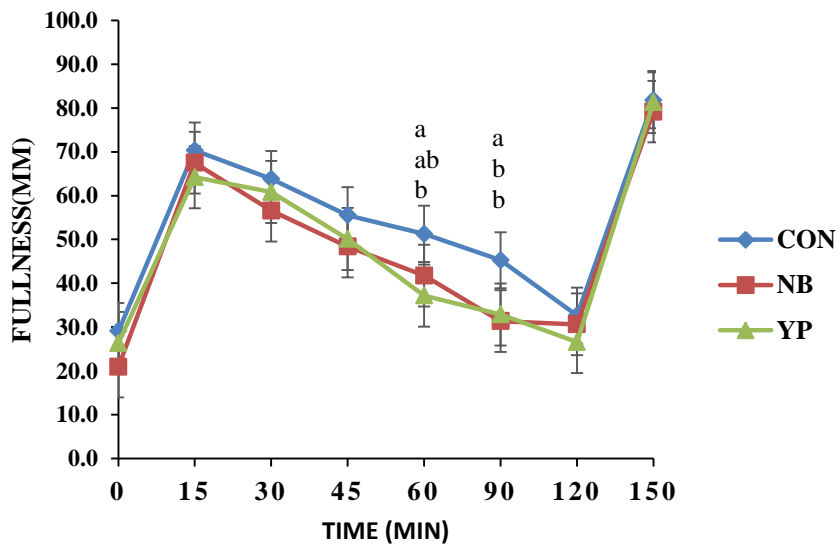


Means \pm SEM, n=33

Two-way ANOVA with Tukey Kramer post-hoc test.

Values with different subscript letters are significantly different ($p < 0.05$).

D) Fullness Score

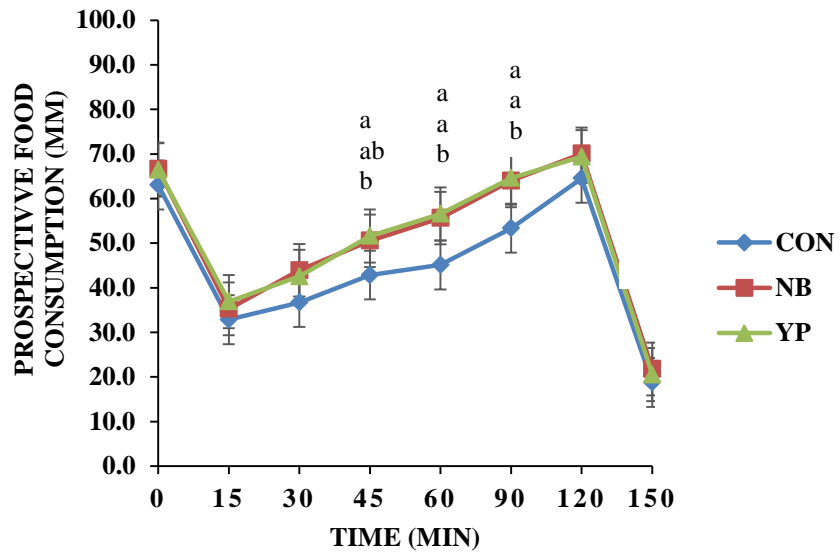


Means \pm SEM, n=33

Two-way ANOVA with Tukey Kramer post-hoc test.

Values with different subscript letters are significantly different ($p < 0.05$).

E) Prospective Food Consumption Score

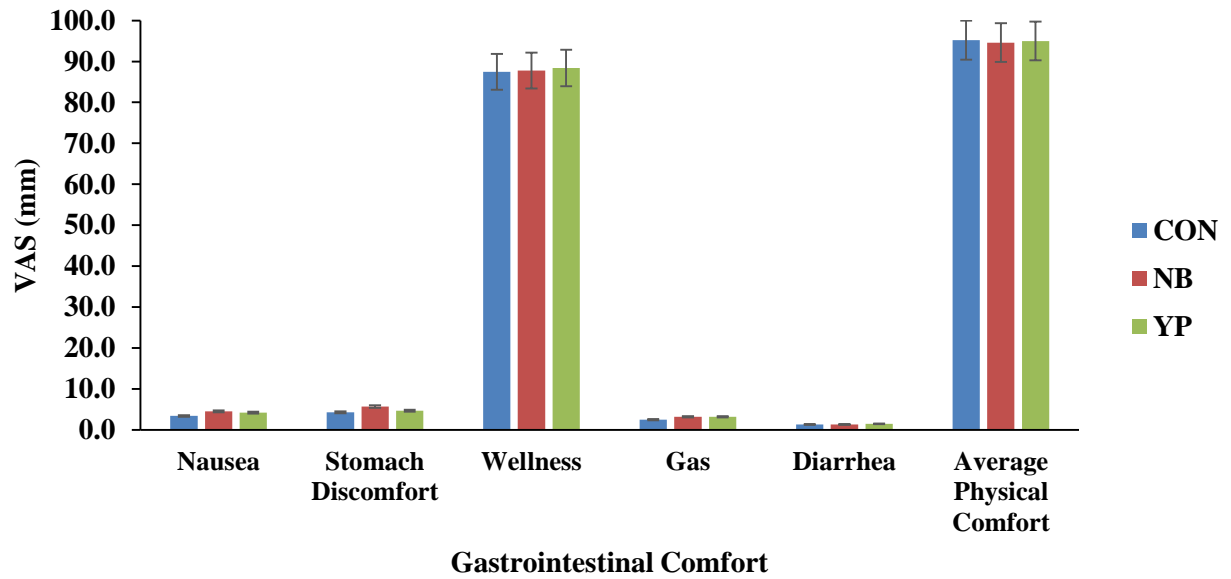


Means \pm SEM, n=33

Two-way ANOVA with Tukey Kramer post-hoc test.

Values with different subscript letters are significantly different ($p < 0.05$).

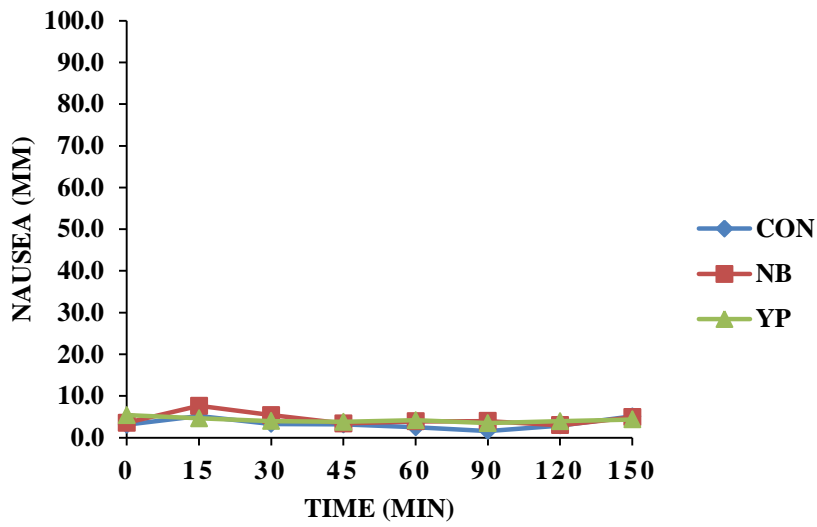
Figure 5.6 Gastrointestinal Comfort Ratings over Two Hours
Gastrointestinal Comfort Ratings over Two Hours



Means \pm SEM, n=33
Two-way ANOVA with a Tukey Kramer post-hoc test.

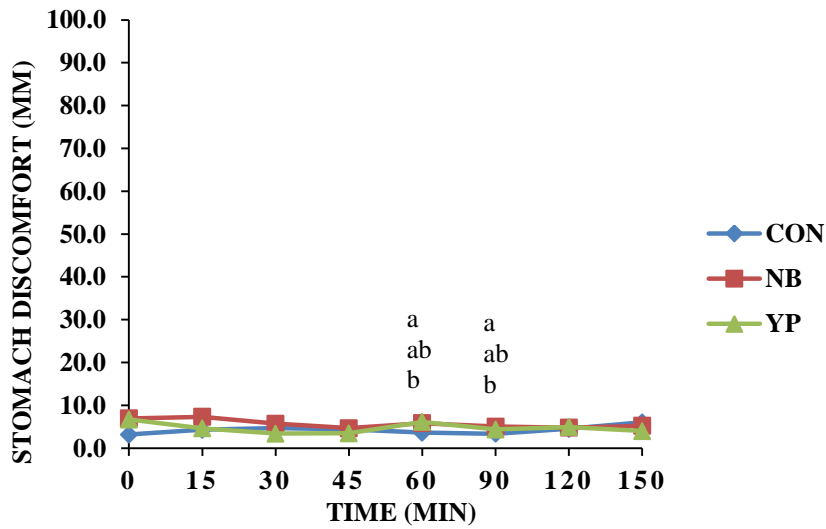
Figure 5.7 Absolute Gastrointestinal Comfort Score over Two Hours

A) Nausea Score



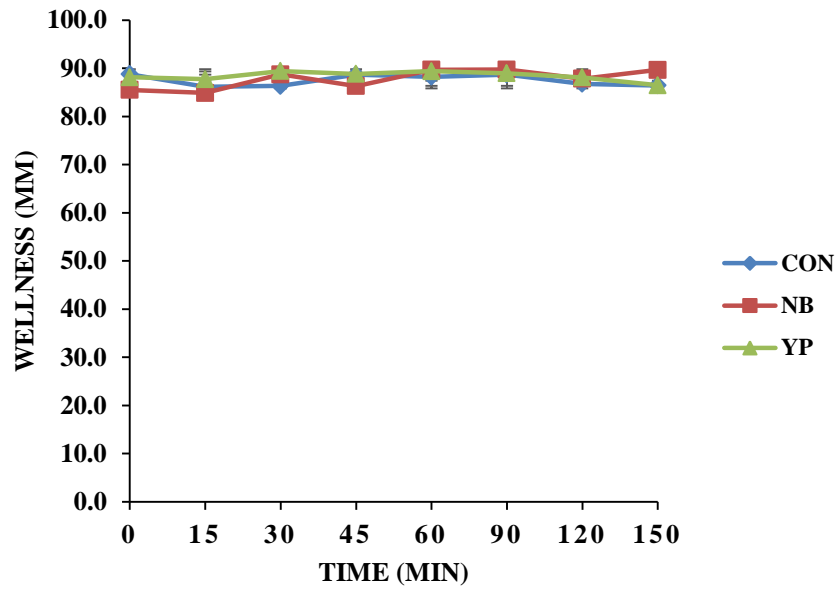
Means \pm SEM, n=33
Two-way ANOVA with Tukey Kramer post-hoc test.

B) Stomach Discomfort Score



Means \pm SEM, n=33
Two-way ANOVA with Tukey Kramer post-hoc test.
Values with different subscript letters are significantly different ($p < 0.05$).

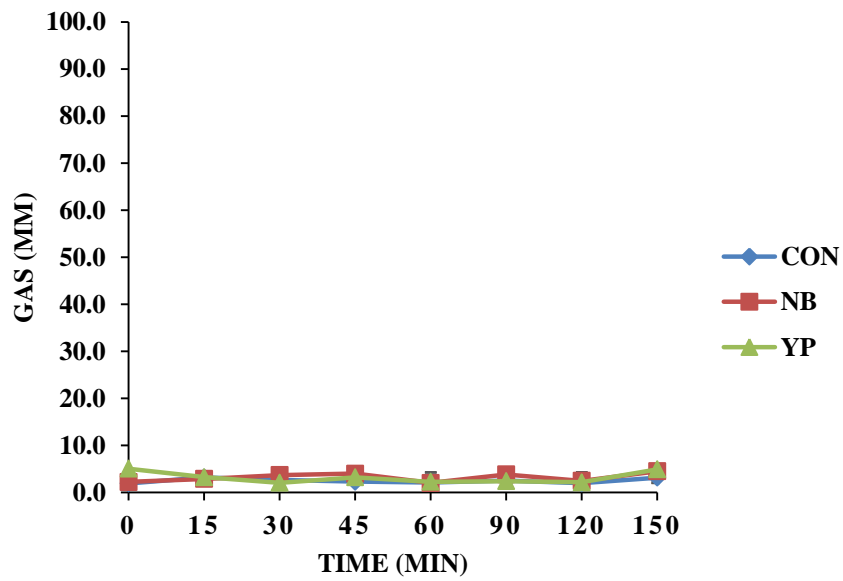
C) Wellness Score



Means \pm SEM, n=33

Two-way ANOVA with Tukey Kramer post-hoc test.

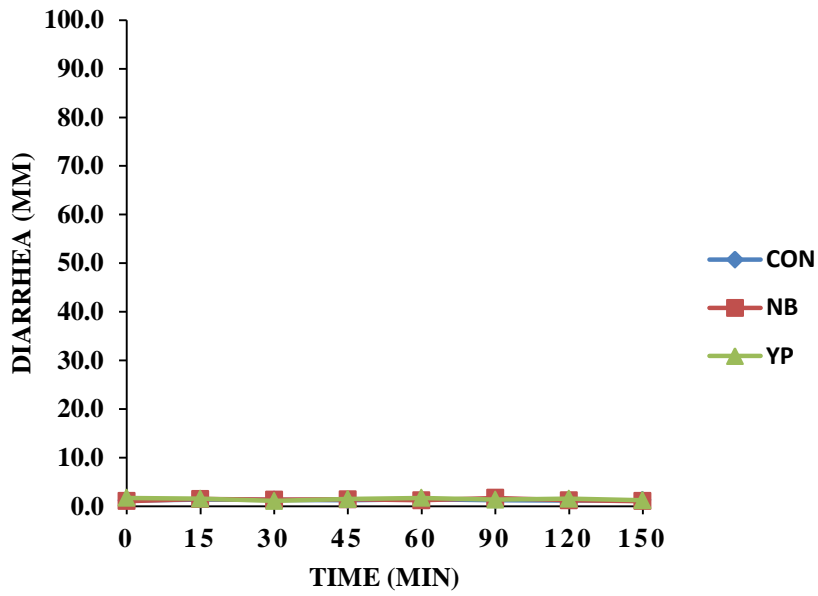
D) Flatulence



Means \pm SEM, n=33

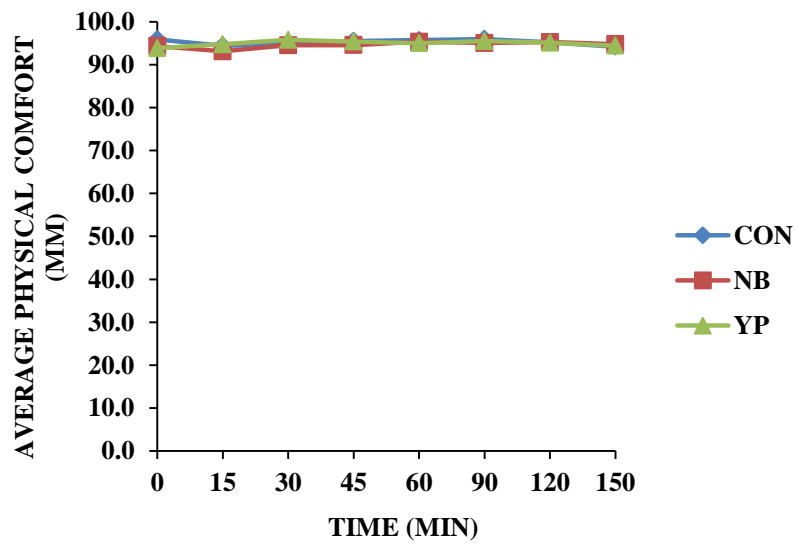
Two-way ANOVA with Tukey Kramer post-hoc test.

E) Diarrhea Score



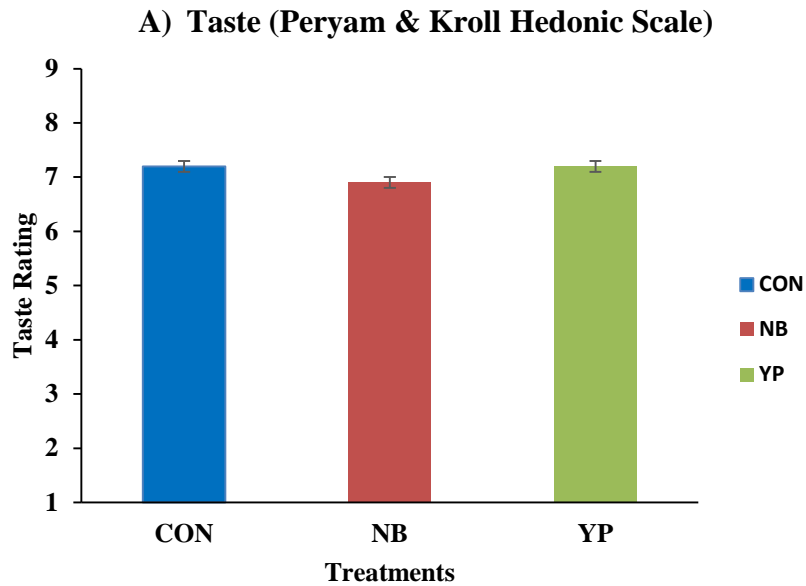
Means \pm SEM, n=33
Two-way ANOVA with Tukey Kramer post-hoc test.

F) Average Physical Comfort Score

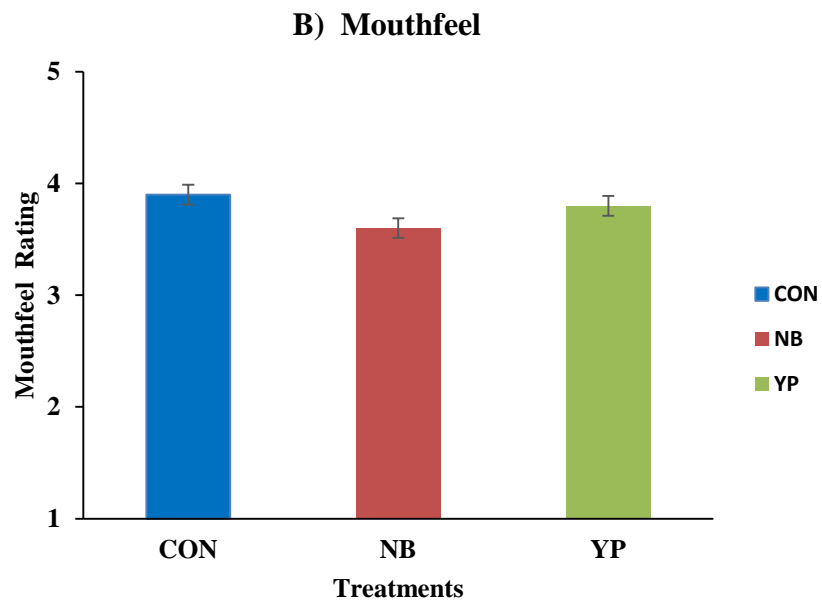


Means \pm SEM, n=33
Two-way ANOVA with Tukey Kramer post-hoc test.

Figure 5.8 Palatability of Treatments

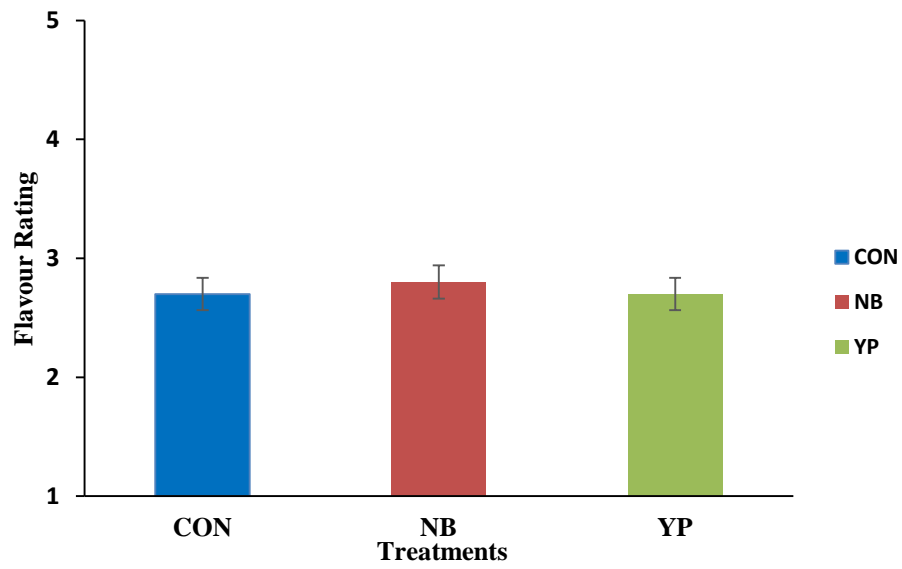


Means ± SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.



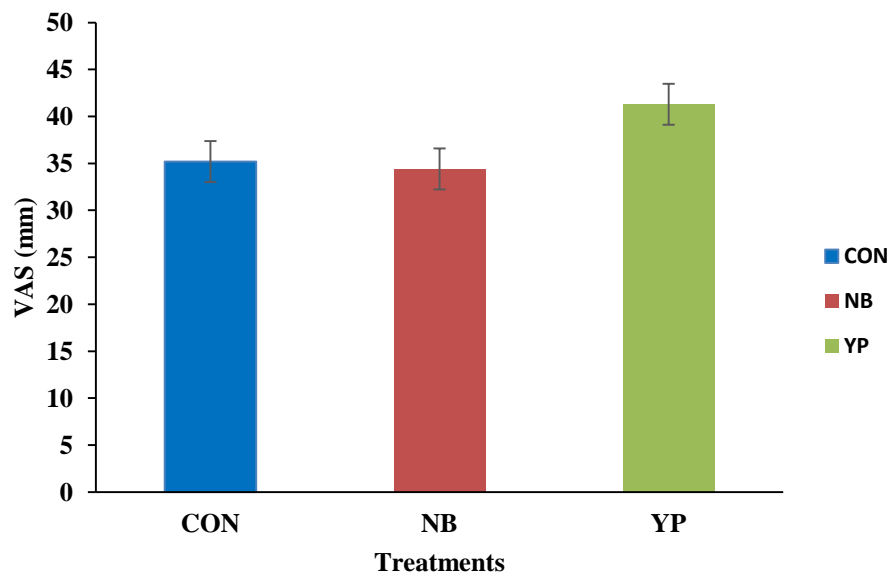
Means ± SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

C) Flavor



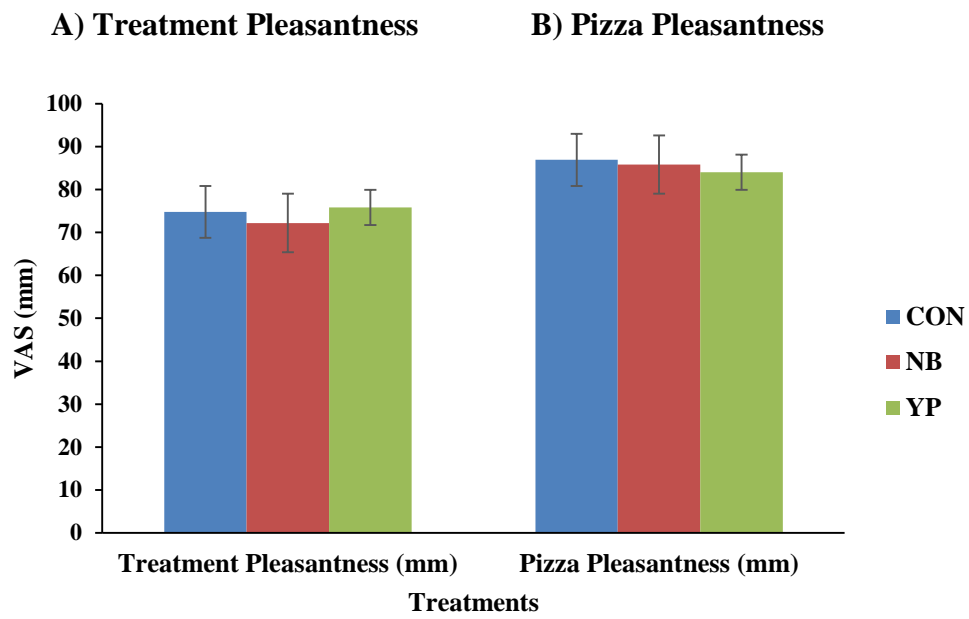
Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

D) Sweetness



Means \pm SEM, n=33
One-way ANOVA with Tukey Kramer post-hoc test.

Figure 5.9 Overall Mean of Pleasantness of the Treatment and Pizza Meal



Means \pm SEM, n=33

One-way ANOVA with Tukey Kramer post-hoc test.

Appendix 1a



The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term Satiety and Food Intake in Children

Recruitment Letter for Parents

Dear Parent,

A team of researchers from Mount Saint Vincent University (MSVU) are investigating the effects of edible beans and peas on energy intake regulation in children and young adolescents. The ultimate goal of this research is to find ways to address the problems of overeating and obesity that are becoming a concern among Canadians.

We are asking the parents of girls and boys 12-14 years old to allow their daughter/son to take part in a research study. On three separate mornings, your child will arrive to our laboratory. In 30 min, we will ask your child to consume a meal with or without pulses (e.g. beans or peas). We will ask your child to complete questionnaires about the taste of this meal, feeling of hunger and physical comfort. In 2 hours, another meal (pizza) will be provided.

The study will take place on three weekend (Saturday or Sunday) visits in our laboratory at 365 Evaristus Hall, Department of Applied Human Nutrition, 166 Bedford Highway. To determine your son/daughter's eligibility you will be asked first to attend a screening/info session.

There are criteria for participation that you need to be aware of, the child must:

- be 12-14 years of age, and
- be healthy, and have been born at term, and
- not be taking medications, or have no known food allergies.

As a thank you for taking part, at each session the child will be given a gift card to the Indigo bookstore, movie theatre or comparable alternative (\$20 gift certificate). In addition, parents will be reimbursed for travel/parking expenses (\$5 or bus tickets).

The ethical components of this research study have been reviewed by the University Research Ethics Board and found to be in compliance with Mount Saint Vincent University's Research Ethics Policy. If you would like your son/daughter to participate, or to get further information about this study beyond that provided in this letter, please contact Ms. Teresa Chiu, 902-457-6378 (Dept. of Applied Human Nutrition).

If you have questions about how this study is being conducted and wish to speak with someone who is not directly involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research Office, at 457-6350 or via e-mail at research@msvu.ca.

Thank you for your support in this important research.

Sincerely,
Dr. Bohdan Luhovyy



Appendix 1b

The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children Study Information Sheet and Parent's Authorization Form

Investigators: Dr. Bohdan Luhovyy, Principal Investigator
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6256
Email: bohdan.luhovyy@msvu.ca

Ms. Teresa Chiu, Study Coordinator
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6378
E-mail: appetite.study@msvu.ca

Ms. Stephanie Keddy, B.Sc. Student
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6378
Email: stephanie.keddy@msvu.ca

Ms. Emily Davenport, B.Sc. Student
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6378
Email: emily.davenport@msvu.ca

Mr. Erik Vandenboer, B.Sc. Student
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6378
Email: erik.vandenboer@msvu.ca

Ms. Kana Inagaki, M.Sc. Student
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6378
Email: kana.inagaki@msvu.ca

Ms. Yuka Yamazaki, B.Sc. Student
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: 902-457-6378
Email: yuka.yamazaki@msvu.ca

INTRODUCTION

Your child is invited to take part in the research study named above. This form provides information about the study. Before you decide if you want your child to participate, it is important that you understand the purpose of the study, the risks and benefits, and what you and your child will be asked to do. We will provide you with information before asking for your authorization to participate. We will keep you informed of any new information that might affect your willingness to continue participating. A member of the research team will be available to answer any questions you have. You may decide not to have your child participate or you may withdraw your child from the study at any time. Your child does not have to take part; it is entirely voluntary (your choice and your child's choice).

Why are the researchers doing the study?

Canada's Food Guide recommends from one to two servings a day of cooked legumes (also known as "pulses" or beans and peas, 1 serving = $\frac{3}{4}$ cup (175 ml)) amid meat and alternative to meat products for children 9-18 years old. Research has shown that current consumption of pulses by children is low. For instance, the data from the School Nutrition Dietary Assessment Study, a cross-sectional, nationally representative study conducted in the U.S., showed that the availability of pulses (mostly baked beans and kidney/ pinto beans) was limited to only 10% of daily lunch menus. Similarly, low pulse consumption was observed in Canada through studies that included both adults and children. Canadian statistics also suggest that more children are overweight and obese than 30 years ago, and more children are being diagnosed with type-2 diabetes. Children have replaced fruits, vegetables and ready to eat products high in fibre such as beans and peas with foods high in calories and low in nutrients. Therefore, the purpose of this study is to determine how much your child will be able to eat when the meal with added beans or peas is provided, and how this meal will change the appetite of your child and much your child will be able to eat in 2 hours' time.

We hope to that the information collected from this study will be able to be used to help prevent future generations from developing obesity and/or other metabolic disorders.

This experiment is being conducted through the Department of Applied Human Nutrition at Mount Saint Vincent University. Your son/daughter will be asked to attend three experimental sessions conducted over a 3-week period and one screening session for a total of 4 visits (1 screening session + 3 experimental sessions) to the Mount Saint Vincent University campus. This study is a randomized clinical trial which means that your child will be asked to consume a randomly selected food product (a meal containing white rice with beans or with peas, or without beans or peas). For example, your child will be asked to consume seasoned rice with whole navy beans on the first session and seasoned rice with whole yellow pea on the second session or opposite seasoned rice with yellow pea on the first session and seasoned rice with whole navy beans on the second session. Before and after the meal, we will ask your son/daughter to complete the questionnaires about the taste of the meal and their physical comfort. The detailed

protocol for the session day is shown below. The maximum duration of the session will be 3 hours.

This study will not cost you anything. Your child will receive \$20 gift card for each session and you will be compensated for the transportation (\$5 per session day or bus tickets).

We anticipate having about twenty-four children enrolled in this study which is the part of large research project that is financially supported by Manitoba Pulse Growers Association. There is no conflict of interests between investigators and the sponsor.

PROCEDURE:

Screening:

If you agree and your child wishes to participate, we will measure his/her weight, height, and body fat. None of these measurements will hurt.

Your child will be asked to complete two questionnaires that will help us to assess your child's physical activity and eating habits. Our Research Assistants will help your child if necessary and answer all questions that your child may have. Then your son/daughter will be asked to rank his/her preference for pizza that will be served as the lunch meal at each session.

- Menstrual Cycle Questionnaire:

Girls will be asked to complete a questionnaire about their menstrual cycle. This information is collected because studies have shown that energy intake and appetite change across the menstrual cycle.

- Tanner Staging:

To assess the effect of pubertal stage on food intake in children, a questionnaire relating to puberty and 3 cartoon images will be administered to the children in lieu of an examination. Your child will be asked to circle the number on the side of the picture that best represents him/her. Tanner stages are scales that assess physical development in children and adolescents, based on external primary and secondary sex characteristics, such as the size of the breasts, genitalia, and development of pubic hair. The way in which appetite is regulated is related to where children are in their pubertal development. If for any reason your child is not willing to participate, he/she has the option of ask you to answer the questionnaire and select the pictograms for him/her. Your child may decline the pubertal staging if he/she wishes.

- Body Composition Assessment:

The painless method of bioelectrical impedance analysis will be used to estimate the amount of muscle and fat tissue in your child's body.

Bioelectrical Impedance Analysis: Bioelectrical impedance analysis (BIA), a recently developed technique for measuring body fat content in both adults and children, is simple and painless and is an effective method for measuring body fat in children. BIA is based on measurement of electrical resistance in the body to a tiny current (that the child cannot feel). The principle of BIA lies in that muscle mass in the body is a better conductor of electricity than fat which contains lesser amounts of water and electrolytes.

Experimental sessions:

Your child will be asked to go to Mount Saint Vincent University (MSVU) for three individual morning sessions. These sessions will be held on weekends or holidays or in summer during vacations over three weeks. Please note that children will be brought to the laboratory and returned home by parents only.

On each of the three test days, your child will have a standardized breakfast of cereal, milk and juice at home, at 8:00 am, and a snack (one granola bar) at 10:00 am at home (the time must be consistent for each session day). The children will arrive at MSVU at 11:00 am. Your child will fast for 12 hours before breakfast and after breakfast until he/she arrives, except for water, which will be allowed up to one hour before their arrival. After arrival to the lab, your child will be asked to complete the questionnaire about her/his recent food intake including breakfast and if any medication was taken. Then your child will be asked to complete questionnaires (scales) on which he/she will place a pencil mark to describe his/her desire to eat ("Very weak" to "Very strong"), hunger ("Not hungry at all" to "As hungry as I've ever felt"), fullness ("Not full at all" to "Very full"), how much food he/she could eat ("A large amount" to "Nothing at all"). Your child will also be asked to complete similar scales on how much he/she likes the provided meal and the pizza provided 2 hours after the first meal. Your child will complete these scales during the information session, in order to become familiar with the test instruments.

After your child, has completed questionnaires, he/she will be given spring water and the meal with or without beans and peas. At 0, 15, 30, 45, 60, 90, 120,150 min, your child will be asked to complete the questionnaire rating his/her appetite, and another questionnaire rating the level of physical comfort will be provided simultaneously with appetite questionnaire at similar times. McCain pizza (purchased at grocery store) and spring water will be served at 120 minutes after the first meal). Your son/daughter will be told that he/she may eat as little or as much pizza as they like. We use pizza as a research tool to find out whether the seasoned rice with or without beans or peas (test meal) will lead to lower calories eaten with pizza. The amount of the test meal and pizza eaten by your child throughout the session will be measured and we will know how much calories were eaten by your child during the session.

Your child will be fully supervised during the study sessions. He/she will be involved in age appropriate entertainment (as distraction) e.g.: reading, cards, educational games and activities, and arts and crafts before lunch. There will be other children there participating in the study. You can pick your child up in 3 hours or you have an option to stay with your child if you wish.

Approximate Time and Activity Schedule for Each Experimental Session:

Time	Activity
Day before: 8:00 pm	The last meal of the day. No food or beverages (except water) should be consumed in the following 12 hours.
Session day: 8:00 am	At home: consume the standardized breakfast provided by research staff.
10:00 am	At home: consume snacks provided by research staff (one granola bar).
11:00 am	Arrive to the lab. (Bring checklist).
11:05 – 11:25 am	Complete stress/activity questionnaires, recent food intake.
11:30 – 11:45 am	Complete baseline questionnaires for appetite and physical comfort.
12:00 pm	Consume a test meal (seasoned rice with or without beans or peas).
12:15 am – 1:45 pm	We will ask you to complete questionnaires about the taste of the meal you just ate, your appetite and how you feel at certain time points.
2:00 pm	Pizza meal is provided. You can eat as much as you want until you feel comfortably full.
2:30pm	Fill out the questionnaires about the taste of the pizza.
2:30 pm	The session is completed.
Total hours in the lab: 3.5 hours	

CONFIDENTIALITY:

Records relating to your child will be kept confidential in a locked cabinet in the Department of Applied Human Nutrition and no disclosure of personal information of the children or parents will take place except where required by law. Participants will have a code and a number that will identify them in all documents, records and files to keep their name confidential. All data from children who have completed the study will be entered into Microsoft Excel files, available only to investigators. The results of the study may be presented at scientific meetings and published in a scientific journal. If the results are published, only averages and not individual values will be reported. Each child will have a file, also only available to the investigators. If your child will withdraw from the study, all her/his data will be removed and all hard copies will be destroyed. All forms and printouts will be stored in the individual files and clearly labelled. All documents will be kept for a minimum of five years and then securely destroyed. No disclosure of personal information of children or parents will take place except where require by law, for example concerns of suspected child abuse.

RISKS:

There is very little risk related to this study. The provided meals are/or prepared from commercially available food products and are safe for human consumption. Children may feel dizzy following the overnight fast, but this is rare. If this happens, they will likely feel fine once they consume the breakfast meal provided. There is a possibility of other unexpected risks.

BENEFITS:

As the causes of obesity remains undefined, the potential benefits from this study will be a better understanding of the regulation food intake in children and might contribute to the prevention of obesity in children. Each child will receive a copy of Canada's Food Guide along with a copy of "My Food Guide" personalized for each child.

QUESTIONS AND FURTHER INFORMATION:

Participation is completely voluntary and failure to participate will not have any consequences. Also, you and your child have the option to stop participating, skip any step/question or withdraw from the study at any time.

If you have any questions or would like further information concerning this research project, please do not hesitate to call: our Study Coordinator Ms. Teresa Chiu (902 457-6378) and leave a message. You may also contact Dr. Bohdan Luhovyy (902 457 6256). We will call you back shortly.

If you have questions about how this study is being conducted and wish to speak with someone who is not directly involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research and International Office, at 457-6350 or via e-mail at research@msvu.ca

We may want to contact you in future to provide information about our other projects you or your child may be interested in and invite your child to participate in these projects.

RESEARCH RIGHTS:

Your signature on the form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree that your child will participate as a subject. In no way does this waive your legal rights nor release the investigator(s), sponsors, or involved institution(s) from their legal and professional responsibilities. Your child is free to withdraw from the study at any time.

I understand that for purposes of the research project, if my child or I choose to withdraw from the study at any time, we may do so without any problems.

Upon completion of each study session, my child will receive a \$20 gift certificate to the movie theatre or Indigo bookstore or comparable alternative. I am aware that the researchers may publish the study results in scientific journals, keeping confidential my son or daughter's identity.

RESEARCH RESULTS:

If you wish, a summary of the study results can be provided. They will be available approximately one year after the end of the study.

The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Participant ID: _____

PARENT AUTHORIZATION:

I have read or had read to me this information and authorization form and have had the chance to ask questions which have been answered to my satisfaction before signing my name. I understand the nature of the study and I understand the potential risks. I understand that my child and I have the right to withdraw from the study at any time without any problems. I have received a copy of the Information and Authorization Form for future reference. I freely agree to participate in this research study.

Would you like to receive a summary of the results when they are available? Yes ___ No ____.

Would you like to be contacted for future research? Yes ___ No ____.

Name of Participant: (Print) _____

Name of Parent: (Print) _____ Parent Signature: _____

Date: _____ Time: _____ Participant ID: _____

If you would like to receive the summary of the results and/or be contacted for future research, please print your address below:

STATEMENT BY PERSON PROVIDING INFORMATION ON STUDY AND OBTAINING
CONSENT

I have explained the nature and demands of the research study and judge that the participant named above understands the nature and demands of the study. I have explained the nature of the consent process to the participant and judge that they understand that participation is voluntary and that they may withdraw at any time from participating.

Name: (Print) _____

Signature: _____ Position: _____

Date: _____ Time: _____

Appendix 1c



The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Child's Assent Form

We are doing a research study to find out how good some foods are for children's health. It is your choice if you want to take part, and no one will be mad at you if you do not want to.

Here's what you will do if you decide to be in the study:

Come to Mount Saint Vincent University (MSVU) with your parent on one day and we measure your body weight, height and ask questions about what you like and don't like to eat, and some questions about how you grow. On three other days, you will come again to MSVU for meal sessions. While you are there, we will ask you some questions about your appetite, whether you thought the food we gave to you was good or not, and how you feel.

At each session, there will be other children like you. We will ask you and your parent to answer some questions about your health and how you are growing up. You do not have to answer any questions if you are feeling shy. We will see how tall you are and how much you weigh. We will measure to see how much body fat you have. It will not hurt. You will not have to miss school because the research will happen on days off.

If you start taking part and decide you want to stop, that is OK. Just tell your parent or the people at the session and you can go home.

To say thank you, we will give you a gift certificate for each session you attend, and your parent will get some money for parking or bus tickets.

"I was present when _____ read this form and gave his/her verbal assent."

Signature: _____

Name of the person who obtained assent: _____

Appendix 2
The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety
and Short-term Food Intake in Children

Telephone Screening Questionnaire: part 1

Part: A / B

Name: _____

ID assigned: _____

Age: _____ years

Date of Birth: (d/m/y) _____

TO BE KEPT SEPARATELY

Appendix 2

The Effect of Cooked Whole Navy Beans and Yellow Peas Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Telephone Screening Questionnaire: part 2

Please print or circle the answer

ID: _____

How many weeks gestational age? _____

What did your child weigh when (s)he was born? _____

Height: _____ cm

Weight: _____ kg

Has your child lost or gained weight recently? Yes / No

Does your Child usually have breakfast? Yes / No

Does your child like:

- Milk: Yes / No
- Honey Nut Cheerios: Yes/No
- Orange juice: Yes/No
- Granola bar (peanut free): Yes/No
- Beans: Yes / No
- Peas: Yes / No
- Tomato based (Rosée) sauce: Yes / No
- Rice: Yes / No
- Pizza: Yes / No

At the end of each session, your child will be provided with pizza. In order to provide your child with a meal that he/she will enjoy, we ask that you rank the following pizzas according to your child's **personal preferences (i.e. 1st, 2nd, 3rd choice)** in the space provided. If he/she does NOT like a particular type of pizza, then do not rank it but instead write "don't like" in the space provided.

- Pepperoni (cheese, pepperoni) _____
- Three-cheese (mozzarella, cheddar, parmesan) _____
- Deluxe (cheese, pepperoni, peppers, mushrooms) _____

Does your child does not like some particular food products? (If yes, please explain):

Is your child following a special diet? Yes / No

Does your child have any food allergies or food sensitivities? Yes / No
(If yes please explain):

Health Problems? Yes / No (If yes please explain):

Medications? Yes / No (If yes please explain):

Education: Grade: _____ Special Class? Yes / No

Has your child skipped or repeated a grade? Yes / No
(If yes which grade): _____

Does your child have any learning difficulties/problems? Yes / No
(If yes please explain):

Does your child have any behavioural or emotional problems? Yes / No
(If yes please explain):

Include in study? Yes / No

Appointment scheduled for: (date and time)

Investigator/Date screened:

Appendix 3a
Puberty Questionnaire (Self-administered)

ID: _____ Date: _____

Would you say that your growth spurt (height):

1. there has been no development
2. development has barely begun
3. development is definitely underway
4. development is already completed

And regarding hair growth (under your arms, your pubic hair), would you say that:

1. there has been no development
2. development has barely begun
3. development is definitely underway
4. development is already completed

Have you noticed changes in your skin (e.g. acne)?

1. there have been no changes
2. changes have barely begun
3. changes are definitely underway
4. changes are already complete

FOR GIRLS:

Have your breasts started to develop?

1. there has been no development
2. development has barely begun
3. development is definitely underway
4. development is already completed

FOR BOYS:

Have you noticed that your voice has changed (lowered)?

1. there have been no changes
2. changes have barely begun
3. changes are definitely underway
4. changes are already complete

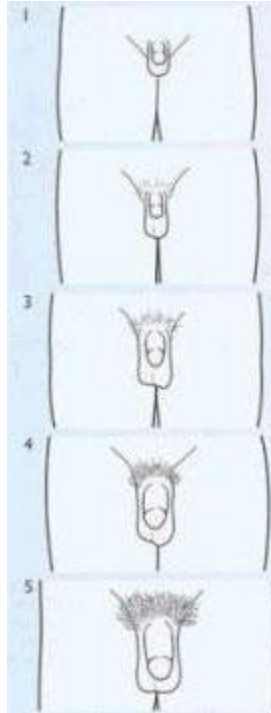
Have you started to have hair on your face?

1. there have been no changes
2. changes have barely begun
3. changes are definitely underway

*NOTE: Girls with menarche start within a year of study visit = Tanner 4, girls with menarche start over one year of study visit = Tanner 5.

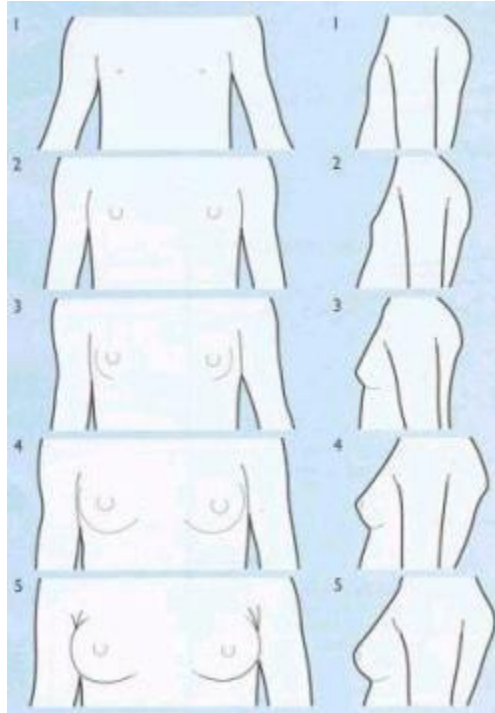
Appendix 3b
Tanner Staging

ID: _____ Date: _____



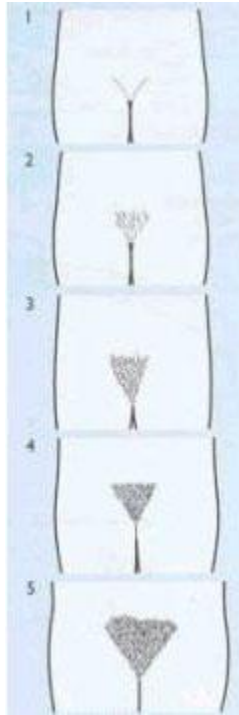
Appendix 3b
Tanner Staging

ID: _____ Date: _____



Appendix 3b
Tanner Staging

ID: _____ Date: _____



Appendix 3c
Menstruel Cycle Questionnaire

ID: _____ Date: _____

1. When were you born? _____
2. Have you had your first period? _____

If you answered no, you are finished this questionnaire.

If you answered yes, please complete the following questions.

3. How old were you when you had your first period?
I was _____ years old when I had my first period.
4. Do you remember the day/month of your first period? Yes/No
5. If you answered “yes”, what was the date of your first period? _____
6. How long is your average menstrual cycle? (from the beginning of menstrual flow
7. [menses] to the beginning of the next menstrual flow [menses])
My average cycle length is _____ days.
8. Currently, for how many days do you typically experience menstrual flow each cycle?
____ 1 day ____ 2 days ____ 3 days ____ 4 days ____ 5 days ____ > 5+ days
9. In the past 3 months, estimate how many menstrual cycles you have had?
I have had _____ cycles in the past 3 months
10. In the past 6 months, estimate how many menstrual cycles you have had?
I have had _____ cycles in the past 6 months
11. In the past 9 months, estimate how many menstrual cycles you have had?
I have had _____ cycles in the past 9 months
12. In the past 12 months, estimate how many menstrual cycles you have had?
I have had _____ cycles in the past 12 months

13. How would you characterize your menstrual flow in the first two days of menses?

Circle one: Heavy Moderate Light

14. Do you experience cramps during menses?

Circle One: Always Sometimes Never

15. Do you typically experience any pain during the middle of your cycle?

Circle one: Always Sometimes Never

16. Do you typically experience spotting or sporadic bleeding not associated with normal menstrual flow?

Circle one: Always Sometimes Never

Appendix 5
Dutch Eating Habits Questionnaire

1. Subject and test details

ID: _____

Age: _____

Gender: male female

Today's date: _____

2. Your weight, height, etc.

A. Current weight (kg): _____

B. Current height (cm): _____

C. Has your body weight been constant over the past six months?

- Yes, my weight did not change much
- No, I lost _____ kg
- No, I gained _ kg
- No, sometimes I gained weight and sometimes I lost weight

D. Have you ever had an episode of eating an amount of food that others would regard as unusually large?

- Yes
- No

Please do not mark below this line

BMI (*please take the age of the child into account*): _____

DEBQ scale	Raw score	Number of items	Scale score	Classification
Emotional eating		7		
External eating		6		
Restrained eating		7		

Please turn over >>>>>

Instructions (PLEASE CHECK TO BE SURE THAT YOU TICKED EVERY QUESTION)

Below you'll find 20 questions about eating. Please read each question carefully and tick the answer that suits you best. Only one answer is allowed.

There are no incorrect answers; it's **your opinion** that counts.

1.	Do you feel like eating whenever you see or smell good food?	No	Sometimes	Yes
2.	If you feel depressed do you get a desire for food?	No	Sometimes	Yes
3.	If you feel lonely do you get a desire for food?	No	Sometimes	Yes
4.	Do you keep an eye on exactly what you eat?	No	Sometimes	Yes
5.	Does walking past a candy store make you feel like eating?	No	Sometimes	Yes
6.	Do you intentionally eat food that helps you lose weight?	No	Sometimes	Yes
7.	Does watching others eat make you feel like eating too?	No	Sometimes	Yes
8.	If you have eaten too much do you eat less than usual the next day?	No	Sometimes	Yes
9.	Does worrying make you feel like eating?	No	Sometimes	Yes
10.	Do you find it difficult to stay away from delicious food?	No	Sometimes	Yes
11.	Do you intentionally eat less to avoid gaining weight?	No	Sometimes	Yes
12.	If things go wrong do you get a desire for food?	No	Sometimes	Yes
13.	Do you feel like eating when you walk past a restaurant or fast food restaurant?	No	Sometimes	Yes
14.	Have you ever tried not to eat in between meals to lose weight?	No	Sometimes	Yes
15.	Do you have a desire to eat when you feel restless?	No	Sometimes	Yes
16.	Have you ever tried to avoid eating after your evening meal to lose weight?	No	Sometimes	Yes
17.	Do you have a desire for food when you are afraid?	No	Sometimes	Yes
18.	Do you ever think that food will be fattening or slimming when you eat?	No	Sometimes	Yes
19.	If you feel sorry do you feel like eating?	No	Sometimes	Yes
20.	If somebody prepares food do you get an appetite?	No	Sometimes	Yes

Appendix 6
The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Recent Food Intake and Activity Questionnaire

Participant's ID: _____ Session: _____

Date: _____ Arrived at: _____

Baseline Questionnaire (to be asked by investigator)

1. Have you had the standardized breakfast this morning? YES/NO

2. At what time did you finish the standardized breakfast? _____

3. Have you had anything to eat or drink for 10 - 12 hours before breakfast? YES/NO

If yes, please describe
briefly

4. Have you had anything to eat or drink after breakfast before arriving here? YES/NO

If yes, please describe
briefly

5. Are you taking any medication? YES/NO

If yes, please describe
briefly

6. What time did you go to bed? _____

7. What time did you wake up? _____

To be completed by staff only.

Comments/Notes:

Treatment code: _____

Treatment started at: _____

Appendix 7a
Visual Analogue Scale
Motivation to Eat

DATE: _____

Session _____

ID: _____

Treatment ID _____

Time point: ____ min

These questions relate to your “motivation to eat” at this time. Please rate yourself by placing a small “x” across the horizontal line at the point which best reflects your present feelings.

1. How strong is your desire to eat?

Very WEAK _____ Very STRONG

2. How hungry do you feel?

Not hungry at all _____ As hungry as I have ever felt

3. How full do you feel?

Not full at all _____ Very full

4. How much food do you think you could eat?

NOTHING at all _____ A LARGE amount

Appendix 7b
Visual Analogue Scale
Physical Comfort

DATE: _____

Session _____

Treatment ID _____

ID: _____

Time point: ____ min

These questions relate to your “stomach” and general feeling at this time. Please rate yourself by placing a small “x” across the horizontal line at the point which best reflects your present feelings.

1. Do you feel nauseous?

NOT at all _____ VERY
much

2. Does your stomach hurt?

NOT at all _____ VERY
much

3. How well do you feel?

NOT well at _____ VERY well
all

4. Do you feel like you have gas?

NOT at all _____ VERY
much

5. Do you feel like you have diarrhea?

NOT at all _____ VERY
much

Appendix 8

The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Visual Analogue Scale
Pleasantness

DATE: _____

Session _____

Treatment ID _____

ID: _____

Actual time _____

This question relates to the palatability of the food you just consumed. Please rate the **pleasantness** of the food by placing a small “x” across the horizontal line at the point which best reflects your present feelings.

How pleasant have you found the food?

NOT at all
pleasant

VERY
pleasant

Appendix 8a

The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Peryam & Kroll hedonic scale

DATE: _____

Session _____

Treatment ID _____

ID: _____

Actual time: _____

Please taste the food sample. How much do you like it? Please circle your answer.

SUPER GOOD

REALLY GOOD

GOOD

JUST A LITTLE GOOD

MAYBE GOOD OR MAYBE BAD

JUST A LITTLE BAD

BAD

REALLY BAD

SUPER BAD
Appendix 8b

The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Hedonic scale: Mouthfeel

DATE: _____






Session _____

Treatment ID _____

ID: _____

Actual time: _____

How the sample feels in your mouth? Please circle your answer.

1	2	3	4	5
				
Really Really Bad	Bad	OK	Nice	Really Really Nice

Appendix 8c

The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Hedonic scale: Flavor

DATE: _____

Session _____

Treatment ID _____

ID: _____

Actual time: _____

Was the flavor intensity of the food sample too weak or too strong? Please circle your answer.

1	2	3	4	5
Much too weak	Too weak	About right	Too strong	Much too strong

Appendix 8d

The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children

Visual Analogue Scale
Sweetness

DATE: _____

Session _____

Treatment ID _____

ID: _____

Actual time: _____

This question relates to the palatability of the food you just consumed. Please rate the **sweetness** of the food by placing a small “**x**” across the horizontal line at the point which best reflects your present feelings.

NOT
sweet
at all

VERY
sweet

Appendix 9

The Effect of Cooked Whole Navy Beans and Yellow Peas
Added to a Mixed-Meal on Satiety and Short-term Food Intake in Children
Advertisement



Mount Saint Vincent University

ATTN: PARENTS OF CHILDREN

AGED 12-14 YEARS

We are conducting a research study to learn more about beans and peas in child nutrition.

REQUIREMENTS: 12-14-year old boys & girls,
healthy, have been born at term and not be taking medication

INVOLVES: 1 screening with information session
and 3 weekend 3 hour sessions.

Children will be asked to eat common foods.

Breakfast and lunch will be provided.

Children will be engaged in educational games and activities,
and arts and crafts with research staff

As a thank you for taking part:

The child will receive a gift card \$20 for each session.

Plus \$5 per visit or bus tickets for parents for travel reimbursement

Please contact us at: (902)-457-6378 or e-mail us:

appetite.study@msvu.ca

Appendix 10

TCPS 2: CORE Certificates

