Mount Saint Vincent University
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The Effect of Mixed Meals with Added Pureed Beans and Peas on Satiety and Food Intake in Children

By
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The objective of this study was to investigate the effect of cooked, pureed navy beans (NB) and yellow peas (YP) on satiety, subsequent food intake and subjective appetite over two hours in 9 to 14 year old children. **Methods:** In a within-subjects randomized single-blinded controlled cross-over design, 25 children (10 boys and 15 girls) were randomly assigned to consume one of the three isocaloric treatments (250kcal) at each session: 1) pureed NB added to cooked durum wheat pasta with tomato sauce (331.56 g, 12.98 g protein, 14.99 g fibre, 0.83 g fat, 47.37 g carbohydrate); 2) pureed YP added to cooked durum wheat pasta with tomato sauce (322.58 g, 12.66 g protein, 11.59 g fibre, 0.88 g fat, 47.56 g carbohydrate) and 3) additional cooked pureed pasta added to cooked durum wheat pasta with tomato sauce (394.32 g, 10.41 g protein, 5.42 g fibre, 0.78 g fat, 29.79 g carbohydrate). Pureed NB, YP and pasta were added to the meal as 44% of energy. Subjective appetite and gastrointestinal comfort were assessed at 0, 15, 30, 45, 60, 90, 120 and 150 min throughout the study session. **Results:** Due to the variability in age, weight status and pubertal stage, participants were separated into 1) younger group (9.8y-12.6y) and older group (12.7y-14.8y); 2) lighter-to-normal weight group (underweight and normal weight) and heavier group (overweight and obese); 3) pre-menarcheal and post-menarcheal for girls, and group I (Tanner's stages 1 & 2) and group II (Tanner's stages 3 & 4) for boys. There was no effect of treatment on subsequent ad libitum food intake at the test meal 120 min later both in terms of weight and energy. There was a significantly higher solid cumulative food intake (treatment + test meal) in weight with the control treatment compared to that of both NB and YP treatments (P=0.001). When adding the volume of the water provided at the treatment meal to the solid cumulative food intake, there was no significant difference in weight among the treatments (P=0.4). Younger children and lighter-to-normal weight children had significantly lower food intake compared to their older (P=0.001) and heavier (P=0.007) counterparts, respectively. Pre-menarcheal girls had significantly lower food intake both in weight (P=0.03) and energy (P=0.04) compared to post-menarcheal girls, boys at Tanner's stages 1 & 2 had significantly lower food intake in energy (P=0.04) than those at Tanner's stages 3 & 4. Analysis of subjective appetite measures showed lower average appetite after the control compared to both pulse treatments (P=0.02), there was lower hunger after the control compared to YP (P=0.03) and a lower prospective food consumption after the control compared to NB (P=0.01). Analysis of gastrointestinal comfort indicated a lower average physical comfort (P= 0.006) and higher flatulence (P=0.02) after YP compared to both NB and control, there was also a higher stomach discomfort after YP compared to NB (P=0.03). All differences of gastrointestinal parameters were in the lowest decile (<10%), which was not clinically meaningful. Adding pulses to pasta and tomato sauce did not change the pleasantness, taste, mouthfeel, flavour and sweetness of the treatments. **Conclusion:** Cooked and pureed pulses added to pasta and sauce were well tolerated, led to similar suppression of short-term food intake as the pasta control, had acceptable palatability and resulted in increased fibre intake.

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List of Abbreviations

A	
ANOVA	Analysis of Variance
AA	Average Appetite
APC	Average Physical Comfort
AUC	Area Under the Curve
B	
BG	Blood Glucose
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
BW	Body Weight
C	
CCHS	Canadian Community Health Survey
CCK	Cholecystokinin
CDC	Centre for Disease Control and Prevention
CI	Confidence Interval
CON	Control
CVD	Cardiovascular Disease
D	
DEBQ	Dutch Eating Behaviour Questionnaire
DTE	Desire to Eat
F	
FFM	Fat-free Mass
FI	Food Intake
FM	Fat Mass
G	
GI	Glycemic Index
GLP-1	Glucagon-like Peptide-1
K	
Kcal	Kilocalories
M	
MetS	Metabolic Syndrome
Min	Minute
N	
NB	Navy Beans
NHANES	National Health and Nutrition Examination Survey
NW	Normal Weight

O

OB	Obese
OW	Overweight

P

PYY	Peptide YY
PFC	Prospective Food Consumption

S

SAS	Statistical Analysis Systems

T

TBW	Total Body Water

U

USDA	United States Department of Agriculture

V

VAS	Visual Analogue Scale

W

WHO	World Health Organization

Y

YP	Yellow Peas

Chapter 1: Introduction

In Canada, the childhood obesity rate has tripled in the past 20 years. According to the 2009-2011 Canadian Health Measures Survey, 31.5% of 5-17-year-olds, an estimated 1.6 million, were classified as overweight (19.8%) or obese (11.7%) (1). In Nova Scotia, one in three children and youth aged 2-17-year-old is overweight or obese most possibly due to unhealthy eating and sedentary behaviour (2). Adverse health consequences associated with childhood obesity include type 2 diabetes, cardiovascular disease and other chronic disorders. For example, type 2 diabetes among children has rapidly increased in the past decade, although it is typically perceived as an adulthood disease. Excessive intake of energy dense foods may have contributed to the increased rate of childhood obesity and diabetes in the last 30 years (1).

Pulses are high in dietary fibre and protein, and low in sugar, fat and energy density (3). It has been reported that pulses exert multiple health benefits in adults, such as lowering glycemic response resulting in better glucose control for people with diabetes (4), increasing satiation (5), reducing the risk of cancer (5), protecting against cardiovascular diseases (6), as well as preventing and relieving constipation in humans due to its high dietary fibre content (7). There has been limited data on the health benefits of pulses in children. Canada's Food Guide recommends 1 to 2 servings of meat and alternatives to children aged 9 to 13 years. Cooked pulses are a meat alternative with each serving being 175 ml or ¾ cup. Therefore the suggested serving(s) of pulses are aimed to meet the daily nutrient and energy requirement from the meat and alternatives category, however the current consumption of pulses by children does not meet these guidelines. Instead, children consume foods high in calories and low in nutrients. Regular consumption of pulses has shown to aid in lower risk for obesity and related metabolic diseases in adults (8).

The extent to which beans and peas can affect children's subsequent appetite has not been extensively studied. More experimental research needs to be conducted to determine whether a causal relationship exists.

Chapter 2: Literature Review

2.1 Current Status of Childhood Obesity in Canada

Obesity is an epidemic in both developed and developing countries, originally prevalent in adults is now affecting children and adolescents. Obesity has become the most prevalent nutritional problem in the world over the past 20 years, surpassing under-nutrition and infectious disease as the most important contributor to morbidity and mortality (9). Based on the Centre for Disease Control (CDC) Growth Charts for children and adolescents aged 2 to 20 years, normal body weight is defined as Body Mass Index (BMI) between the 5th and 85th percentile for age and gender and overweight is defined as between 85th and 95th BMI percentile for age and gender, obese is defined as equal to or greater than the 95th BMI percentile for age and gender (10).

Results of the Canadian Community Health Survey in 2004 estimate that 1 in 4 (26%) children and adolescents between the age of 2 and 17 are overweight, and the national obesity rate has increased from 2% to 10% in boys and 2% to 9% in girls in the past 15 years (9, 11). Childhood obesity is especially of concern among the aboriginal population in Canada. It is estimated that 55% of First Nations children living on reserves and 41% living off reserves are overweight or obese (9, 12). Moreover, the incidence of obesity is not uniformly distributed across Canada. There is a higher overweight and obesity rate in the Maritime provinces (12-14). In 2003, 282 out of 291 public schools grade five classes in Nova Scotia responded to the Harvard's Youth/Adolescent Food Frequency Questionnaire (15). It showed that the self-reported prevalence of overweight and obesity was 32.9% and 9.9%, respectively (14). There was no significant difference in the prevalence of overweight between girls (32.9%) and boys (33.0%). However, it was reported that the prevalence of obesity is higher among boys (10.9%) compared to girls (9.0%) (14). In 2013, 12,132 Nova Scotia youth self-reported as being overweight or obese, this accounts for approximately 3% of total Canadian population that self-reported as being overweight or obese (16).

Childhood obesity is also a factor that contributes to the economic burden in Canada. In 1997, a conservative estimate of $2 billion a year was allocated towards treating obesity and obesity related health issues, accounting for 2.4% of total health care expenditure (17). Costs associated with the increased prevalence of overweight and obesity is on the rise over the past decade. An analysis of the Canadian Community Health Survey (CCHS), National Population Health Survey (NPHS) and Economic Burden of Illness in Canada data indicate an increase of $735 million from $3.9 to $4.6 billion between 2000 and 2008, including both direct cost to health care system and indirect cost associated with decreased labour productivity (18).

This increase in the prevalence of overweight and obesity is of concern because obesity-related health issues occur at a much earlier stage in children. At the current rate of increase, the prevalence of overweight and obesity among adults will likely continue to increase as the current generation of children enters adulthood (9).

2.2 Risk Factors Associated with Childhood Obesity

2.2.1 Metabolic Risk Factors

The Metabolic Syndrome (MS), also called Syndrome X, was first proposed by Dr. Reaven in his Banting lecture at Stanford University in 1988, and was described as a "link between insulin resistance and hypertension, dyslipidemia, type 2 diabetes, and other metabolic abnormalities associated with an increased risk of atherosclerotic cardiovascular disease in adults" (19, 20).

There is no universal definition of metabolic syndrome. There are at least three major concepts that have been frequently discussed in the literature. First, an increase in obesity and decrease in physical activity are responsible for the metabolic syndrome epidemic (21, 22). Based on this concept, it is proposed that lifestyle change is crucial in treating metabolic disorders (21, 22). The second concept described by the World Health Organization (WHO) suggests insulin resistance is the underlying cause of the metabolic syndrome (21, 23). This concept implies that treatment options for metabolic disorder should go beyond lifestyle changes. Insulin sensitizing agent should be included when dealing with metabolic syndrome (21, 23). The third concept proposed that "inflammation might be the underlying cause of the metabolic syndrome" (21, 24). This concept promotes the use of anti-inflammatory agents such as statins, ACE inhibitors and ARBs, on top of the use of insulin sensitizing agents and life style changes (21, 24).

In 2009, a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International

Association for the Study of Obesity was published and an international standard to define metabolic syndrome was developed (25). Five metabolic risk factors that contribute to metabolic syndrome include 1) abdominal (central) obesity (waist circumference ≥ 94cm for males, ≥ 80cm for females for individuals of European origins); 2) elevated blood pressure (BP) (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥85 mmHg); 3) elevated fasting plasma glucose (FPG) (FPG ≥ 5.6 mmol/L), 4) high serum triglyceride (TG) (TG ≥ 1.7 mmol/L); and 5) low high-density-lipoprotein cholesterol (HDL) levels (HDL < 1.03 mmol/L in males and HDL<1.29 mmol/L in females) (26). The American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) requires the presence of three out of the five risk factors listed above to support a diagnosis of metabolic syndrome (21, 26). The International Diabetes Foundation (IDF) requires the presence of abdominal (central) obesity as one of the three risk factors.

2.2.2. Food and Eating Patterns related to Increased Metabolic Risks

Food consumption patterns are influenced by factors including environmental, political, socioeconomic status, parental and child food choices and preferences, and the accessibility to food (27). Trends on the consumption of commercially available food products are influenced by politics, which also play a key role in the change of diet among both adults and children. There has been a shift from cooking at home to eating foods away-from-home, such as fast food chains, cafeteria and restaurants among both adults and children in the United States (28-32). This change in dietary habit results in decreased nutrient density with less than 20 percent meeting USDA guidelines for a healthy diet, including fruits and vegetables, whole grains, lean protein sources and low-fat dairy products (33, 34). In Canada, food consumption in children and adolescents is also highly influenced by their immediate environment. 6099 Canadian students aged 11 to 15 years from 255 schools participated in the 2009-2010 Health Behaviour in School-Aged Children Survey (HBSC) (35). It was reported that students who lived in neighbourhoods with moderate and high density fast-food outlets or restaurants were more likely to be fast-food consumers compared to students who lived in areas with limited numbers of fast-food stores (35). It was also found that neighbourhoods with a moderate or high density of fast-food stores accounted for approximately 31% of excessive fast-food consumption (35). Increased consumption of foods that are energy dense and low in essential nutrients contributes to increased energy intake as well as the development of obesity-related health issues, such as metabolic syndrome (33).

a. Snacking Behaviors

Recent findings report that half of the energy consumed by children from fast food is consumed at home (30). This phenomenon is contributed by the lack of time to prepare meals by parents, commercially available ready-to-eat foods become the top choice for parents and children since only minimal preparation is required (36, 37). In addition, there is a shift towards increased consumption of small meals (38, 39) and snacking (40) as people tend to choose convenient pre-packaged snacks instead of consuming full meals. Snacking among children and adolescents is common. Approximately 87-88% of American adolescents aged 12 to 18 years consume at least one snack per day which accounts for approximately 25% of their daily energy intake (41-43). Not only does snacking contribute to energy intake, undesirable health outcomes may occur as a result from unhealthy snack choices. A recent U.S. observational study indicates the percentage of consumption of the entire sugar-sweetened and flavored salty snacks provided to children is 89% and 82% respectively, while only 59% and 49% of children consumed the entire fruit and unflavored grain snacks provided. Approximately 15% to 47% of fruit was wasted, compared with 8% to 38% of sugar-sweetened, flavored salty and unflavored grain snacks (44). This study found that when given a choice, children prefer cookies, chips or candy over fruits or vegetables. They are also more likely to choose unhealthy snacks such as sugar-sweetened and salty snacks (44). This eating pattern potentially contributes to childhood obesity and associated metabolic dysfunction (41, 42). Outside of school, the wide availability of low-nutrient, energy dense snacks on the market is also a key factor that promotes purchase among adults and children. A U.S. observational study conducted in 2009 found snack foods in 96% of pharmacies, 94% of gasoline stations, 22% of furniture stores, 16% of apparel stores, and 29% to 65% of other types of stores (45). Most common items within arm's reach of the cash register queue include candy (33%), sweetened beverages (20%), and salty snacks (17%) (45).

Snacking also plays a key role in the regularity of consumption of main meals. It is shown that adolescents who frequently snack on the run were more likely to skip meals (41). Based on the Youth Eating Patterns (YEP) survey, two main contributing factors resulting in meal skipping include lack of time in the morning (52%) and not hungry (22%) (41). Snacking on the run and on the way to or from school are behaviours that are associated with the lack of time, and this behaviour supports that snacking in these contexts increases the likelihood of skipping breakfast. Adolescents tend to report diminished sense of hunger when they snack at midnight because it reduces the length of overnight fasting period, resulting in not feeling hungry in the morning (41).

b. Frequency of Vending Machine Use

For more than a decade, snack choices available in school vending machines and low-nutrient, energy-dense food products offered to students in cafeteria are two most important barriers to implementing healthy eating environment in middle and high schools (46-48). According to the United States School Health Policies and Programs Study (2006), approximately 62% of middle schools and 86% of high schools had one or more vending machines available for students (47). It was also found that sugar-sweetened beverages and high-fat, calorie-dense foods were among the most popular items sold to students (47). In a Canadian study, the Web-Survey of Physical Activity and Nutrition (Web-SPAN) was conducted in high schools in Alberta. 51% of the students reported the presence of snack-vending machines in their schools and 62% reported the presence of beverage-vending machines. Approximately 40% of students reported the presence of snack logos in their schools and slightly over half (57%) reported the presence of beverage logos (49). The study concluded that the presence of beverage-vending machines in schools was associated with the weight status of students, and the presence of snack-vending machines and logos was associated with students' frequency of consuming vended goods. Moreover, the presence of snack-vending machines and logos was associated with the frequency of salty snack consumption (49).

Strategies to prevent childhood obesity and metabolic syndrome and to foster healthy school eating environments need to be initiated. The 2008 Bill 8, Ontario's Healthy Food for Healthy Schools Act, requires school boards to ensure that food and beverages sold in vending machines comply with established nutritional standards. Middlesex-London, Elgin, and Oxford health units initiated the Healthy Vending Machine Pilot Project (HVMPP) to promote a healthier nutrition environment. A 50:50 ratio of healthier choices and conventional vending products was provided in the vending machines in four pilot schools. Product selection was approved by the vending supply company according to the company's pre-established criteria. Healthier choice vending products were required to be low in total fat (<6 g per package), low in saturated and trans fat (<2 g per package), low in sodium (<2 g per package) (50). The study found that sales ranged from 14% to 17% after replacing vending machines with healthier choices during the implementation of HVMPP. Vending revenues declined from 0.7% to 66%, with an average of 33% during the pilot study (50).

c. Food Insecurity

There is growing evidence to show that low income families spend a higher proportion of their household income on food and tend to have less healthy diets compared to more affluent households (51-53). According to the Canadian Community Health Survey (CCHS), households with children (16%) were more likely to experience food insecurity compared to households without children (11%) (54). In 2011, 12.3% of Canadian households including over 1.1 million children or 17% of all children under the age of 18 experienced some level of food insecurity over the previous 12 months. Of those food insecure households, 20.7% were severely food insecure. In 2011, the rate of severe food insecurity was much higher than the national average in Nova Scotia (4.6%), Northwest Territories (4.2%) and New Brunswick (3.4%) (54). It was proposed that the higher rate of childhood obesity in the Maritime provinces (12-14) is associated with the higher rate of food insecurity. A lack of affordable, healthy foods is one of the contributing factors underlying both food insecurity and obesity among children (55, 56). According to Drewnowski and colleagues (57), foods high in energy, sugar and fat, low in nutrients are more affordable compared to diets based on lean meats, fish, fresh vegetables and fruits. Furthermore, this purchasing behaviour is reinforced by the high palatability of sugar and fat. A Finnish study indicated that children from families with higher socioeconomic status tend to consume a less energy dense diet with more vegetables and fruits compared to children from households with lower socioeconomic status (58). On the other hand, those people who reported as being food insecure showed a greater consumption of low-cost, energy-dense foods (57, 59). The consumption of energy dense, nutrient low foods on a long term basis contributes to obesity (57), which predispose these individuals to metabolic syndrome (60-62).

The consumption of fast foods has been a popular trend in North America for more than the past decade and the number is still on the rise (63). According to United States studies, families that experience food insecurity are more likely to have decreased access to grocery stores (64-67), and increased access to fast food outlets (68). In a systematic review by Fleischhacker and colleagues (68), fast food restaurants were more prevalent in low income areas compared with middle-to higher-income areas. It was found in an American study that adults and children who were frequent fast food consumers had higher intakes of energy, fat, saturated fat, sodium, carbonated soft drink, and lower intake of vitamins A and C, milk, fruits and vegetables (69).

2.3 Regulation of Food Intake

2.3.1 Food Intake Regulation in Children and Adults

Cravings of food and its regulation are highly influenced by age. Silvers and colleagues (70) conducted an experiment on how adults and children handle food cravings. It was found that adults had less cravings compared to children as evidenced by the increased recruitment of dorsolateral, ventrolateral and dorsomedial prefrontal regions, which is responsible for high level of cognitive control process (71). Moreover, it was observed that the activation of reward-related circuitry was attenuated including the ventral striatum and ventromedial prefrontal cortex when trying to curb craving in adults (72, 73). Adults are able to use cognitive strategies to curb craving, such as reappraisal, which is to look at food items in a different way to decrease their desire of consumption (73-75). The ability to regulate craving is not fully developed in children, therefore, children do not exhibit similar behaviour as adults (70).

The neuro-circuitry involved in the self-regulation of food intake is highly affected by the signals caused by behavioural disturbances that in turn results in increased energy intake and energy imbalance (76-78). Inhibitory control may play a role in impeding food-related thoughts and/or appetitive behaviours in the face of situational cues for over-consumption of snack foods (79). The ability to cognitively control emotion may also play a role in overweight and obesity, as negative mood states have been shown to increase food intake (76). For adolescents and children, the cognitive system is not fully mature and is greatly influenced by the type of foods presented to them. For example, energy-dense, palatable food items may be extremely rewarding for adolescents and children and these types of foods place high emotional and/or motivational drives on their cognitive system (80, 81). A study conducted by Riggs and colleagues (76) indicated that "youth with enhanced cognitive inhibitory and emotional control skills are better at inhibiting the rewarding cognitive and emotional characteristics of snack food", and youth with greater working memory capacities can keep up with their healthful goals when presented with challenges of eating healthy.

Not only does palatability influence food choice among children and adults, it is also positively associated with the amount of foods that they consume (82-85). This positive association between palatability and food intake is present in both obese and non-obese males and females (86-88). Blundell's satiety cascade indicates that the pleasantness of foods is involved in the process of meal termination and/or satiation (89). However, the importance of palatability decreases during the course of eating (90). In the long term, satiety and satiation are regulated by various gastrointestinal (GI) hormones that are secreted into the stomach (e.g., ghrelin), the small intestine and colon (e.g., cholecystokinin (CCK), and the glucagon-like peptide 1(GLP-1)) and the pancreas (e.g., insulin).

2.3.2 The Association between Adiposity and Food Intake

It is indicated that the brain responses to satiation is different between obese and non-obese people (91), because adipose tissue itself secrets hormones with profound effects on satiation mechanisms and energy balance. These hormones (e.g., leptin, insulin, adiponectin) decrease an individuals' ability to detect GI satiety peptides such as GLP-1, oxyntomodulin, pancreatic polypeptide, and peptide YY_{3-36} (PYY), which implies that it may take longer before satiety signals are sensed by brain in individuals with excess adiposity (92). Therefore, individuals who are overweight or obese tend to consume foods for a longer period of time before they realize that they are full compared to their leaner counterparts. Moreover, a study conducted by Scharmüller and colleagues (93) indicated that enhanced craving and brain reward systems were associated with increase adiposity. When food cues were present, there was a higher insula activation, an indicator of motivation to eat, in obese participants compared to lean participants. Studies conducted on both obese and lean males and females reported that when attempting to attenuate cravings for food, the obese group showed a stronger activation in dorsolateral prefrontal cortex, an area exerting an inhibitory control on brain activation in response to external and internal stimuli, compared to individuals of normal weight (91, 93).

Gastrointestinal hormones including ghrelin and PYY_{3-36} are responsible for regulating food intake. Ghrelin is a hormone secreted by the stomach that has orexigenic effect and is important in meal initiation (94). Studies confirmed that ghrelin increases after protein intake and decreases after carbohydrate and fat intake in adults (95, 96). This effect was not seen in the study conducted by Misra and colleagues where they compared the changes in levels of active ghrelin and PYY_{3-36}, hunger and subsequent food intake in obese and normal-weight adolescent girls after macronutrient intake (94). In contrast to the finding in adults, obese adolescent girls had higher increase in active ghrelin level after the intake of a high-carbohydrate breakfast and a lower level increase in PYY_{3-36} following the high-fat breakfast compared to normal-weight girls. This is consistent with their finding in subsequent food intake. Following high-fat and high-carbohydrate breakfasts, obese girls had higher food intake compared to normal-weight girls, this effect was not observed after the consumption of a high-protein breakfast (94). Literature indicates that ghrelin secretion is influenced by pubertal stage and total ghrelin level decreases with progression through puberty (97, 98), however sex does not seem to play a role in ghrelin secretion (99, 100). PYY is a peptide secreted by colon mucosa that increases postprandially. PYY inhibits hypothalamic neurons activated by ghrelin and decreases food intake (94). Misra and colleagues found that there was a lower change in PYY_{3-36} level in obese girls after the consumption of a high-fat breakfast compared to normal-weight girls. This was consistent with the finding that subsequent food intake was higher in obese girls indicating a reduced anorexigenic stimulus (94, 101). The results indicated that hormonal regulation of food intake is different in adults compared to children and adolescents as there is tremendous flux in hormonal milieu in early age. Moreover, gastrointestinal hormones affect food intake differently in obese children and adolescents compared to their normal-weight counterparts.

2.4 Role of Pulses in Regulation of Food Intake, Satiety and Blood Glucose

2.4.1 Pulses: Production and Variety

Pulses are part of the legume family, but the term “pulse” refers only to the dried seed (102, 103), which are rich sources of protein, complex carbohydrates, vitamins and minerals and are low in fat (104). Canada is one of the major pulse (particularly beans and lentils) producers and exporters in the world along with India, China, Myanmar and Brazil. 2010 statistics from the United Nation's Food and Agriculture Organization (FAO) indicated that the most widely produced pulses include beans, chickpeas, cowpeas, peas, pigeon peas, and lentils, together accounting for 86% of total pulse output. To date, the three top pulse productions are dry beans (39.3%), chickpeas (15.8%) and peas (8.3%). Canada's core pulse industry situates in Saskatchewan. In 2012, 96% of Canada's lentil crop, 90% of Canada's chickpea crop and 70% of Canada's dry pea crop were produced in Saskatchewan (103).

2.4.2 Nutrient Content of Pulses

Approximately 60% of carbohydrate, including oligosaccharides, dietary fibres and resistant starch, and less than 6% of lipid can be found in pulses (105). Dietary fibre content is especially high compared to that of many other food products. Thus, it is shown that there is 20 g fibre per 100 g of pulses, whereas there is only 12g, 9g and 3g of fibre in 100 g of wheat, soybean and rice, respectively (105). Pulses are also rich in protein with high content of lysine, which is limiting amino acid in grain cereals. Other pulse-derived nutrients include water soluble vitamins, (e.g., vitamin B2, B3, B6 and folate), minerals (e.g., calcium, copper, iron, magnesium, phosphorus, potassium and zinc) as well as antioxidants, polyphenols and other phytochemicals that are essential in human health (106-109). Pulses have low glycemic index, and are a rich source of polyunsaturated fatty acids (110, 111). Studies have shown that pulses have multiple health benefits on human health, such as lowering glycemic index which translates into better glucose control for people with diabetes (4), increasing satiation, reducing the risk of cancer (5), protecting against cardiovascular diseases (6), as well as preventing and relieving constipation in humans due to its high dietary fibre content (7).

Pulses exist in different forms, such as dry, canned, pureed, pulse flour and pulse fractions (112). Moreover, pulses can be prepared by different methods for human consumption. There are many ways to include whole pulses as part of the diet, such as in soup, stew, salad, on pizza, or as snacks. When cooking whole pulses, dry beans and chickpeas need to be soaked, while dry lentils and split peas only need to be rinsed prior to cooking (112). Whole pulses can be cooked in a slow cooker, pressure cooker, oven, or on stove top. Acidic ingredients such as vinegar, should be added when the pulses are already tender due to the fact that acids tend to slow down the cooking process (112). Canned pulses are very popular convenient food products that can be easily incorporated as part of a healthy diet. Canned legumes need to be drained and rinsed thoroughly to remove as much salt and other preservatives as possible before serving. Research has shown that drained beans contain 36% less sodium, and drained and rinsed beans contain 41% less sodium (113). Pulse purees are excellent for making dips, sauces and baked goods (114). Hummus is a common food product derived from legumes, when combined with vegetables such as celery and carrots, they contribute to our daily need for dietary fibres, protein and vitamins and minerals. The use of pureed pulses as the main ingredient in vegan burgers, perogies and lasagna has been increasingly favoured by consumers (114). This is an innovative food item for the general consumers, and it is suitable for individuals who do not consume meat. Pulse flour is widely used in cakes, muffins and cookies to increase fibre and protein. It is especially popular in gluten-free baked products (114). Snacks made with pulses are an excellent on-the-go energy source for both adults and children, such as granola bars made with lentils (115). In the present study, pulses were pureed and added into whole pasta and sauce to assess its effect in satiety, subsequent food intake and subjective appetite in children aged 9 to 14 years.

2.4.3 Effects of Pulses on Blood Glucose

Glycemic regulation is the process by which the levels of blood glucose are maintained by negative feedback in order to keep the body in homeostasis. For optimal health, the human body needs blood glucose to be maintained in a very narrow range through the secretion of pancreatic endocrine hormones: insulin and glucagon. When blood glucose falls to dangerously low levels, the alpha cells of the pancreas start to release glucagon which acts on the liver to convert glycogen into glucose. When the level of blood glucose rises due to the glycogen breakdown or absorption of dietary glucose, insulin is released from beta cells in the pancreas. Insulin stimulates the liver to convert glucose into glycogen and force tissues to take up glucose from the bloodstream through GLUT4 transporter (116). While all dietary carbohydrates contribute to the concentration of blood glucose, they can alter blood glucose and insulin in markedly different ways (116). Jenkins and colleagues proposed a systemic way to classify carbohydrates based on glycemic responses. Glycemic response to a food is determined by the carbohydrate type and by other dietary factors affecting food digestibility, gastrointestinal motility, or insulin secretion (117-122). As discussed above, pulses are classified as having a low glycemic index.

Moreover, high level of dietary fibre present in pulses helps lower glycemic response by delaying gastric emptying by acting as a physical barrier to glucose uptake into the small intestine (123). It has been suggested that dietary fibre does not play a direct role in blood glucose regulation, it is the high level of amylose content in pulses that results in the lower postprandial glucose level. Amylose is a type of starch containing a linear glucan with few branches that is resistant to digestion in the small intestine as compared with cereal, root and tuber starches, most of which are lower in amylose (124, 125). Amylopectin is the other component of starch that is a soluble polysaccharide and highly branched polymer of glucose found in plants. It has been suggested that raw starches high in amylopectin can be digested in rats more quickly than those high in amylose (126, 127). The glucose chains of amylose starch are more closely intact with each other by hydrogen bonds making them less available for amylolytic attack which makes it resistant to digestion, whereas amylopectin is a much larger molecule that has many branched chains of glucose available for breakdown, which results in higher rate of digestibility compared to amylose (128, 129). Pulse starch contains an intermediate level of amylose, there is approximately 30 to 40% amylose and 60-70% amylopectin in their starch granules, where most other foods high in carbohydrates contain 25 to 30% amylose and 70 to 75% amylopectin (130).

Torsdottir and colleagues (131) investigated the different glycemic response after the ingestion of mashed beans and potato flakes meals. The fibre and resistant starch content of the mashed-bean flakes (13.5g of fibre with 3.9 g of resistant starch) was more than 3 times higher than that of the potato flakes (2.8 g of fibre with 0.6 g of resistant starch). It was found that the postprandial responses of blood glucose and serum insulin were lower after the meal with mashed-bean flakes than after the meal with potato flakes. There was a significantly smaller glucose increase after mashed-bean flakes consumption which was 28% of that after potato flakes at 20 min, 34% at 30 min, and 41% at 45 min. Similarly, the increase in insulin after mashed-bean flakes was 43% of that after potatoes at 20 min (131). Authors postulated that due to the higher resistant starch content in mashed-bean flakes, the difference in the starch digestion rate between potato flakes and mashed-bean flakes was the key determinant for the glycemic responses to the meals. The nature of the starch and its entrapment in fibrous thick-walled cells prevent complete swelling during cooking (132). The high amylose content of bean starch, 35%, contributes to such limited swelling and to the low glycemic response (131), but the structural integrity of the cells filled with starch granules seems to play a predominant role (132). It could also be argued that due to the high level of resistant starch available in the mashed-bean flakes, a major proportion of the legume starch might have escaped digestion and absorption in the small intestine and fermented in the large intestine, which is responsible for the low glycemic index (131). Some other studies also found that dietary fibre was not the primary component that predicts postprandial glucose level. According to Nestel and colleagues (133), the higher amylose content and the botanical structure in chickpeas both contribute to lower plasma glucose. Similar to the study by Torsdottir and colleagues (131), 15% of starch in chickpeas escaped from hydrolysis in the small intestine and underwent the fermentation process in the large intestine (133).

Glycemic responses vary depending on different pulse types. Mollard and colleagues (134) investigated the effects of *ad libitum* consumption of different pulses on blood glucose

(BG) level at different time points. Overall, it was found that chickpea, lentil, navy bean and yellow pea treatments (44% of energy derived from each pulse type with pasta and sauce) exert significant lower cumulative BG responses compare to control (pasta and sauce). Besides the treatment effect, the time-by-treatment effect was also present. At 20 min, navy bean treatment resulted in a lower BG responses compared to chickpea treatment. At 60 and 200 min, lentil and navy bean treatments led to a significant reduction of BG response compared to yellow pea treatment and control. At 260 min, only navy bean treatment led to a lower BG concentration compared to chickpea treatment and control. There was no significant effect detected on BG concentration among the treatments after the consumption of pizza, therefore, it was concluded that post-pizza meal BG was only affected by time, but not by treatment. Despite the absence of post-pizza meal effects among the treatments, there was a lower post-pizza meal BG area under the curve (AUC) after the consumption of chickpea treatment compared to that of navy bean and yellow pea treatments (134). The observation of lower BG immediately following the consumption of all pulse treatments was confirmed by the same research team in another study where participants consumed isocaloric treatments (135), however, in this study, they found no significant difference on pre-pizza meal BG AUC among the treatments. They also found that blood glucose after the consumption of the test meal (post-pizza meal BG) was lower after consuming chickpea and lentil treatments compared to yellow pea treatment and control (135). Unlike the study conducted on *ad libitum* treatment consumption (134), this study found that both chickpea and lentil treatments led to a lower BG AUC compared to yellow pea treatment and control.

Both research studies incorporated different kinds of pulses in high GI pasta, which resulted in lower cumulative BG AUC compared to control. Both studies showed that yellow peas were the least effective pulse type in reducing BG response (134, 135). The pulse-containing meals were higher in protein and fibre, and lower in available carbohydrate compared to pasta and sauce, which contributed to the lowering of BG response in participants. Yellow pea treatment did not show this effect mostly due to the fact that yellow peas were the highest in available carbohydrate and lowest in fibre among all pulse types (134). The importance of protein on BG concentration was confirmed by Smith and colleagues (136) that tomato soup with 10 g (P10) and 20 g (P20) added yellow pea protein were able to suppress mean pre-meal BG compared to control (only tomato soup), P20 treatment also exhibited a lowering effect in mean post-meal BG compared to control. A study conducted by Samra and Anderson (137) demonstrated the importance of fibre in BG regulation by showing that a high amount of insoluble fibre served in a breakfast cereal reduced glycemic response to a meal 70 min later. Luhovyy and colleagues (138) found that a decrease in BG AUC of 16% did not change insulin response, which suggested improved insulin sensitivity that may have been due to higher fibre intake. Authors further explained that fibre may slow down the absorption of glucose in small intestine by increasing the viscosity of food bolus (139), and improving the insulin sensitivity through fermentation of fibre in the large intestine and the production of short-chain fatty acids (140, 141). The discrepancy found in the study conducted by Smith and colleagues (136) and those that found fibre was an irrelevant component in predicting both FI and BG AUC could be due to the different doses of fibre used. Smith and colleagues proposed several explanations for the absence of the effect provided by high-fibre treatment. First of all, this study isolated fibre from the hulls of yellow peas, which are very high in fibre. However, the ratio of soluble:insoluble fibre in the hulls and their functional properties are very different from that of whole yellow peas. Dehulling peas reduces the insoluble fibre content of whole peas by 45.8% and the soluble fibre content by 21.0% (142). Since hulls are a byproduct by most processing techniques and yellow peas are consumed dehulled, the fibre treatment in this study may not represent the effects of whole yellow pea consumption. Furthermore, in the study conducted by Samra and Anderson (137), a higher fibre dose (33g) was used as opposed to only 20g in this study. 20 g of added yellow pea fibre was chosen because this is the maximum amount of fibre an individually would normally consume if they ate approximately two servings of whole pulses (136).

Not only does the high fibre content in pulses affect BG regulation, when consumed with a food high in available carbohydrate, the combination of pea protein and hull fibre exerts positive effect on reducing the glycemic response compared to a high glycemic control (143). Calbet and colleagues (144) indicated that the combination of protein ingestion and carbohydrate had a synergistic effect in increasing plasma insulin level, and therefore leads to lower BG concentration after a meal. An explanation was that pea protein consumed with a food high in available carbohydrate led to an accelerated rate of gastric emptying through the release of GI hormones (143, 144), which resulted in a faster release of insulin into the blood. It was also found that the plasma amino acid concentration was the highest around 30 min after a meal and returned to baseline well before 120 min (144). This was consistent with the finding by Smith and colleagues (136) that protein of whole yellow peas fractions lowered glycemic response at 30 min after food consumption and such effect was not present at 120 min.

Aside from testing whole pulses and nutrient isolates from pulses on blood glucose regulation, a study by Anderson and colleagues (145) used pulse powders to investigate if they retain the biological benefits as observed in whole pulses. It was found that there was an effect by time and treatment by time interaction, but not treatment in the pre-meal period. At 15 min, blood glucose decreased significantly after whole navy bean and pureed navy bean meals compared to whole wheat flour (control), while navy bean powder led to an intermediate effect on blood glucose. At 30 min, whole navy bean, pureed navy bean and navy bean powder had a significant lowering effect of blood glucose compared to whole wheat flour. During the post-meal period, there was an effect of time and treatment, but not treatment by time interaction on blood glucose. Whole navy bean was able to lower post-meal blood glucose compared to whole wheat flour, while pureed navy bean and navy bean powder both led to an intermediate effect (145). There was a treatment effect on both pre-meal and post-meal BG AUC. Navy bean powder significantly suppressed pre-meal BG AUC compared to whole wheat flour. During the post-meal period, whole navy bean meal led to a lower BG AUC compared to whole wheat flour, while pureed navy bean and navy bean powder produced intermediate effect. This lowering effect of BG AUC was not present in any of the chickpea meals including whole chickpeas, pureed chickpeas and chickpea flour. In the lentil treatments, whole lentils and lentil powder exerted a lowering effect of pre-meal BG AUC compared to whole wheat flour and there was no such effect seen on the post-meal BG AUC (145). It was evident that the processing of pulses into powders does not eliminate their benefits on blood glucose response. This informs the continued use of pulse powders as part of the diet to augment postprandial glycemic responses.

2.4.4 Effects of Pulses on Food Intake and Satiety Regulation

According to glucostatic theory introduced by Jean Mayer in early 1950s, a rise in the plasma glucose level after a meal is detected by the sensory cells in the hypothalamus, and this led to termination of feeding. Alternately, if there was a decrease in the blood glucose, feeding is initiated (146, 147). Based on this theory, glucose was then thought of as a short-term appetite control factor. In the 1980s, it was discovered that food intake was regulated through the numbers of gastrointestinal hormones including the most potent satiety hormone such as cholecystokinin (CCK). CCK is a gut hormone known to suppress hunger. CCK is secreted by cells of the upper small intestine when food from the stomach reaches the duodenum. CCK acts as a regulator of gastric emptying, and thus augment the rate of digestion and absorption (148). Both insulin and CCK are indicators of gastrointestinal response to different fibre content. In the study done by Bourdon and colleagues (148), gastrointestinal response was investigated by measuring the CCK level after the high fibre bean flake meal with 60 g bean flakes added (providing 11.8 g of dietary fibre, 3.2 g of insoluble fibre), and the low fibre control meal with instant rice and skim milk powder added to balance the protein and carbohydrate of the bean flakes without contributing much additional fibre. It was found that the postprandial incremental CCK response was significantly higher in the bean flake meal compared to the control meal. The CCK remained consistently higher than baseline for 4 hours in participants who consumed bean flake meal, whereas after the control meal, the overall CCK level was not significantly different compared to that of baseline. It was stated that the difference in the response of CCK was not due to the different amounts of fat and protein of the two test meals, the compositional properties of beans contribute to the difference of CCK response. First, there is higher dietary fibre content in beans, and this high dietary fibre content helps slow the digestion of the meal from the stomach and small intestine, this prolongs the period of CCK release. The second contributor to the difference in CCK response is the activity of trypsin inhibitor (TI) in beans, TI is found in most legumes and its function is to stimulate CCK release by binding free trypsin in the gut lumen and this decrease of free trypsin concentrations leads to the release of CCK (149). However, other research has shown that TI is largely destroyed during the heating process. In the study conducted by Kadam and colleagues (150), there was a complete degradation of TI activity observed within 5 minutes when heated at 80°C. The combination of high viscous polysaccharides and high TI activity in beans may augment the CCK response, resulting in the higher CCK level, which indicates a longer time course before the participants feel hungry in the high fibre bean flake meal compared to the low fibre control meal without beans (148). A different perspective on the role of protein in CCK release was proposed by Liddle (151) and colleagues that protein, and not fat or carbohydrates, was the main stimulators of CCK release in rats. In humans, when given high-protein and adequate-protein meals, the CCK responses sustained compared to participants who consumed high-fat and high-carbohydrate and low-protein meals (152). In both lean and obese participants, protein led to a suppression of energy intake mainly mediated by CCK responses (152).

A different perspective on the nutrient that contributes to decreased food intake (FI) was proposed by Smith and colleagues (136). In their research, they conducted two separate experiments on the measurement of food intake at 30 min and 120 min after the consumption of the treatments. They concluded that protein and not fibre, is the primary component in yellow peas that decreased subsequent FI at a meal served at 30 min after the consumption of whole yellow peas. The effects of whole yellow peas on FI beyond 30 min cannot be explained by neither the fibre nor protein content. It was found that there was a significant decrease in pre-meal FI at 30 min after the 20g pea protein treatment compared to 10g pea fibre, 20g pea fibre, 10g pea protein treatments, and tomato soup. The cumulative FI including the consumption of both treatment and pizza meal, was significantly lower after 20g pea protein treatment compared to 10g pea fibre treatment, while all other treatments led to intermediate cumulative FI. The second experiment found that there was no significant difference in post-meal FI at 120 min among all the treatments (136).

Research has shown that pulse-containing meals have an effect on satiety and satiation both within and at a later meal (134, 135, 153), however, such effect varies based on different pulse types (134, 135, 154). In the study conducted by Mollard and colleagues (135), it was found that healthy male participants who received lentil and yellow pea treatments at a fixed amount of 250 kcal, and with macaroni and tomato sauce reduced appetite ratings during the pre-pizza meal period, as well as FI at the pizza meal compared to control (macaroni and cheese). Chickpea treatment did not exert a significant effects on lowering appetite ratings or subsequent FI (135). Another study confirmed the effects of a fix-size lentil treatment on reducing appetite compared to white bread (153). However, the finding on the appetite ratings of these two research projects was not supported when participants receive *ad libitum* treatment meals (134). It was found that there was no effect of treatment on the cumulative, pre-pizza meal or post-pizza meal appetite ratings when participants received *ad libitum* treatments. Within the treatment meal, it was found that healthy male participants who received lentil treatment (containing pasta and tomato sauce and 44% of energy from lentils) had significantly lower *ad libitum* FI compared to participants who receive chickpeas treatment, yellow pea treatment and control, which contained pasta and tomato sauce and 44% of energy from chickpeas, pasta and tomato sauce and 44% of energy from yellow peas and only pasta and tomato sauce, respectively. The navy beans treatment (containing pasta and tomato sauce with 44% of energy from navy beans) only exhibits a significant lower FI compared to chickpea treatment. Even though there was no significant difference in FI among the treatments at the pizza meal which was provided 4 hours after the *ad libitum* treatment meals, lentil treatment reduced cumulative FI compared to control. Overall, lentils had the strongest satiating properties compared to other types of pulses such as chickpeas, navy beans and yellow peas (134, 135, 153).

A systemic review and meta-analysis found that whole dietary pulses had an effect on acute satiety, but not on second meal food intake (155). This meta-analysis excluded those studies that used protein or fibre isolates, or contained confounding variables that may contribute to fibre content such as whole grains as well as non-human trials. Studies selected for the meta-analysis were isocaloric including both healthy men and women. In the nine trials included in the meta-analysis, it was found that a dietary pulse meal led to a 31% greater satiety incremental area under the curve compare to an isocaloric non-pulse meal. However, the pulse meals had no significant effect on second meal food intake (155). There are several explanations for the lack of effects of pulse meals on subsequent food intake. First, two of the studies used varied buffets for the second meal, this is not representative of a typical meal and may promote certain individuals to have higher food consumption resulting in a higher variability in food intake (156, 157). Moreover, the timing at which second meal was consumed also contributed to the lack of effect on second meal food intake. To best represent realistic mealtimes, it was suggested that second test meal should be consumed around 3-6 hours after the treatment meal. However, only two studies that provided second meal over 3 hours after the treatment meal showed significant food intake reduction (155).

2.5 Pulses in Adults' and Children's Diet

In 1996, the average consumption of pulses (also referred as grain legumes) in the world was 6.36 kg per person, made up of 2.51 kg of dry beans, 0.61 kg of peas and 3.26 kg of others. It was estimated that pulse consumption in the Western world is less than 3.5kg/capita per year, whereas approximately 10 kg/capita of pulse consumption was reported in South America and India and 40kg/capita was reported in Burundi (158, 159).

Human consumption of grain legumes in European countries is relatively low. According to FAO data (1996), in central, northern and western continental Europe, the consumption of grain legumes averaged 2.37 kg per person, with a range of 0.2-9.3 kg depending on the country. In many regions of the world, including Mediterranean countries, the Middle East, North America and East Africa, the consumption of grain legumes is three to four times higher (ranging from 7.0 to 10.9 kg per person (160). The consumption of grain legumes has been decreasing in Europe for several decades. It was shown that the consumption of legumes is not associated with economic factors, such as family income. According to household budget surveys in the Czech Republic, consumption between low income families with small children was not statistically different compared to that of middle income families (160).

A completely opposite phenomenon was observed in South America. In Venezuela, there is an apparent positive relationship between social status and consumption of beans, ranging from an average of 70 g daily among the economically disadvantaged population to approximately 50 g among the more affluent population (161). Consumption of both dried and fresh legumes, mostly lima beans, faba beans and cow peas, is relatively high in Ecuador. A range between 3 and 42 g daily of dry legumes consumption was reported in one survey, coupled with this were consumptions of up to 140 g daily per head of fresh legumes in areas of high dry pulse consumption (161). Season is a big factor that determines the amount of pulse consumption due to its availability in some countries in South America, such as Peru. It was reported that on average a person consumes 20 g of legumes in February, whereas approximately 70 g of legumes would be consumed in July. It is also indicated that increased availability of fish is associated with decreased consumption of legumes, this implies that fish is chosen over legumes as a protein source (161).

In North America, inadequate consumption of pulses is also an issue. According to the advisory committee on the Dietary Guidelines for Americans in 2010, it was recommended that all Americans should include cooked dry beans and peas as part of their diet. Along with this recommendation, the US Department of Agriculture also encouraged Americans to consume 2.5 to 3.5 cups of pulses per week (162, 163). Similar to other countries, data from the US National Health and Nutrition Examination Survey (NHANES) 1999-2000 showed that only one third or less than the recommended servings of pulses was consumed by Americans, this rounds to less than one cup per week (164). In Canada, the most current Survey of Household Spending (SHS) 2012 demonstrated that the average household food expenditure in 2012 is $7,739, while a household only spent $4 on peas (bottled or canned) and $6 on beans (bottled or canned) on average annually (165). Under the category “dried vegetables and legumes”, on average, Canadian households spent $7 annually. According to Canada’s Food Guide, it is recommended that children and adults consume 1-2 servings and 2-3 servings of meat and alternatives ever day, respectively. One serving of cooked legumes, which is a meat alternative, is 175 ml or ¾ cup (166). Canadians do not meet the recommended servings based on their average annual expenditure on legumes (165). Based on the analysis of the CCHS 2.2 in 2004, only 13.1% of Canadian adults consumed dry beans, peas or lentils on any given day. New Brunswick was the province that had the highest average pulse intake while Quebec had the lowest average pulse intake. In Ontario and British Columbia, there is the highest proportion of pulse consumers as residents. The age group of 51-70 years accounts for the highest proportion of pulse consumers. Within Canada, the level of pulse consumption differs between different ethnic groups. Asian Canadians were 3.6 times more likely to be pulse consumers compared to Caucasians, while participants who identified themselves as being Arabic, Latin and African Canadians or of multiple cultural origins were 1.6 times more likely to be pulse consumers than Caucasians (167).

The consumption of pulses in children has not been extensively studied. It was reported in a Namibian study that along with vegetables and fruits, the consumption of legumes was very low among children aged 8 to 15 years living both in small town and rural areas (168). It was also reported that the only type of pulses that they consume were canned beans. Similar situation was present in Asian countries. According to Arlappa and colleagues (169), the intake of pulses were less than recommended daily intake (RDI) in 73% of households, and the proportion of households consuming less than even 50% of RDI was 46% in India. This finding was alarming as legumes are considered staples in Southeast Asia, especially South India (170).

Pulses play an important role in people's diet due to their rich content of protein, dietary fibre, unsaturated fats, vitamins and minerals. To ensure nutritional adequacy among the snack consuming population, such as children, who are more vulnerable to nutritional deficiencies, it has been recommended to provide blends of legumes and other ingredients, such as grains, because of their low cost and high nutritional quality. A study conducted by Granito and colleagues (171) assessed the nutritional value and sensory evaluation of cakes, brownies and cookies partially made with fermented and non-fermented legumes. Cakes were formulated substituting 20% of wheat flour with *Phaseolus vulgaris* flour, brownies with 30% of Cajanus cajan flour and cookies with 30% of *Vigna sinensis* flour. On a hedonic scale of 7 points, values higher than 5 in the attributes taste, colour and overall quality were obtained for all three products. The preference was assessed with a group of 90 school children, results were in congruence with the sensory evaluation. The protein contents were higher than those made with wheat flour alone, it was found that the protein contents were between 12 and 13% for the cake, 10 and 11% for the brownies and 10% for the cookies (171). Having enough protein and acceptable sensory qualities are essential in snacks marketed towards children.

The consumption pattern and health effects of pulses in adults have been reported in the literature, however, the consumption of pulses in children and its related effect of pulses on the regulation of food intake and satiety have not been extensively studied. In the present study, the role of two main Canadian pulse crops, yellow pea and navy beans, pureed and added to a mixed meal were studied on their ability to affect subjective appetite, short-term food intake and physical comfort in children.

Chapter 3: Rationale, Hypothesis and Objectives

3.1 Rationale

Pulses are high in dietary fibre and protein, and low in fat and sugar. They are also rich in minerals and vitamins, and contain antioxidants, polyphenols and phytochemicals (106-109). Children and adolescents tend to choose food products that are dense in energy and low in nutrient for convenience and palatability (57, 59). This eating behaviour contributes to increased energy intake. At present, pulses are under-consumed by children. Therefore, it is important to introduce pulses into children's diet. This study is aimed to examine if there is a causal relationship between pulse consumption and short-term food intake and appetite in children aged 9 to 14 years.

3.2 Hypothesis

Pureed pulses (beans and peas) added to a meal will be well tolerated, have acceptable palatability, increase satiety and decrease subsequent food intake in 9 to 14 year old children compared to a pulse-free meal of the same energy content.

3.3 Main Objective

To evaluate the effect of pulses on a subjective appetite and subsequent food intake two hours later in children.

Secondary objectives:

1. To determine children's gastrointestinal comfort (e.g., nausea, stomach discomfort and diarrhea) within two hours after pulse consumption;
2. To determine the palatability (e.g., pleasantness) and sensory properties (e.g., sweetness, flavor and texture) of meals formulated with pulses.

Chapter 4: Materials and Methods

4.1 Research Design

The study employed a within-subjects randomized single-blinded controlled cross-over design to examine the effects of pureed beans and peas added to a mixed meal on food intake and satiety in children aged 9 to 14 years. On each session day, participants received one of the three treatments that had been matched for calories (isocaloric), volume (isovolumetric), colour and flavour: 1) pasta with tomato sauce; 2) yellow peas added to pasta with tomato sauce; and 3) navy beans added to pasta with tomato sauce. Treatments were assigned to participants randomly in order to avoid the order effects. An *ad libitum* pizza lunch was provided 120 min after the treatment. Average appetite and physical comfort were assessed at different time points throughout the study session using Visual Analogue Scale (VAS). Sensory properties of the treatments and the pleasantness of the treatments and pizza lunch were also assessed.

4.2 Inclusion and Exclusion Criteria

Twenty five children (including both boys and girls) aged 9 to 14 years were recruited for the study. Children were excluded from the study if they had sensitivities or intolerances to any ingredients of the foods that were provided in the course of the study including breakfast, treatments and test meals, or were unable to tolerate any of the foods. Children who were not born at term (≥37 and ≤42 weeks), or did not consume breakfast regularly were excluded. Children who were taking medications or had any health conditions which may affect their appetite and food intake, and those with behavioural, emotional or learning difficulties were excluded from the study.

4.3 Recruitment

Participants were recruited through advertisements (**Appendix 1)** posted at Mount Saint Vincent University, Dalhousie University and Saint Mary's University, local community centers, libraries and shopping malls, through the MSVU Appetite Lab database and by word of mouth. Recruitment cards **(Appendix 2)** were distributed to children and parents in occasions in which they may be present.

Parents who initiated contact with our research group by phone or email completed the Telephone Screening Questionnaire (**Appendix 3**) to determine the children's eligibility to participate in this study. If children met the requirements, they were invited to the Appetite Lab at MSVU for an in-person screening. During the in-person screening, a copy of parents recruitment letter (**Appendix 4a)** was provided to the parents and the details of the research study were explained to the parents and children in plain language and all questions and concerns were addressed. Parents' written consent **(Appendix 4b)** and children's written assent (**Appendix 4c)** to participate in this research study were obtained. Personal information provided during the first stage of the screening process were reviewed and validated (i.e., body weight and height). Anthropometric measures were obtained: height in meters using a stadiometer, weight in kilograms, and body composition by non-invasive tetrapolar bioelectrical impedance analysis (Tanita Body Composition Analyzer TBF 300A, Tanita Corporation, Tokyo, Japan). Participants and parents were informed that a small undetectable electrical impulse would be sent through the body by the Tanita Body Composition Analyzer in order to measure children's body composition. A self-administered Puberty Questionnaire **(Appendix 5a)** and Tanner’s Staging **(Appendix 5b)**(172) were distributed to male participants; the Puberty Questionnaire **(Appendix 5a)**, Tanner’s Staging **(Appendix 5b)** and Menstrual Cycle Questionnaire **(Appendix 5c)** were distributed to female participants to measure the stage of their pubertal growth because energy intake regulation varies based on different pubertal stages (173). Children had the freedom to complete the questionnaires independently or with the assistance of their parents when they answer questions related to pubertal growth. Participants also completed a Physical Activity Questionnaire **(Appendix 6).**

The Dutch Eating Habits Questionnaire **(Appendix 7)** provides a useful measure of possible dietary restraints and overeating tendencies in children (174). Questions in this questionnaire were designed to assess whether participants demonstrate a high level of restrained (7 questions), emotional (7 questions) and external eating behaviours (6 questions) (174). This questionnaire was composed of 20 questions with answers "Yes", "Sometimes" and "No", and was administered to children during the screening session. Participants were instructed to pick the answer that best described their eating habits.

4.4 Dietary Treatments

Dried navy beans and hulled split yellow peas, durum wheat pasta (Cateli Alphabets, Ronzoni Foods Canada, Montreal, PQ), strained tomatoes (Loblaws Inc, Bella Tavola^{TM}, Toronto, ON) and seasoning (Club House Parmesan and Herbs, McCormick Canada, London, ON) were purchased at Atlantic Superstore (Loblaws Inc, Toronto, ON). Pulse Canada Guide (http://www.pulsecanada.com/food-health/how-to-cook-pulses) was followed to prepare dried beans and peas. Cooked pasta with tomato sauce and seasoning were used as a base for all three dietary treatments to have the same visual appearance and flavour. A stick mixer was used to puree cooked navy beans (NB), yellow peas (YP) or pasta (C, Control). The proximate analysis of cooked pulses and pasta was performed by Maxxam Analytics (Mississauga, ON), the ISO 17025 laboratory accredited by the Standards Council of Canada. The composition of the treatments is shown in **Tables 4.1.** For the pulse treatments, 79.6 g of navy beans and 70.7 g of yellow peas were added to 331.6 g and 322.6 g of treatments, respectively. The added beans or peas accounted for 108.3 kcal or 44% of 250 kcal of the treatment meal. Navy Beans and Yellow peas were soaked for 12 hours and were cooked according to the instructions on the packages. They were drained and measured using a 250ml graduated cylinder. The measurements were repeated three times and an average was obtained. 79.6 g of navy beans was equal to 112 ml and 70.7 g yellow pea was equal to 92 ml.

Table 4.1 Nutritional Composition of Dietary Treatments (per 250 kcal)

Treatments	CON[1]	YP[1]	NB[1]
Weight, g	394.3	322.6	331.6
Protein, g	10.4	12.7	13.0
Fat, g	0.8	0.9	0.8
Carbohydrate, g	49.8	47.6	47.4
Fibre, g	5.4	11.6	15.0
Energy (kcal)	250.0	250.0	250.0

[1]CON, regular pasta and pasta sauce; YP, pureed yellow peas with regular pasta and pasta sauce; NB, pureed navy beans with regular pasta and pasta sauce

4.5 Measurements

4.5.1 Subjective Appetite

Visual Analogue Scale (VAS) is a psychometric tool for converting subjective sensations into a quantifiable objective measure and were used to assess children's subjective appetite throughout the session. This includes motivation to eat, physical comfort, pleasantness, sweetness, flavour and texture of the treatments and the test meal (175). VAS is a quick and easy way of measuring subjective variables, and it does not require the participants to provide their own descriptive terms. Moreover, it is presented in a standardized format and can be compared under a variety of different experimental variables. The VAS is best used in a within-subject, repeated-measures design because it allows the comparison of different treatments under similar conditions (176). The VAS takes the form of a 100mm-long straight line with two extreme states anchored at either end. The VAS was administered to children at 0, 15, 30, 45, 60, 90, 120 and 150 min **(Appendices 9, 10, 11, 12).** Participants were instructed to mark an "X" that intersected the 100 gradated scale that best describes their sensation at the moment. The line was measured in millimetres from the left end of the line to the intersection of the "X", and this was the individual score that best reflected their present feelings (137).

VAS for subjective appetite assessed the following components: desire to eat (DTE), hunger (H), fullness (F), and prospective food consumption (PFC) **(Appendix 9).**

The average appetite score was calculated as (177):

Average Appetite Score= [DTE +H + (100-F) +PFC]/4

4.5.2 Gastrointestinal Comfort

The following components of physical comfort were investigated. Subjective feeling of nausea (N), stomach discomfort (SD), wellness (W), flatulence (F), and diarrhea (D) **(Appendix 10).**

The average physical comfort was calculated as:

Average Physical Comfort= [(100-N) + (100-SD) + W + (100-F) + (100-D)]/5

4.5.3 Sensory Characteristics of the Treatments

The sensory characteristics of the treatment included pleasantness **(Appendix 11)** and sweetness measure with VAS **(Appendix 11d),** taste with Peryam & Kroll hedonic scale **(Appendix 11a)**, and mouthfeel **(Appendix 11b)** and flavour **(Appendix 11c)** with 5-point hedonic scale.

4.6 Study Protocol

The experiment was conducted in the Department of Applied Human Nutrition, Mount

Saint Vincent University. There was one screening session and three experimental sessions conducted one week apart for a total of four visits. Children were provided with the standardized breakfast of 310 kcal (milk, orange juice and cheerios) at the in-person screening session. On an experimental session day, children arrived at the lab after a 12-hour overnight fast (i.e., 7pm-7am) two hours after consuming a standardized breakfast. Upon arrival, baseline measures, i.e., Recent Food Intake and Activity Questionnaire **(Appendix 8)**, Motivation to Eat **(Appendix 9)** and Physical Comfort **(Appendix 10)** were recorded. Children were given approximately 15 minutes to consume their treatment meal and the palatability **(Appendix 11)**, taste **(Appendix 11a)**, mouthfeel **(Appendix 11b)**, flavour **(Appendix 11c)** and sweetness **(Appendix 11d)** of the treatment meal were assessed immediately after the consumption. All treatments were provided to children in a random order so the experiment was counterbalanced. The average appetite and physical comfort were measured at 0, 15, 30, 45, 60, 90, 120 and 150 min. Deep n' Delicious pizza was used as a test meal to assess children's subsequent food intake 120 minutes following the treatment. The pleasantness of pizza **(Appendix 12)** was also assessed.

On a study session day, participants arrived after the consumption of the standardized breakfast. A standardized breakfast included 29 g of Honey Nut Cheerios, 236 ml of Tropicana 100% Pure Natural Florida Orange Juice, and 250 ml of Baxter Fat Free Skim Milk. Upon arrival, dietary treatments were provided to participants in random order. The dietary treatments were equal in calories (250 kcal) but differed in weight **(Table 4.1)**. Water was adjusted to make up for any weight difference and was provided along with the treatment. Treatments were prepared the night before the study session with pasta (Alphabets) made from durum wheat and tomato sauce from strained tomatoes, beans and peas. Both the water and treatment were weighed prior to the participants' arrival on a session day. The amount of these treatments was: 1) 331.6 g/250 kcal pureed navy beans with regular pasta and 231 g of water; 2) 322.6 g/250 kcal pureed yellow peas with regular pasta and 240 g of water; and 3) 394.3 g/250 kcal regular pasta and 170 g of water. The treatments were heated in a microwave under high power for 1 minute and 40 seconds before serving. Participants were instructed to finish the pasta and water at a normal pace before they proceeded to the next step of the study session.

4.7 Food Intake

McCain Deep 'N Delicious Mini Pizza (McCain Foods Limited, CA) was used as test lunch meal to measure food intake two hours after the consumption of the treatment meal. Two choices (Pepperoni and Three-cheese) were available to children at the screening session, they were advised to choose one type for three study sessions. This type of pizza was selected due to the lack of crust and its uniform energy content and macronutrients composition. Another important consideration is that children are familiar with the taste and texture of pizza. One bottle of Nestlé Pure Life® Natural Spring Water was served with pizza and more were provided if requested. Pizza was cooked at 400°C for 10 minutes in a conventional oven and was sliced into four pieces. The first tray of pizza was served 120 min into the study session. Participants were instructed to eat and drink until they were comfortably full. Ten minutes was allotted for participants to consume each tray of pizza. Any leftover pizza and water were weighed and recorded after the participant has finished his or her consumption. The amount of pizza consumed in grams was converted into energy (kcal) according to the nutrition fact table provided by the manufacturer.

4.8 Participants

Sex, age and weight status were used as covariates in order to investigate if there was an effect of any covariate on the main outcome (food intake). The present study included both children and adolescents, it was of interest to examine if there was a difference in food intake between younger and older participants. Therefore if there was an effect of age on food intake, the participants were divided into two categories for data analysis, participants were separated into the younger group ranged from 9.8y – 12.6y (n=12), and older group ranged from 12.7y – 14.8 y (n=13). Similarly, if there was an effect of sex on food intake, the results were analysed separately for boys (n=10) and girls (n=15). There were four types of weight statuses determined by the participants' body mass index (BMI), if there was a difference in food intake in terms of weight statuses, participants were separated into the lighter-to-normal weight group (including underweight and normal weight) (n=20) and the heavier group (including overweight and obesity) (n=5) for analysis. According to Patel and colleagues (173), physical maturity had an influence on food intake as evidenced by the finding that post-menarcheal girls tended to self-regulate food intake due to their concern with body image. In the present study, girls were separated into two groups, the pre-menarcheal group (n=10) and the post-menarcheal group (n=5) to assess if puberty had an effect on food intake. For easy comparison, boys were separated into two groups based on their Tanner’s stage. The first group included Tanner’s stages 1 and 2 (n=5), and the second group included Tanner’s stages 3 and 4 (n=5).

4.9 Data Analysis

Statistical Analysis Systems (SAS) version 9.2 (SAS Institute Inc., Cary, NC, USA) was used for all data analyses. The results were reported as mean ± 95% CI (95% confidence interval of the mean). All ANOVAs included session as a repeated measure to control for within-subject variability. Two-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, menarcheal stage (for girls) and Tanner's stage (for boys) on food intake was also analyzed using a two-way repeated measures ANOVA. Tukey-Kramer post-hoc test was used to describe mean differences among treatments. The statistical significance was set at $P<0.05$. Correlation analyses among treatments and outcome measures were conducted using Pearson correlation coefficients.

Chapter 5: Results

5.1 Subject Baseline Characteristics

Thirty subjects were recruited and twenty five (10 boys and 15 girls) completed the study **(Table 5.2)**. The average BMI percentile was 46.4 ± 12.9 (normal weight) **(Table 5.1).** Seventeen subjects were between the 5th and 85th (normal weight), three were less than the 5th (underweight), two were between the 85th and 95th (overweight), and three were equal to or greater than the 95th (obese) age- and sex- specific BMI percentiles. On average, participants rated their likelihood of restrained, emotional and external eating behaviours as between "no" and "sometimes". This indicated that they did not display any restrained eating behaviours. All baseline characteristics of the participants are listed in **Table 5.1**.

Table 5.1 Subject Baseline Characteristics

Subject Characteristics	Mean (n=25) (10 boys and 15 girls)
Age (years)	12.4 ± 0.6
BW[1] (kg)	44.6 ± 5.9
Height (m)	1.5 ± 0.05
BMI[2] (kg/m^2)	18.8 ± 1.6
BMI %ile (CDC)	46.4 ± 12.9
FM[3] (kg)	9.0 ± 3.3
FFM[4] (kg)	35.5 ± 3.1
TBW[5] (kg)	26.0 ± 2.3
Restrained Eating Score	1.3 ± 0.1
Emotional Eating Score	1.1 ± 0.1
External Eating Score	1.9 ± 0.2
Average DEBQ[6]	1.4 ± 0.1

Data are means ± 95% CI, n= 25. [1]BW, body weight; [2]BMI, body mass index; [3]FM, fat mass; [4]FFM, fat-free mass; [5]TBW, total body water; [6]DEBQ, Dutch Eating Behaviour Questionnaire.

5.2 Ad libitum Food and Water Intake

5.2.1 Food and Water Intake

There was no effect of a treatment on energy (P=0.4) and weight (P=0.4) intake with a pizza meal **(Table 5.3) (Figure 5.1A&B).** There was no treatment effect on the water intake (P=0.4) during the pizza meal **(Table 5.3) (Figure 5.3A).**

There was an effect of age on energy **(Table 5.4)** and weight intake **(Table 5.4)** with pizza meal. It was found that younger children (9.8y-12.6y) had a significantly lower energy (P=0.002) and weight intake (P=0.001) compared to older children (12.7y-14.8y). There was no effect of age on water intake (P=0.07) **(Table 5.4)**.

There was an effect of weight status on energy **(Table 5.6)** and weight intake **(Table 5.6)** with pizza meal. It was found that the lighter-to-normal weight group (including underweight and normal weight) had a significantly lower energy (P=0.004) and weight intake (P=0.007) compared to the heavier group (including overweight and obese). There was no effect of weight status on water intake (P=0.7) **(Table 5.6)**.

There was a session effect of energy and weight intake with a pizza meal with a higher consumption of pizza during the first study session compared to the second session in terms of both energy (P=0.02) and weight (P=0.02). There was no significant effect of session on food intake between the second and third or the first and third session **(Table 5.7)**.

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

5.2.2 Cumulative Food and Water Intake

Both pulse treatments including navy bean (P=0.01) and yellow pea (P=0.001) treatments led to a lower cumulative solid food intake compared to the control **(Table 5.3) (Figure 5.2A).** There was no significant difference on cumulative solid food intake between navy bean and yellow pea treatments (P=0.7). The amount of water provided at the treatment meal was adjusted in order to equalize the weight of the treatment meal. When combining the weight of water provided at the treatment and the cumulative solid food intake, there was no effect of treatment on weight intake (P=0.4) **(Table 5.3) (Figure 5.2B)**.

It was found that there was an effect of treatment on cumulative water intake (P=0.001). Both pulse treatments including navy bean (P=0.001) and yellow pea (P=0.004) treatments led to a higher cumulative water intake compared to the control **(Figure 5.3B)**. There was no significant difference on cumulative water intake between navy bean and yellow pea treatments (P=0.9).

There was an effect of age on the energy **(Table 5.4)** and weight intake **(Table 5.4)** of solid cumulative food intake. There was an effect of age on the combined weight intake that included the treatment and pizza meal as well as the water provided at the treatment **(Table 5.4)**. It was found that younger children (9.8y-12.6y) had a significantly lower cumulative energy (P=0.002) and weight (P=0.001) intake compared to older children (12.7y-14.8y) **(Table 5.4)**. There was an effect of treatment (P=0.03) on solid cumulative food intake in weight in the older age group. The post hoc test revealed the control treatment led to a higher solid cumulative food intake in weight compared to both the navy bean (P=0.04) and yellow pea (P=0.05) treatments. There was no significant difference between navy bean and yellow pea treatments (P=0.6) in solid cumulative food intake **(Table 5.4)** in the older age group. There was no effect of age on cumulative water intake (P=0.07) **(Table 5.4)**.

There was no effect of sex on solid cumulative food intake in weight. However, it was found that there was a treatment effect (P=0.05) on solid cumulative food intake in weight among girls. The control treatment led to a higher solid cumulative food intake compared to the yellow pea treatment (P=0.04) in terms of weight. There was no significant difference between control and navy bean (P=0.1) or navy bean and yellow pea (P=0.3) treatments in solid cumulative food intake in girls **(Table 5.5).** There was no effect of sex on cumulative water intake (P=0.9) **(Table 5.5)**.

There was an effect of weight status on energy **(Table 5.6)** and weight intake **(Table 5.6)** of solid cumulative food intake. There was an effect of weight status on the combined weight intake that included the treatment and pizza meal as well as the water provided at the treatment **(Table 5.6)**. It was found that the lighter-to-normal weight group (including underweight and normal weight) had a significantly lower cumulative energy (P=0.004) and weight intake (P=0.007) compared to the heavier group (including overweight and obese). In the lighter-to-normal weight group, there was an effect of treatment on solid cumulative food intake in weight (P=0.003). The post hoc test revealed that the control treatment led to a higher solid cumulative food intake compared to both navy bean (P=0.003) and yellow pea (P=0.05) treatments in terms of weight. There was no significant difference between navy bean and yellow pea treatments

(P=0.9) in solid cumulative food intake in the lighter-to-normal weight group. There was no effect of weight status on cumulative water intake (P=0.7) **(Table 5.6)**. However, in the lighter-to-normal weight group, there was an effect of treatment on cumulative water intake (P=0.002). It was found that that the control treatment led to a lower cumulative water intake compared to both navy bean (P=0.002) and yellow pea (P=0.007) treatments. There was no significant difference between navy bean and yellow pea treatments (P=0.9) in cumulative water intake in the lighter-to-normal weight group **(Table 5.6)**.

There was no interaction between treatment and session, treatment and age, treatment and sex or treatment and weight status on cumulative energy, weight and water intake.

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

Age	Number of Participants
Younger (9.8y-12.6y)	12
Older (12.7y-14.8y)	13

(A)

Sex	Number of Participants
Boys	10
Girls	15

(B)

Weight Status	Number of Participants
Lighter-to-Normal Weight	20
Heavier	5

(C)

Table 5.3 Energy and Weight of Food Intake and Water Intake

	Pizza Meal			Cumulative			
Treatment	Energy (kcal)	Weight (g)	Water Volume (ml)	Energy (kcal)	Weight (solid) (g)	Weight (solid + water at the treatment) (g)	Water Volume (ml)
CON	835.7 ± 154.5	391.9 ± 68.8	187.8 ± 55.5	1085.7 ± 154.5	786.20 ± 68.8 [1]	956.2 ± 68.8	357.8 ± 55.5 [1]
NB	866.0 ± 174.1	406.8 ± 78.2	181.3 ± 57.2	1116.0 ± 174.1	740.1 ± 78.2 [1]	971.1 ± 78.2	412.3 ± 57.2 [1]
YP	870.5 ± 147.9	409.0 ± 67.0	176.0 ± 72.4	1120.51 ± 147.9	733.75 ± 67.0 [1]	973.8 ± 67.0	416.032 ± 72.4 [1]
P(treatment)	0.4	0.4	0.3	0.4	0.001	0.4	0.001

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect (P<0.05) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9] treatment × weight status interaction

Table 5.4 Food and Water Intake categorized by Age

		Treatments				
	Age Category	CON	NB	YP	P value (treatment)	P value (age)
Food Intake (kcal)	Younger (n=12)	624.5 ± 111.5 [4]	619.5 ± 166.7 [4]	662.2 ± 133.7 [4]	1.0	0.002
	Older (n=13)	1030.7 ± 246.5 [4]	1093.5 ± 253.4 [4]	1062.8 ± 220.1 [4]	0.3	
Food Intake (g)	Younger (n=12)	294.2 ± 50.9 [4]	291.2 ± 74.3 [4]	313.0 ± 64.2 [4]	0.9	0.001
	Older (n=13)	482.1 ± 106.8 [4]	513.6 ± 110.7 [4]	497.7 ± 96.6 [4]	0.2	
Cumulative Food Intake (kcal)	Younger (n=12)	874.5 ± 111.5 [4]	869.5 ± 166.7 [4]	912.2 ± 133.6 [4]	1.0	0.002
	Older (n=13)	1280.7 ± 246.5 [4]	1343.5 ± 253.4 [4]	1312.8 ± 220.1 [4]	0.3	
Cumulative Food Intake-solid only (g)	Younger (n=12)	688.5 ± 50.9 [1,4]	624.5 ± 74.3 [1,4]	637.7 ± 64.2 [1,4]	0.2	0.001
	Older (n=13)	876.4 ± 106.9 [1,4]	846.9 ± 110.7 [1,4]	822.4 ± 96.6 [1,4]	0.03	
Cumulative Food Intake-solid and water at treatment (g)	Younger (n=12)	858.5 ± 50.9 [4]	855.5 ± 74.3 [4]	877.7 ± 64.2 [4]	0.9	0.001
	Older	1046.4	1077.9	1062.4		

	(n=13)	± 106.8 [4]	± 110.7 [4]	± 96.6 [4]	0.2	
Water Intake (g)	Younger (n=12)	144.8 ± 87.9	158.0 ± 64.2	118.5 ± 92.1	0.2	0.07
	Older (n=13)	227.5 ± 74.2	202.7 ± 101.1	229.2 ± 114.4	0.6	
Cumulative Water Intake (g)	Younger (n=12)	314.8 ± 87.9 [1]	389.0 ± 64.3 [1]	358.5 ± 92.1 [1]	0.1	0.07
	Older (n=13)	397.5 ± 74.2 [1]	433.7 ± 101.1 [1]	469.2 ± 114.4 [1]	0.1	

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect ($P<0.05$) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9] treatment × weight status interaction

Table 5.5 Food and Water Intake categorized by Sex

		Treatments				
	Sex	CON	NB	YP	P value (treatment)	P value (sex)
Food Intake (kcal)	Boys (n=10)	872.9 ± 186.6	888.7 ± 230.9	948.5 ± 199.4	0.4	0.6
	Girls (n=15)	810.9 ± 244.5	850.9 ± 269.7	818.5 ± 222.8	0.1	
Food Intake (g)	Boys (n=10)	413.0 ± 85.1	421.7 ± 106.5	449.1 ± 93.5	0.4	0.5
	Girls (n=15)	377.8 ± 107.9	396.9 ± 120.1	382.3 ± 99.5	0.1	
Cumulative Food Intake (kcal)	Boys (n=10)	1122.9 ± 186.6	1138.7 ± 231.1	1198.4 ± 201.5	0.4	0.8
	Girls (n=15)	1060.9 ± 244.5	1100.9 ± 269.7	1068.5 ± 222.8	0.1	
Cumulative Food Intake-solid only (g)	Boys (n=10)	807.3 ± 85.1 [1]	755.0 ± 106.5 [1]	773.8 ± 93.5 [1]	0.2	0.5
	Girls (n=15)	772.1 ± 107.9 [1]	730.2 ± 120.1 [1]	707.0 ± 99.5 [1]	0.05	
Cumulative Food Intake-solid and water at treatment (g)	Boys (n=10)	977.3 ± 85.1	986.0 ± 106.5	1013.8 ± 93.5	0.4	0.6
	Girls	942.1	961.2	947.0		

	(n=15)	± 107.9	± 120.1	± 99.5	0.1	
Water Intake (g)	Boys (n=10)	195.6 ± 111.7	191.9 ± 92.6	190.9 ± 137.3	0.9	0.9
	Girls (n=15)	182.6 ± 68.4	174.2 ± 82.2	166.1 ± 93.9	0.9	
Cumulative Water Intake (g)	Boys (n=10)	365.6 ± 111.7 [1]	422.9 ± 92.6 [1]	430.9 ± 137.3 [1]	0.5	0.9
	Girls (n=15)	352.6 ± 68.4 [1]	405.2 ± 82.2 [1]	406.1 ± 93.9 [1]	0.1	

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect ($P<0.05$) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9] treatment × weight status interaction

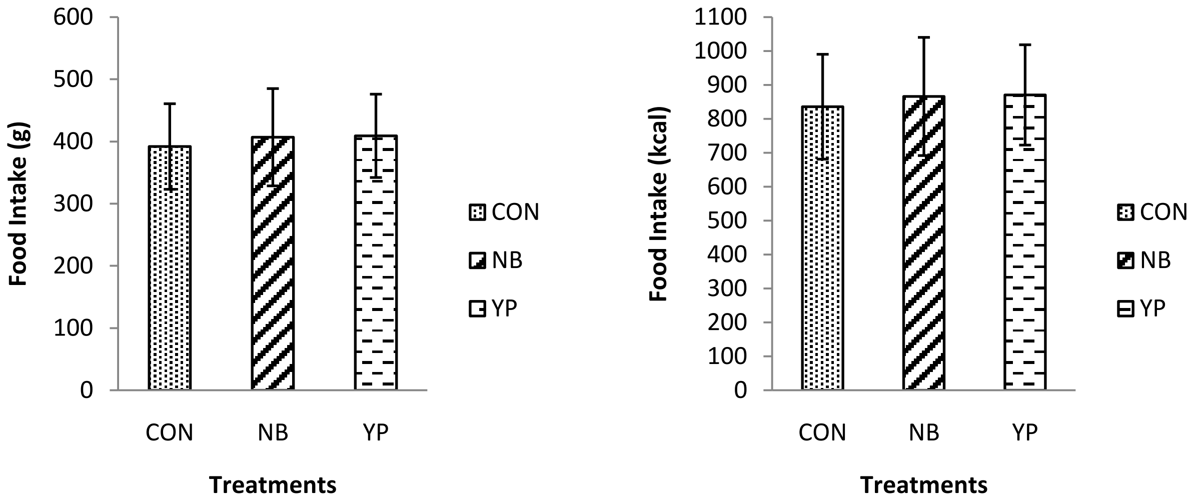
Table 5.6 Food and Water Intake categorized by Weight Status

		Treatments				
	Weight Status	CON	NB	YP	P value (treatment)	P value (weight status)
Food Intake (kcal)	Lighter-to-normal weight (n=20)	731.8 ± 104.5 [8]	744.3 ± 132.2 [8]	796.6 ± 139.0 [8]	0.2	0.004
	Heavier (n=5)	1251.5 ± 717.7 [8]	1352.6 ± 700.5 [8]	1166.3 ± 574.3 [8]	0.5	
Food Intake (g)	Lighter-to-normal weight (n=20)	348.0 ± 48.3 [8]	354.4 ± 61.9 [8]	378.0 ± 64.2 [8]	0.3	0.007
	Heavier (n=5)	567.4 ± 323.6 [8]	616.7 ± 312.7 [8]	533.2 ± 261.9 [8]	0.5	
Cumulative Food Intake (kcal)	Lighter-to-normal weight (n=20)	981.8 ± 104.5 [8]	994.3 ± 132.3 [8]	1046.6 ± 139.0 [8]	0.2	0.004
	Heavier (n=5)	1501.4 ± 717.7 [8]	1602.6 ± 700.5 [8]	1416.3 ± 574.3 [8]	0.5	
Cumulative Food Intake-solid only (g)	Lighter-to-normal weight (n=20)	742.3 ± 48.3 [1,8]	687.7 ± 61.9 [1,8]	702.7 ± 64.2 [1,8]	0.003	0.007
	Heavier (n=5)	961.7 ± 323.6 [1,8]	950.0 ± 312.7 [1,8]	857.9 ± 261.9 [1,8]	0.2	
Cumulative	Lighter-to-normal	912.3	918.7	942.7		

Food Intake-solid and water at treatment (g)	weight (n=20)	± 48.3 [8]	± 61.9 [8]	± 64.2 [8]	0.3	0.007
	Heavier (n=5)	1131.7 ± 323.6 [8]	1181.0 ± 312.7 [8]	1097.9 ± 261.9 [8]	0.5	
Water Intake (g)	Lighter-to-normal weight (n=20)	167.7 ± 52.7 [9]	191.8 ± 68.4 [9]	187.5 ± 87.7 [9]	0.6	0.7
	Heavier (n=5)	268.2 ± 242.7 [9]	139.3 ± 131.4 [9]	130.1 ± 149.3 [9]	0.3	
Cumulative Water Intake (g)	Lighter-to-normal weight (n=20)	337.7 ± 52.7 [1,9]	422.8 ± 68.4 [1,9]	427.5 ± 87.7 [1,9]	0.002	0.7
	Heavier (n=5)	438.2 ± 242.7 [1,9]	370.3 ± 131.4 [1,9]	370.1 ± 149.3 [1,9]	0.6	

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect ($P<0.05$) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9] treatment × weight status interaction

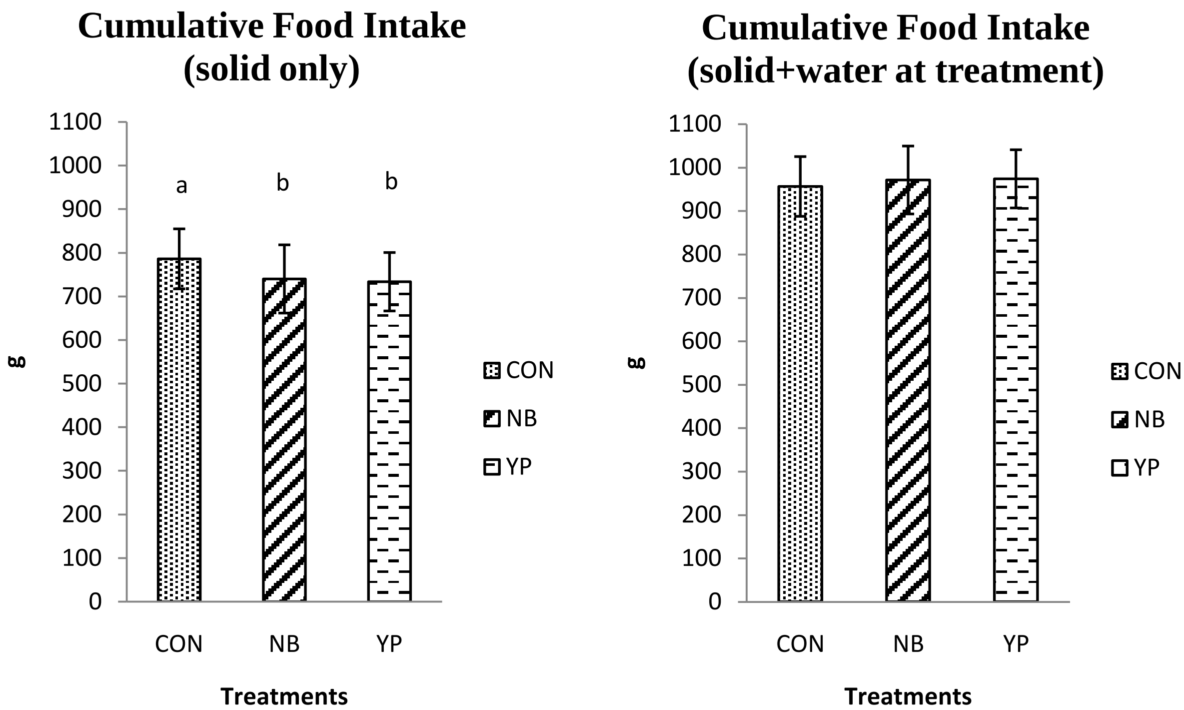
Figure 5.1 Food Intake at the Ad Libitum Pizza Meal



(A) (B)

All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

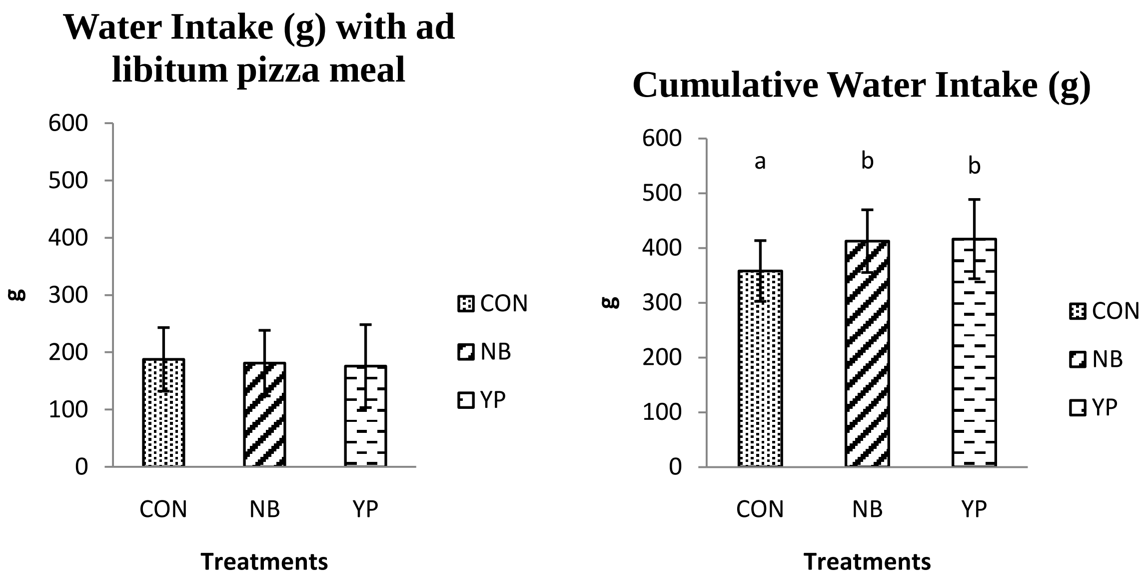
Figure 5.2 Cumulative Food Intake



(A) (B)

All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

Figure 5.3 Water Intake at the Pizza Meal and Cumulatively



(A) (B)

All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

Table 5.7 Effect of Session on Food Intake at the Ad Libitum Pizza Meal

Session	Food Intake (g)	Food Intake (kcal)
1	420.8 ± 76.2 [a]	897.6 ± 170.7 [a]
2	383.7 ± 65.9 [b]	817.2 ± 146.2 [b]
3	403.3 ± 71.4 [ab]	857.4 ± 158.4 [ab]
P value (Session)	0.02	0.02

Data are means ± 95% CI, n= 25.Two-way ANOVA with Tukey's post-hoc test. Different superscripts indicate significant difference, P<0.05

5.2.3 Effect of Menarche on Food and Water Intake for Girls

The average age for pre-menarcheal and post-menarcheal girls is 11.4 y and 14.2 y respectively. Pre-menarcheal girls had significantly lower pizza intake in terms of both weight (P=0.03) and energy (P=0.04) **(Table 5.8).** Similarly, pre-menarcheal girls had significantly lower cumulative food intake in both weight (P=0.03) and energy (P=0.04) compared to post-menarcheal girls **(Table 5.8).**

There was no effect of the onset of menarche on water intake at the pizza meal (P=0.4) or cumulative water intake (P=0.4) **(Table 5.8).**

Table 5.8 Effect of Menarche on Food and Water Intake for Girls

			Treatments			
	Menarcheal Stage	Count	CON	NB	YP	P value (menarcheal stage)
Pizza Intake (g)	Pre-menarcheal	10	300.8 ± 65.9 [a]	302.7 ± 86.5 [a]	317.1 ± 85.3 [a]	0.03
	Post-menarcheal	5	531.9 ± 326.7 [b]	585.2 ± 317.0 [b]	512.8 ± 274.8 [b]	
Pizza Intake (kcal)	Pre-menarcheal	10	642.8 ± 150.3 [a]	646.7 ± 194.0 [a]	676.2 ± 188.3 [a]	0.04
	Post-menarcheal	5	1147.2 ± 756.1 [b]	1259.2 ± 737.1 [b]	1103.1 ± 631.2 [b]	
Cumulative Food Intake (g)	Pre-menarcheal	10	695.1 ± 65.9 [a]	636.1 ± 86.5 [a]	641.8 ± 85.3 [a]	0.03
	Post-menarcheal	5	926.2 ± 326.7 [b]	918.5 ± 317.0 [b]	837.5 ± 274.8 [b]	
Cumulative Food Intake (kcal)	Pre-menarcheal	10	892.8 ± 150.3 [a]	896.7 ± 194.0 [a]	926.2 ± 188.3 [a]	0.04
	Post-menarcheal	5	1397.2 ± 756.1 [b]	1509.2 ± 737.1 [b]	1353.1 ± 631.2 [b]	

Water Intake (g)	Pre-menarcheal	10	131.5 ± 78.1	163.3 ± 133.9	157.5 ± 152.8	0.4
	Post-menarcheal	5	284.8 ± 103.3	195.9 ± 189.6	183.2 ± 174.6	
Cumulative Water Intake (g)	Pre-menarcheal	10	301.5 ± 78.1	394.3 ± 95.8	397.5 ± 109.3	0.4
	Post-menarcheal	5	454.8 ± 103.3	426.9 ± 235.4	423.2 ± 270.9	

All values are means ± 95% CI, n=15. Two-way ANOVA with Tukey's post-hoc test. Different superscripts indicate significant difference, $P<0.05$

5.2.4 Effect of Tanner's Stage on Food and Water Intake for Boys

The average age for boys in group I and group II is 11.9 y and 13.1 y respectively. Boys in group I (Tanner's stage 1 & 2) had significantly lower food intake at the pizza meal in terms of energy (P=0.04) and weight (P=0.05) **(Table 5.9).** Similarly, boys in group I had significantly lower cumulative food intake in both energy (P=0.04) and weight (P=0.05) compared to boys in group II (Tanner's stage 3 & 4) **(Table 5.9).**

There was no effect of Tanner's stage on water intake at the pizza meal (P=0.2) or cumulative water intake (P=0.2) **(Table 5.9).**

Table 5.9 Effect of Tanner's Stage on Food and Water Intake for Boys

			Treatments			
	Tanner's Stage	Count	CON	NB	YP	P value (Tanner's stage)
Pizza Intake (g)	Group I (Stage 1 & 2)	5	353.5 ± 150.0 [a]	342.6 ± 190.4 [a]	386.1 ± 185.1 [a]	0.05
	Group II (Stage 3 & 4)	5	472.5 ± 113.7 [b]	500.9 ± 128.2 [b]	512.1 ± 98.3 [b]	
Pizza Intake (kcal)	Group I (Stage 1 & 2)	5	731.4 ± 310.4 [a]	708.8 ± 394.0 [a]	808.2 ± 401.6 [a]	0.04
	Group II (Stage 3 & 4)	5	1014.5 ± 249.9 [b]	1068.5 ± 286.7 [b]	1088.7 ± 194.7 [b]	
Cumulative Food Intake (g)	Group I (Stage 1 & 2)	5	747.8 ± 150.0 [a]	675.9 ± 190.4 [a]	710.8 ± 185.1 [a]	0.05
	Group II (Stage 3 & 4)	5	866.8 ± 113.7 [b]	834.2 ± 128.2 [b]	836.8 ± 98.3 [b]	
Cumulative Food Intake (kcal)	Group I (Stage 1 & 2)	5	981.4 ± 310.4 [a]	958.8 ± 394.0 [a]	1058.2 ± 401.6 [a]	0.04
	Group II (Stage 3 & 4)	5	1264.5 ± 249.9 [b]	1318.5 ± 286.7 [b]	1338.7 ± 194.7 [b]	

Water Intake (g)	Group I (Stage 1 & 2)	5	113.2 ± 125.3	150.4 ± 182.1	126.7 ± 273.1	0.2
	Group II (Stage 3 & 4)	5	278.0 ± 206.7	233.4 ± 135.3	255.1 ± 193.2	
Cumulative Water Intake (g)	Group I (Stage 1 & 2)	5	283.2 ± 125.3	381.4 ± 182.1	366.7 ± 273.1	0.2
	Group II (Stage 3 & 4)	5	448.0 ± 206.7	464.4 ± 135.3	495.1 ± 193.2	

All values are means ± 95% CI, n=15. Two-way ANOVA with Tukey's post-hoc test. Different superscripts indicate significant difference, $P<0.05$

5.3 Subjective Appetite Scores

5.3.1 Average Appetite (AA)

There was an effect of treatment on subjective feeling of AA (P=0.01). The post-hoc analysis revealed that the treatment with added navy bean (P=0.02) and added yellow pea (P=0.02) both led to a higher AA score compared to control treatment (P=0.02) over two hours. There was no significant difference between navy bean and yellow pea treatment (P=1.0) on AA scores **(Table 5.10) (Figure 5.4).** There was no effect of treatment on AA scores at each time point **(Figure 5.5 A).**

There was a significant effect of weight status on subjective feeling of AA (P<0.0001). Thus, the children from the lighter-to-normal weight group (including underweight and normal weight) had a lower AA score compared to children from the heavier group (including overweight and obese).

There was a significant effect of time on AA scores (P<0.0001), there was no effect of age (P=0.7), sex (P=0.1), the interaction between treatment and time (P=0.9), treatment and age (P=0.4), treatment and sex (P=0.4) or treatment and weight status (P=0.2) on AA scores.

5.3.2 Desire to Eat (DTE)

There was no effect of treatment on subjective feeling of DTE (P=0.08). **(Table 5.10) (Figure 5.4)**. However, when comparing the effect of treatment on DTE scores at each time point, at 90 min, the treatment with added navy bean led to a higher DTE score compared to the control treatment (P=0.04). At 120 min, the treatment with added yellow pea led to a higher desire to eat score compared to the control treatment (P=0.04) **(Figure 5.5B)**.

There was a significant effect of weight status on subjective feeling of DTE (P<0.0001). The children from the lighter-to-normal weight group (including underweight and normal weight) had a lower DTE score compared to children from the heavier group (including overweight and obese).

There was a significant effect of time (P<0.0001), the interaction between treatment and age (P=0.004) and treatment and sex (P=0.005) on DTE scores. There was no effect of age (P=0.9), sex (P=0.1), the interaction between treatment and time (P=0.8) or treatment and weight status (P=0.3) on DTE scores.

5.3.3 Hunger

There was an effect of treatment on subjective feeling of hunger (P=0.02). The treatment with added yellow pea led to a higher hunger score compared to the control treatment (P=0.03) over two hours. There was no significant difference between control and navy bean treatment (P=0.07) or navy bean and yellow pea treatments (P=0.9) on hunger scores **(Table 5.10) (Figure 5.4).** There was no effect of treatment on hunger scores at each time point **(Figure 5.5C).** There was a significant effect of weight status on subjective feeling of hunger (P<0.0001). The post-hoc analysis revealed that children from the lighter-to-normal weight group (including underweight and normal weight) had a lower hunger score compared to children from the heavier group (including overweight and obese).

There was a significant effect of time on hunger scores (P<0.0001). There was no effect of age (P=0.7), sex (P=0.2), the interaction between treatment and time (P=0.5), treatment and age (P=0.2), treatment and sex (P=0.09) or treatment and weight status (P=0.2) on hunger scores.

5.3.4 Fullness

There was no effect of treatment on subjective feeling of fullness (P=0.6) **(Table 5.10) (Figure 5.4).** There was no effect of treatment on fullness scores at each time point **(Figure 5.5D).**

There was a significant effect of weight status on subjective feeling of fullness (P=0.01). The children from the lighter-to-normal weight group (including underweight and normal weight) had a higher fullness score compared to children from the heavier group (including overweight and obese).

There was a significant effect of time (P<0.0001) and the interaction between treatment and sex (P=0.007) on fullness scores. There was no effect of age (P=0.5), sex (P=0.9), the interaction between treatment and time (P=0.3), treatment and age (P=0.1) or treatment and weight status (P=0.2) on fullness scores.

5.3.5 Prospective Food Consumption (PFC)

There was an effect of treatment on subjective feeling of PFC (P=0.009). The treatment with added navy bean treatment led to a higher PFC score compared to the control treatment (P=0.01). There was no significant difference between control and yellow pea treatment (P=0.3) or navy bean and yellow pea treatment (P=0.1) on PFC score **(Table 5.10) (Figure 5.4).** There was no effect of treatment on PFC scores at each time point **(Figure 5.5E).**

There was a significant effect of weight status on subjective feeling of PFC (P=0.01). The children from the lighter-to-normal weight group (including underweight and normal weight) had a lower PFC score compared to children from the heavier group (including overweight and obese).

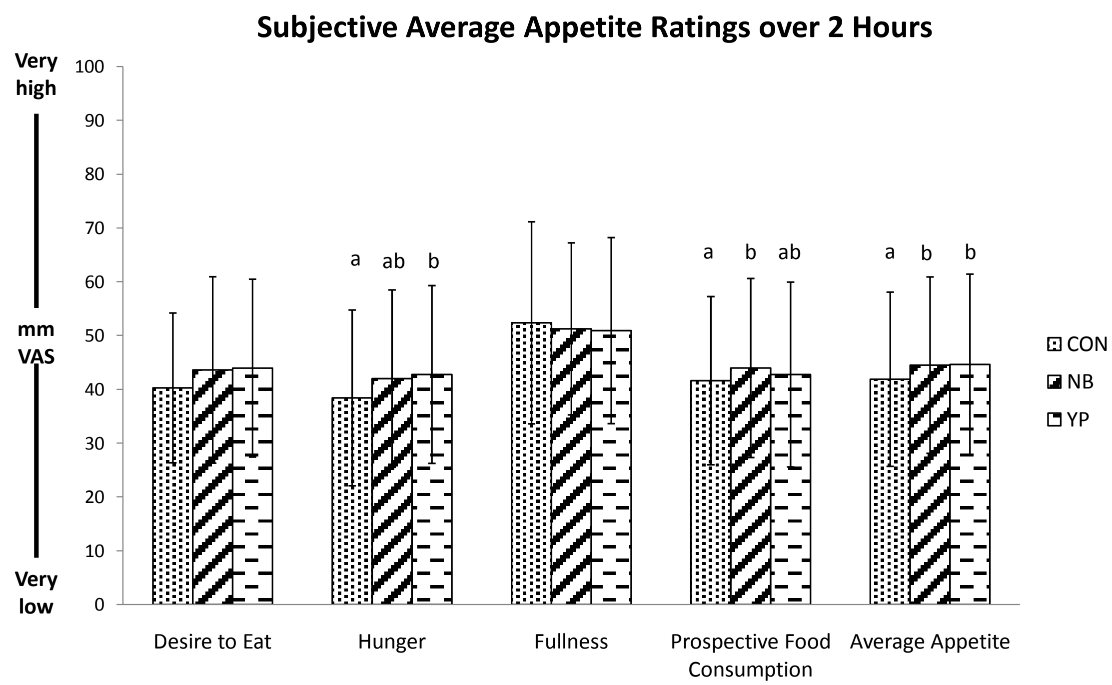
There was a significant effect of time (P<0.0001), the interaction between treatment and age (P=0.003) and treatment and sex (P=0.01) on PFC scores. There was no effect of age (P=0.9), sex (P=0.5), the interaction between treatment and time (P=0.9) or treatment and weight status (P=0.2) on PFC scores.

Table 5.10 Subjective Average Appetite Scores over 2 Hours

	Treatments			P value (treatment)
	CON	NB	YP	
Average Appetite (mm)	42.0 ± 16.2 [1,2,8]	44.5 ± 16.4 [1,2,8]	44.6 ± 16.8 [1,2,8]	0.01
Desire to Eat (mm)	40.3 ± 13.9 [2,5,7,8]	43.6 ± 17.3 [2,5,7,8]	44.0 ± 16.5 [2,5,7,8]	0.08
Hunger (mm)	38.4 ± 16.3 [1,2,8]	42.0 ±16.5 [1,2,8]	42.8 ± 16.5 [1,2,8]	0.02
Fullness (mm)	52.4 ± 18.8 [2,7,8]	51.3 ± 16.0 [2,7,8]	50.9 ± 17.3 [2,7,8]	0.6
Prospective Food Consumption (mm)	41.6 ± 15.6 [1,2,5,7,8]	44.0 ± 16.6 [1,2,5,7,8]	42.8 ± 17.2 [1,2,5,7,8]	0.009

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect (P<0.05) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9]treatment × weight status interaction

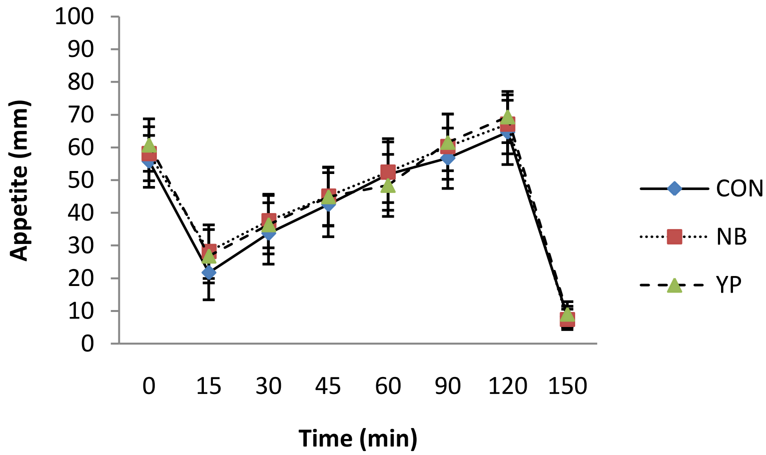
Figure 5.4 Subjective Average Appetite Scores over 2 Hours



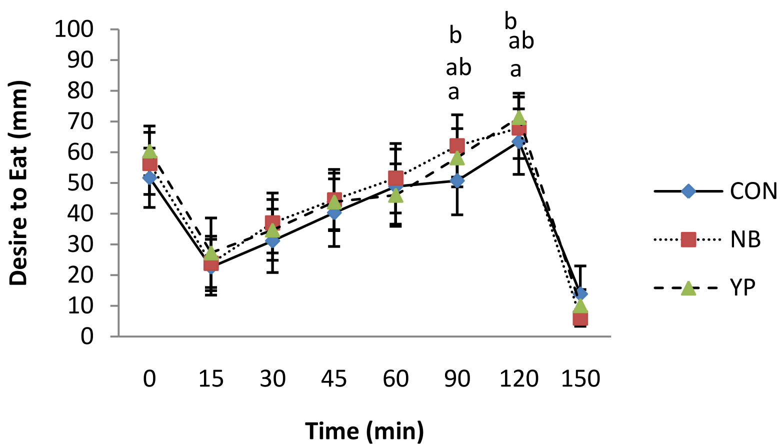
All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

Figure 5.5 Absolute Subjective Average Appetite Scores over 2 Hours

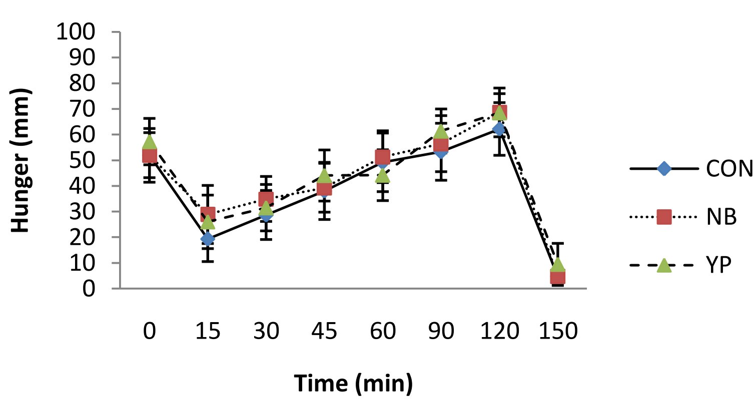
(A) Average Appetite Score



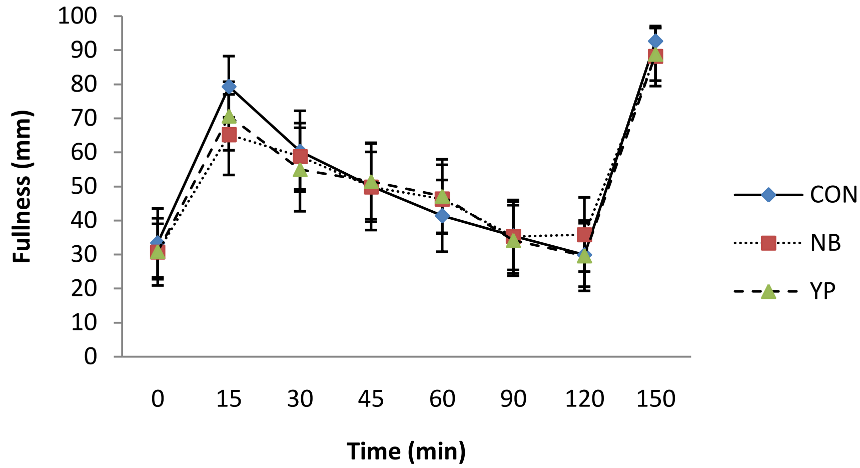
(B) Desire to Eat Score



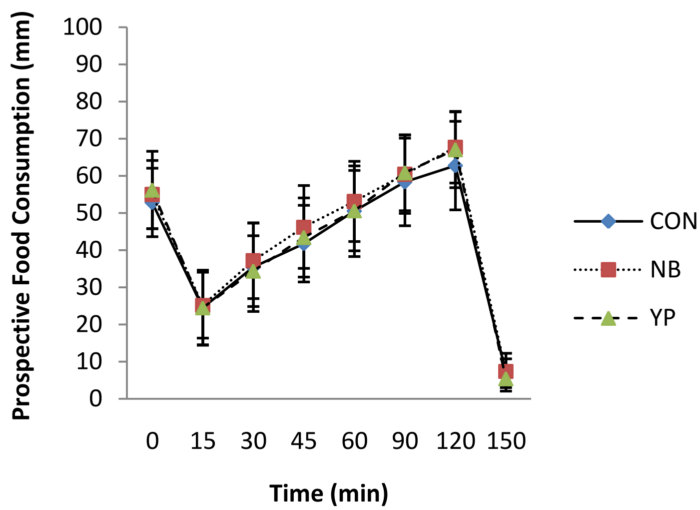
(C) Hunger Score



(D) Fullness Score



(E) Prospective Food Consumption Score



All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

5.4 Gastrointestinal Comfort Scores

5.4.1 Nausea

There was no effect of treatment on the subjective feeling of nausea (P=0.4) **(Table 5.11) (Figure 5.6)**. There was no effect of treatment on nausea scores at each time point **(Figure 5.7A).** There was an effect of time on nausea scores (P=0.003), it peaked at 15 min and decreased over time. There was no effect of age (P=0.4), sex (P=0.6), weight status (P=0.06) or the interaction between treatment and time (P=0.9), treatment and age (P=0.3), treatment and sex (P=0.7) or treatment and weight status (P=0.8) on nausea scores.

5.4.2 Stomach Discomfort

There was an effect of treatment on subjective feeling of stomach discomfort (P=0.03)**.** The post-hoc analysis revealed that the treatment with added navy bean led to a lower average stomach discomfort score compared to the treatment with added yellow pea (P=0.03). There was no significant difference between control and navy bean treatments (P=0.8) or control and yellow pea treatments (P=0.2) on stomach discomfort score **(Table 5.11) (Figure 5.6)**.

The yellow pea treatment led to a higher stomach discomfort score compared to the navy bean and control treatments at 15 (P=0.02) and 30 (P=0.01) mins. At 60 min, the navy bean treatment led to a lower stomach discomfort score compared to the yellow pea treatment (P=0.04) **(Figure 5.7B).**

There was an effect of time (P=0.01) and the interaction between treatment and sex (P=0.008) on stomach discomfort score. There was no effect of age (P=0.5), sex (P=0.4), weight status (P=0.09), the interaction between treatment and time (P=0.3), treatment and age (P=0.2) or treatment and weight status (P=0.7) on stomach discomfort scores.

5.4.3 Wellness

There was no effect of treatment on subjective feeling of wellness (P=0.1) **(Table 5.11) (Figure 5.6).** There was no effect of treatment on wellness scores at each time point **(Figure 5.7C).**

There was an effect of time (P=0.002) on wellness scores. There was no effect of age (P=0.4), sex (P=0.4), weight status (P=0.1), the interaction between treatment and time (P=0.4), treatment and age (P=0.2), treatment and sex (P=0.4) or treatment and weight status (P=0.3) on wellness scores.

5.4.4 Flatulence

There was an effect of treatment on subjective feeling of flatulence (P=0.02). The post-hoc analysis revealed that both the control (P=0.02) and navy bean (p=0.03) treatments led to lower flatulence score compared to the yellow pea treatment. There was no difference between control and navy bean treatment (P=0.6) on the flatulence score **(Table 5.11) (Figure 5.6).** There was no effect of treatment on flatulence scores at each time point **(Figure 5.7D).**

There was an effect of sex (P=0.003) on flatulence scores. Boys reported higher flatulence scores compared to girls. There was no effect of age (P=0.7), weight status (P=0.9), the interaction between treatment and time (P=1.0), treatment and age (P=0.5), or treatment and weight status (P=0.9) on flatulence scores.

5.4.5 Diarrhea

There was no effect of treatment on subjective feeling of diarrhea (P=1.0) **(Table 5.11) (Figure 5.6).** There was no effect of treatment on diarrhea scores at each time point **(Figure 5.7E).**

There was no effect of time (P=0.4), age (P=1.0), sex (P=0.6), weight status (P=0.6), the interaction between treatment and time (P=1.0), treatment and age (P=0.2), treatment and sex (P=0.5) or treatment and weight status (P=0.4) on diarrhea scores.

5.4.6 Average Physical Comfort (APC)

There was an effect of treatment on subjective feeling of APC (P=0.006). The post-hoc analysis revealed that the treatment with added navy bean led to a higher APC score compared to the yellow pea treatment (P=0.005). The control treatment led to a higher APC score compared to yellow pea treatment as well (P=0.04). There was no significant difference between control and navy bean treatment (P=1.0) on APC score (**Table 5.11) (Figure 5.6).**

At 15 and 60 min, the nay bean treatment led to a higher APC score compared to the yellow pea treatment (P=0.0455, P=0.0489). At 60 min, the control treatment led to a higher APC score compared to the yellow pea treatment (P=0.006) **(Figure 5.7F).**

There was a significant effect of weight status on the subjective feeling of APC (P=0.01).

The post hoc analysis revealed that children from the lighter-to-normal weight group (including underweight and normal weight) had a higher APC score compared to children from the heavier group (including overweight and obese) **(Table 5.11)**.

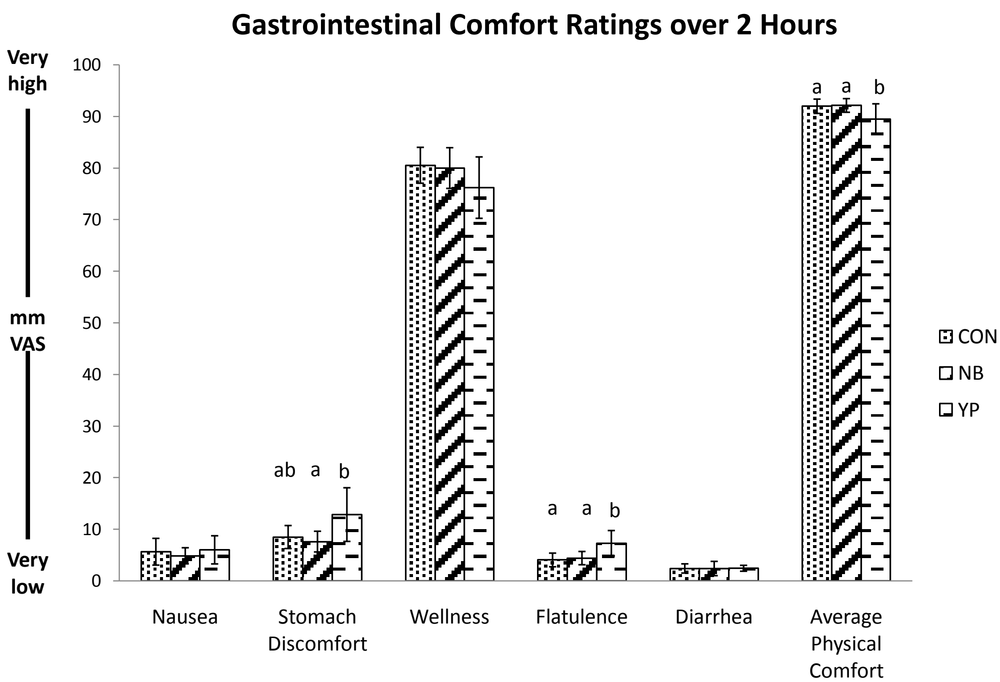
There was a significant effect of time (P=0.0002) and the interaction between treatment and sex (P=0.03) on APC scores. There was no effect age (P=0.5), sex (P=0.6), the interaction between treatment and time (P=0.4), treatment and age (P=0.1) or treatment and weight status (P=0.8) on APC scores.

Table 5.11 Gastrointestinal Comfort Scores

	Treatments			P value (treatment)
	CON	NB	YP	
Nausea (mm)	5.6 ± 2.6 [2]	4.8 ± 1.6 [2]	6.0 ± 2.7 [2]	0.4
Stomach Discomfort (mm)	8.4 ± 2.2 [1,2,7]	7.6 ± 2.0 [1,2,7]	12.8 ± 5.2 [1,2,7]	0.03
Wellness (mm)	80.6 ± 3.5 [2]	80.0 ± 3.9 [2]	76.2 ± 6.0 [2]	0.1
Flatulence (mm)	4.0 ± 1.3 [1,6]	4.4 ± 1.3 [1,6]	7.3 ± 2.5 [1,6]	0.02
Diarrhea (mm)	2.4 ± 1.0	2.4 ± 1.4	2.4 ± 0.6	1.0
Average Physical Comfort (mm)	92.0 ± 1.4 [1,2,7,8]	92.1 ± 1.3 [1,2,7,8]	89.5 ± 2.9 [1,2,7,8]	0.006

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect ($P<0.05$) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9]treatment × weight status interaction

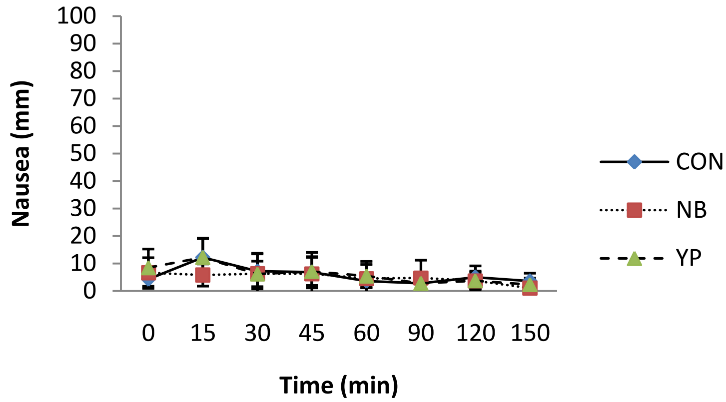
Figure 5.6 Gastrointestinal Comfort Ratings over 2 Hours



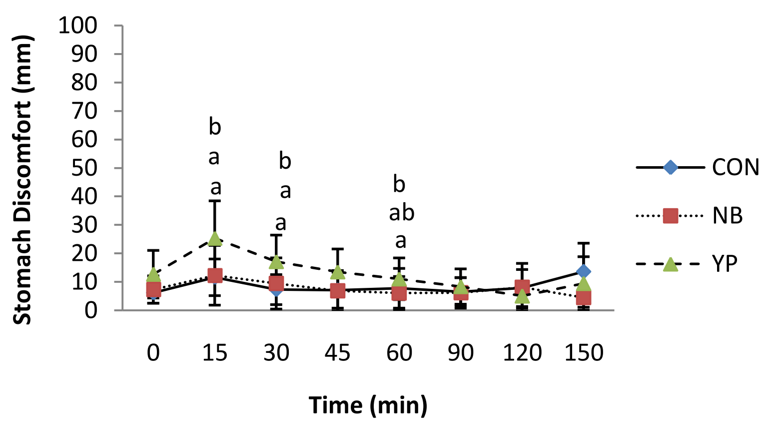
All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

Figure 5.7 Absolute Gastrointestinal Comfort Scores over 2 Hours

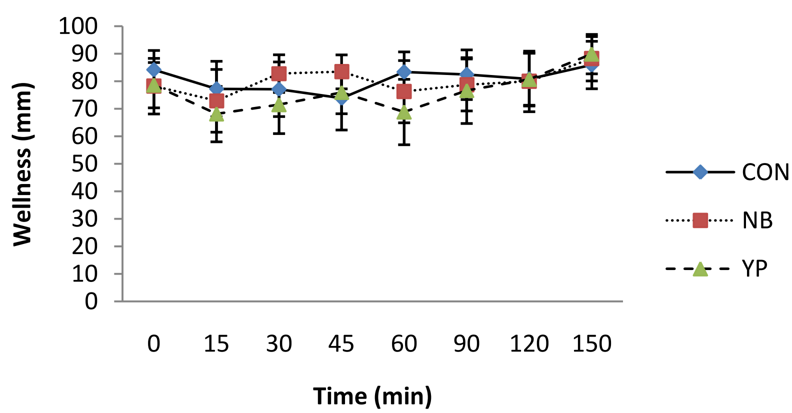
(A) Nausea Score



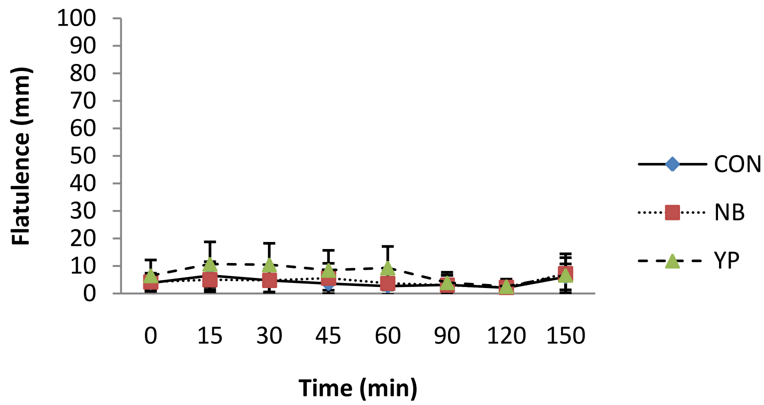
(B) Stomach Discomfort Score



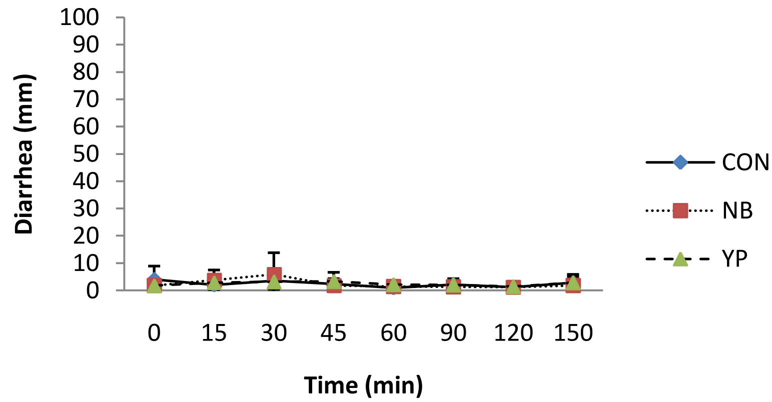
(C) Wellness Score



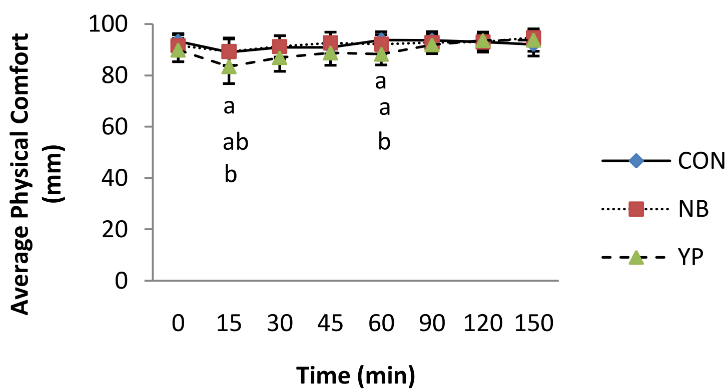
(D) Flatulence Score



(E) Diarrhea Score



(F) Average Physical Comfort Score



All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

5.5 Palatability of Treatments

Taste

There was no effect of treatment (P=0.3), age (P=0.1), sex (P=0.07), weight status (P=0.5), the interaction between treatment and age (P=0.3), treatment and sex (P=0.9), or treatment and weight status (P=0.7) on taste score at the treatment meal **(Table 5.12) (Figure 5.8A)**.

Mouthfeel

There was no effect of treatment (P=0.6). There was an effect of age (P=0.03) on mouthfeel score. Younger children (9.8y-12.6y) had a significantly higher rating for mouthfeel compared to older children (12.7y-14.8y). **(Table 5.12) (Figure 5.8B)**.

There was no effect of sex (P=0.1), weight status (P=0.6), the interaction between treatment and age (P=0.3), treatment and sex (P=0.8), or treatment and weight status (P=0.5) on mouthfeel scores at the treatment meal.

Flavour

There was an effect of treatment (P=0.04) that the flavor of the control treatment received a significantly higher rating compared to navy bean (P=0.04), there was no difference between the control and yellow pea treatments (P=0.2) or the navy bean and yellow pea treatments (P=0.7) **(Table 5.12) (Figure 5.8C)**.

There was no effect of age (P=0.5), sex (P=0.2), weight status (P=0.6), the interaction between treatment and age (P=0.9), treatment and sex (P=0.08), or treatment and weight status (P=0.9) on the flavour score at the treatment meal.

Sweetness

There was no effect of treatment (P=0.6). There was an effect of sex (P=0.03) on sweetness score. Girls had a higher rating of sweetness of the treatments compared to boys **(Table 5.12)**.

There was an effect of weight status (P=0.003) on sweetness score. Children from the lighter-to-normal weight group (including underweight and normal weight) had a lower sweetness score compared to children from the heavier group (including overweight and obese)

(Table 5.12).

There was a session effect (P=0.006) on sweetness score. There was a higher sweetness score during the second session compared to the third session (P=0.004), there was no difference between the first and second (P=0.6) or between the first and third session (P=0.2).

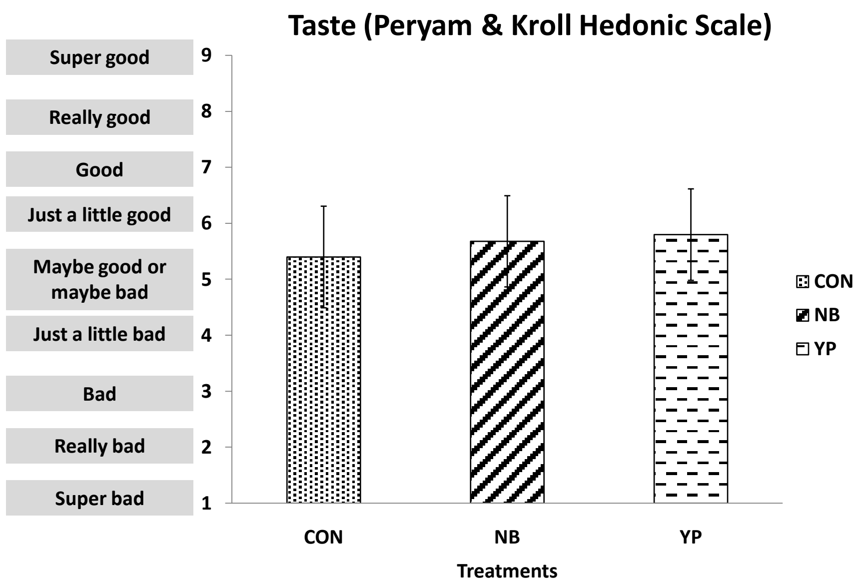
There was no effect of age (P=0.3), the interaction between treatment and age (P=0.6), treatment and sex (P=0.8) or treatment and weight status (P=0.5) on sweetness score at the treatment meal **(Table 5.12) (Figure 5.8D)**.

Table 5.12 Overall Mean of Palatability of the Treatments

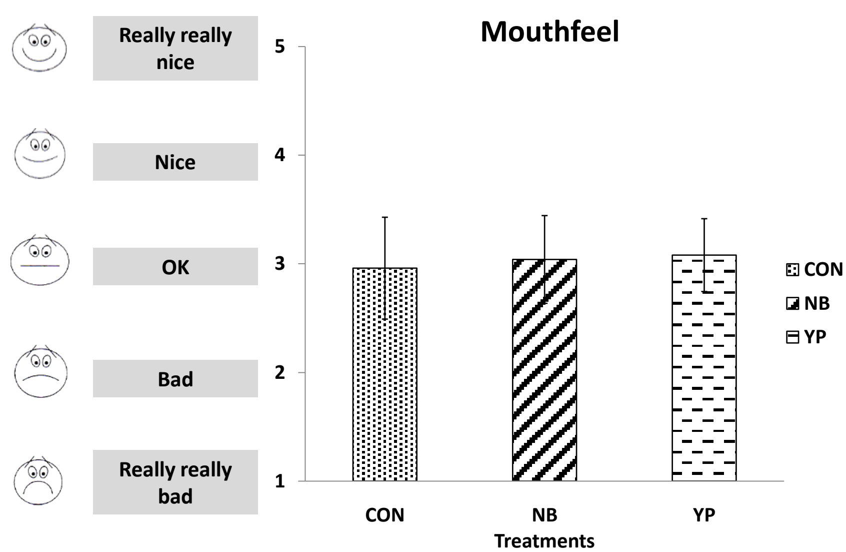
	Treatments			P value (treatment)
	CON	NB	YP	
Taste (1-9)	5.4 ± 0.9	5.7 ± 0.8	5.8 ± 0.8	0.3
Mouthfeel (1-5)	3.0 ±0.5 ^{4}	3.0 ± 0.4 ^{4}	3.1 ± 0.3 ^{4}	0.6
Flavour (1-5)	3.5 ± 0.3 ^{1}	3.2 ± 0.3 ^{1}	3.3 ± 0.3 ^{1}	0.04
Sweetness (mm)	41.8 ± 11.4 ^{6,8}	40.1 ± 8.4 ^{6,8}	36.5 ± 8.9 ^{6,8}	0.6

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect (P<0.05) of:
^{1}treatments; ^{2}time; ^{3}treatment × time interaction; ^{4}age; ^{5}treatment × age interaction; ^{6}sex; ^{7}treatment × sex interaction; ^{8}weight status; ^{9}treatment × weight status interaction

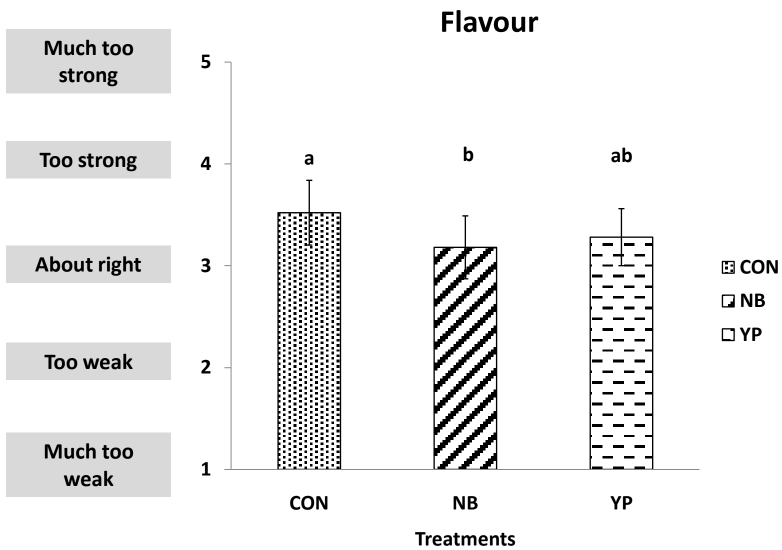
Figure 5.8 Palatability of Treatments



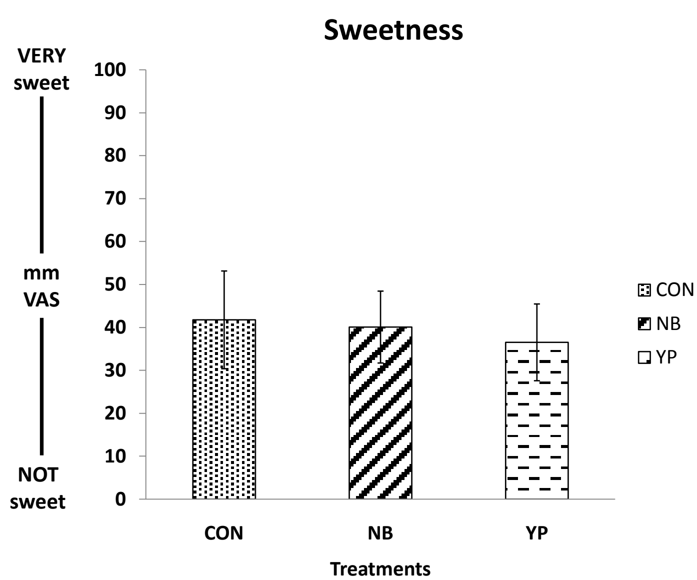
(A)



(B)



(C)



(D)

All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

5.6 Pleasantness of Treatment and Pizza

Treatment Pleasantness

There was no effect of treatment (P=0.5), age (P=0.09), sex (P=0.5), weight status (P=0.2), the interaction between treatment and age (P=0.2), treatment and sex (P=1.0), or treatment and weight status (P=0.9) on the rating of treatment pleasantness **(Table 5.13) (Figure 5.9A)**.

Pizza Pleasantness

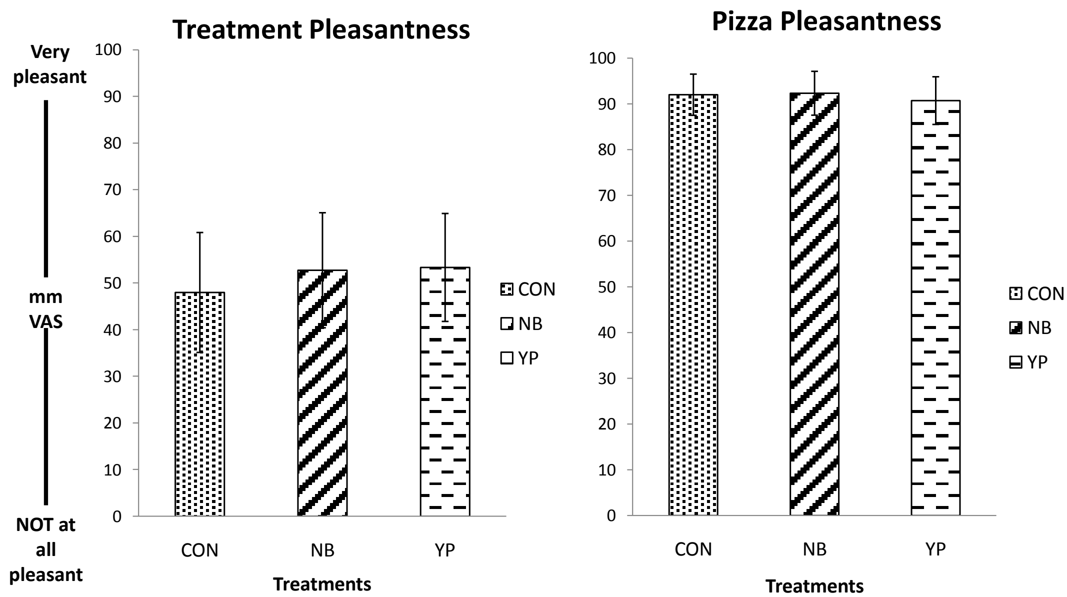
There was no effect of treatment (P=0.4), age (P=0.3), sex (P=0.6), weight status (P=1.0), the interaction between treatment and age (P=0.3), treatment and sex (P=0.8), or treatment and weight status (P=0.6) on the rating of pizza pleasantness **(Table 5.13) (Figure 5.9B)**.

Table 5.13 Overall Mean of Pleasantness of the Treatments and Pizza Meal

	Treatments			P value (treatment)
	CON	NB	YP	
Treatment pleasantness (mm)	48.0 ± 12.8	52.8 ± 12.3	53.4 ± 11.6	0.5
Pizza pleasantness (mm)	92.0 ± 4.5	92.3 ± 4.8	90.7 ± 5.2	0.4

All values are means ± 95% CI, n=25.
Two-way ANOVA with a Tukey Kramer post-hoc test. Superscripts represent significant effect (P<0.05) of:
[1]treatments; [2]time; [3]treatment × time interaction; [4]age; [5]treatment × age interaction; [6]sex; [7]treatment × sex interaction; [8]weight status; [9]treatment × weight status interaction

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



(A) (B)

All values are means ± 95% CI, n=25.
Treatment effects were analyzed using the PROC MEANS with t-test

5.7 Relations among Dependent Variables

Average appetite (r=0.52284, P<0.0001), desire to eat (r=0.51909, P<0.0001), hunger (r=0.50034, P<0.0001) and prospective food consumption (r=0.48132, P<0.0001) were positively related to food intake **(Table 5.14)**. Fullness (r= -0.41797, P=0.0002) was negatively related to food intake **(Table 5.14).**

Nausea (r=0.29047, P=0.01) and stomach discomfort (r=0.31910, P=0.005) had a weak and positive correlation with food intake **(Table 5.14).** Wellness (r= -0.24940, P=0.03) and average physical comfort (r= -0.31446, P=0.006) had a weak and negative correlation with food intake **(Table 5.14).** Flatulence (r=0.13543, P=0.2) and diarrhea (r=0.12815, P=0.3) were not related to food intake **(Table 5.14).**

Taste (r=0.01983, P=0.9), mouthfeel (r= -0.05071, P=0.7) and flavour of the treatments (r= -0.00562, P=1.0) were not related to food intake **(Table 5.14).** Sweetness (r=0.24337, P=0.04) of the treatment had a weak and positive correlation with food intake **(Table 5.14).**

Pleasantness of the treatments (r=0.01339, P=0.9) and pleasantness of the pizza meal (r=0.05324, P=0.7) were not related to food intake **(Table 5.14).**

Table 5.14 Correlations of Dependent Variables with Food Intake

Variables	Food Intake	
	Correlation (r)	P value
Average Appetite	r= 0.52284	P<0.0001
Desire to Eat	r= 0.51909	P<0.0001
Hunger	r= 0.50034	P<0.0001
Fullness	r= -0.41797	P=0.0002
Prospective Food Consumption	r= 0.48132	P<0.0001
Nausea	r= 0.29047	P=0.01
Stomach Discomfort	r= 0.31910	P=0.005
Wellness	r= -0.24940	P=0.03
Flatulence	r= 0.13543	P=0.2
Diarrhea	r= 0.12815	P=0.3
Average Physical Comfort	r= -0.31446	P=0.006
Taste of Treatment	r= 0.01983	P=0.9
Mouthfeel of Treatment	r= -0.05071	P=0.7
Flavour of Treatment	r= -0.00562	P=1.0
Sweetness of Treatment	r= 0.24337	P=0.04
Pleasantness of Treatment	r= 0.01339	P=0.9
Pleasantness of Pizza	r= 0.05324	P=0.7

Pearson Correlation Coefficients. Superscripts represent significant effect (P<0.05)

Chapter 6: Discussion

The present study results do not support the hypothesis that pureed pulses added to a meal will decrease subsequent food intake in 9 to 14 year old children compared to a pulse-free meal if provided on an isocaloric basis. There was a decrease in average appetite after the pulse-free control compared to the treatments formulated with pulses.

In this study, pulses were added as 44% of energy of the treatment meal, this percentage was determined based on previous studies. As mentioned in the methods section, 79.6 g of navy beans and 70.7 g of yellow peas were used in this study, and they accounted for 108.2 kcal with 141.8 kcal from pasta and sauce for a total of 250 kcal. Based on repeated experimental measurements, there was 112 ml in 79.6 g of navy beans and 92 ml in 70.7 g yellow peas. According to the Canada's Food Guide (166), in the age group of 9 to 13 year olds, 1-2 servings of meat and alternatives were recommended daily with each serving being 175 ml or 3/4 cup. The amount of pulses provided in this research was less than one serving of the recommended amount by Canada's Food Guide. However, this amount is determined based on the average food consumption at the treatment in a preliminary study, therefore it represents the amount of food children would normally eat.

It was shown in other studies that both protein and fibre are positively associated with satiety (105, 178). The high fibre content in both navy bean and yellow pea treatments has bulking action on food, water is absorbed to the food as they move through the digestive system, this action helps increase gastric distension leading to a sensation of fullness (179). Fibre also prolongs the digestion phase of food and absorption through thickened gastric content (180). According to NHANES 2007-2008, the average fibre intake in 6-11 year old children was 13.7 g/day, which was below the recommended level (181). One of the main objectives in the 2010 Dietary Guidelines was to increase dietary fibre intake among American children. In the present study, 44% of energy comes from added pureed pulses with 56% of energy from pasta and sauce in navy bean and yellow pea treatments, the control is composed of only pasta and sauce. The fibre content differed significantly among treatments. The navy bean and yellow pea treatments contained 6.17g and 9.57 g more fibre compared to the control treatment in 250 kcal in the present study **(Table 4.1)**. However, there was no significant difference in subsequent food intake at the pizza meal in terms of both weight and energy after the consumption of three types of treatments **(Figure 5.1A&B)**. The finding is consistent with the study conducted by Smith and colleagues (136), they explained that the duration of the study session, 120 min, is not sufficient to see an effect of fibre consumption on subsequent food intake. Bacteria in the large intestine, especially in the caecum and proximal portions of the colon, help with the fermentation process of fibre by producing short-chain fatty acids (SCFA) (140, 141). The duration of the present study was 120 min, which was not long enough for the food to reach the colon where the fermentation process takes place. Therefore, even though the fibre content was significantly higher in both navy bean and yellow pea treatments, the duration of the study session was not long enough for the effect of fibre on the second meal food intake to be shown. Aside from the differences in fibre content, all three treatments had high protein level as the base meal was made from durum wheat pasta, however, there was an increase of 2 to 3 grams in the protein content in meals formulated with pulses compared to the control. In this study, the slight increase in protein level did not have an effect on subsequent food intake in children. This was consistent with the finding by Smith and colleagues (136), they found that the protein fraction of whole yellow peas led to food intake suppression up to 30 min after their consumption. It was further explained that yellow pea protein led to a peak in plasma amino acids, anorexigenic hormones, insulin and GLP-1 between 20 and 40 min after ingestion, however, they all returned to baseline well before 120 min after consumption (136). Food intake was measured at 120 min in this study, therefore the effect of protein was not observed.

Both navy bean and yellow pea treatments led to a significantly lower solid cumulative food intake in terms of weight compared to pasta and sauce **(Table 5.3) (Figure 5.2A)**, such effect was not found in cumulative energy intake **(Table 5.3)**. As mentioned in the methods section, the study was designed to provide isocaloric treatments (250 kcal) in order to eliminate variability in food intake among the participants at the treatment meal. For all treatment meals to have the same energy density, the solid weights of navy bean (331.56 g) and yellow pea (322.58 g) treatments were lower compared to that of the control treatment (394.32g). Food intake at the subsequent pizza meal did not differ among treatments in terms of weight, therefore, the only reason that could account for the significant difference in cumulative solid food intake among the treatments was the different weights of the treatment meal. However, water was provided along with the treatment meal and the purpose was to adjust the total weight of the treatments in order for all three treatments to have the same weight. There was no significant difference among the treatments when the weight of the water provided at the treatment meal was added to the weight of the solid cumulative food intake **(Figure 5.2B).**

There was no significant difference in water intake at the pizza meal among the treatments **(Figure 5.3A)**, however, significantly higher cumulative water intake (water intake with the treatment and pizza meal) was observed with navy bean and yellow pea treatment compared to the control treatment **(Figure 5.3B)**. As mentioned above, the amount of water was adjusted in order for all treatment meals to have the same weight. The amount of water given with the control treatment was less (170 g) compared to that of the navy bean (231 g) and yellow pea (240 g) treatments because the solid weight of the control treatment was the highest, this had resulted in a significantly lower cumulative water intake with the control treatment.

In the present study, water was served with the treatment meals for all three treatments, the study design did not allow for comparison of subsequent food intake between water served with treatment and water incorporated into a treatment meal. Rolls and colleagues (182) compared the energy intake at lunch and dinner among three isoenergetic preloads served in different forms. These are 1) chicken rice casserole; 2) chicken rice casserole served with a glass of water and 3) chicken rice soup. The purpose was to investigate if decreasing energy density by incorporating water into the treatment meal would affect satiety (182). It was found that there was a significantly lower energy intake at an ad libitum lunch meal after the consumption of the chicken rice soup, there was also a higher fullness score and lower hunger and prospective consumption scores with chicken rice soup compared to chicken rice casserole and chicken rice casserole served with a glass of water (182). Their finding indicated that adding water to the treatment decreased the energy density and increased the volume of the treatment, and this could enhance the effect of the food on satiety. The author hypothesized that the chunky soup may have remained in the stomach for a longer period of time compared to the other two preloads, this increased gastric distension and promoted satiety (182). It could also be possible that the nutrients in the soup was more evenly spread in the stomach compared to solid food, this had an effect on gastric emptying rate (183, 184). Authors also found that having water served on the side did not have an effect on subsequent energy intake. It was indicated that consuming chicken rice casserole served with a glass of water on the side did not significantly affect subsequent food intake compared to the consumption of casserole without water. The finding by Rolls and colleagues was consistent with the results of the present study that there was no effect of treatment on subsequent energy intake. As explained by Rolls and colleagues, this finding could be due to the fact that water was served separately from the treatment meal, therefore, the density and volume of the treatments did not alter as it did for the chicken rice soup in the study conducted by Rolls and colleagues (182). The effect of the addition of water on subsequent energy intake could only be observed when water was added into the treatment, therefore, there would be no effect on subsequent energy intake when one simply consumed a large amount of water at a meal. It is helpful to investigate the effect of pulses served in different forms on subsequent energy intake and appetite in future studies.

The present study included both children and adolescents based on the age criteria, the Centre for Disease Control and Prevention specifies that the age group of 9 to 11 years is considered as middle childhood and the age group of 12 to 14 is considered young teen (185). In order to better examine the effect of age on food intake, two age groups **(Table 5.2 A)** were formed based on the median of the participants' age. It was found that younger children (9.8y-12.6y) had significantly lower food intake in terms of weight and energy at the pizza meal compared to older children (12.7y-14.8y) **(Table 5.4)**. During growth period, food intake for both boys and girls increases as they age. Their food intake behaviour can be explained by their energy requirement. According to the Canada's Food Guide, as children and adolescents progress into adulthood, the energy requirements should increase accordingly. For instance, for sedentary boys, 1500 calories, 1700 calories, 1900 calories and 2300 calories are required per day for age 8-9y, 10-11y, 12-13y and 14-16y respectively. For sedentary girls, 1400 calories, 1500 calories, 1700 calories and 1750 calories are required per day for age 8-9y, 10-11y, 12-13y and 14-16y respectively (186).

Not only did age affect food intake, weight status was also a main factor that influences food intake. According to Patel and colleagues (187), there was a higher level of insulin, PYY and lower level of ghrelin in obese adolescents than their normal weight counterparts, obesity affected macronutrient-stimulated appetite hormone secretion which may alter food intake in obese adolescents. Based on this finding, children were separated into two weight categories for food intake analysis. It was found that children in the lighter-to-normal weight group had significantly lower food intake at the pizza meal compared to their heavier counterparts **(Table 5.6)**.

Patel and colleagues found that pubertal stage affected food intake in both boys (187) and girls (173). In the present study, boys and girls were divided into two groups according to their pubertal stage and were analyzed separately. It was found that boys at Tanner's stages 3 & 4 had significantly higher food intake at the pizza meal compared to their counterparts at Tanner's stages 1 & 2 **(Table 5.9)**. This finding was supported by Patel and colleagues (187) that mid-later pubertal male adolescents had higher food intake. On the other hand, post-menarcheal girls had significantly higher food intake at the pizza meal compared to their pre-menarcheal counterparts in this study **(Table 5.8)**. This finding was not consistent with the results found by Patel and colleagues (173), it was indicated that post-pubertal female participants intentionally limited their food intake due to the concern of body image. An explanation for the phenomenon observed in this study could be due to the age difference and their respective energy requirement. Post-menarcheal girls were older compared to their pre-menarcheal counterparts and their energy requirements were higher. In order to control the differences in age, it is helpful to recruit participants of the same age and separate them according to their pubertal stage so the effect of puberty on food intake can be better examined.

The present study measured subjective appetite and physical comfort using Visual Analog Scale (VAS) as a research tool. There was a significant effect of time on all subjective appetite measures that they increased over time and decreased significantly after the test meal at 120 min, except for fullness which increased significantly at 120 min **(Table 5.10)**. This indicated that VAS was a valid tool in predicting food intake by assessing the perception of desire to eat, hunger, fullness and prospective food consumption (176, 188, 189). For the subjective feeling of appetite, it was observed that the control treatment led to a significantly lower average appetite compared to navy bean and yellow pea treatments over the 150 min **(Figure 5.4)**. However, there was no significant difference in average appetite among the three treatments at each time point **(Figure 5.5A)**. For the subjective feeling of desire to eat, there was no significant difference over the 150 min **(Figure 5.4)**, however, differences were observed at 90 and 120 min among the three treatments **(Figure 5.5B)**. Similarly, the control treatment led to a significantly lower prospective food consumption compared to navy bean over the 150 min **(Figure 5.4)**, however, such effect was not observed when assessing the subjective feeling of prospective food consumption at each time point **(Figure 5.5E)**. This observation was due to the fact that the differences among the treatments were too small at each time point that the effects were not necessarily reflected in the average score of each component of subjective appetite over 150 min. The observation of the components of average appetite is consistent with the finding that there was a higher solid cumulative food intake in weight with the control treatment compared to the navy bean and yellow pea treatments **(Figure 5.2A)**, therefore, the subjective feeling of desire to eat, hunger, prospective food consumption and average appetite was lower after the control treatment compared to navy bean, yellow pea and/or both treatments.

It is worth to note that there was an effect of weight status on all components of subjective appetite **(Table 5.10)**. Heavier children had higher ratings in the subjective feeling of appetite, desire to eat, hunger, prospective food consumption and a lower rating in fullness compared to their lighter-to-normal weight counterparts. As discussed above, there is a higher increase in ghrelin level and a lower change in PYY_{3-36} level in obese girls compared to normal-weight girls after the consumption of a breakfast (101). The change in gastrointestinal hormones is consistent with the subjective feeling of appetite in obese girls. Moreover, this observation of average appetite supports the finding that heavier children had higher food intake at the pizza meal both in weight and energy **(Table 5.6)**.

Similar to the aforementioned components of subjective appetite, the average subjective feeling of flatulence was higher with the yellow pea treatment compared to the navy bean and control treatments **(Figure 5.6)**. However, this effect did not show when assessing the flatulence scores by time points **(Figure 5.7D)**. A study conducted by Seewi and colleagues (190) confirmed that pea flour induced a significantly higher level of flatulence compared to pea starch due to its natural constituents of the pea seeds, that is the high fibre and oligosaccharides contents. It was found that yellow pea treatment was rated higher in terms of stomach discomfort and flatulence compared to navy bean and control treatments, this had translated into a lower average physical comfort score after the yellow pea treatment. There was a 1.2% difference in the nausea score between yellow pea and navy bean treatments, 3% difference in flatulence score and 2.6% difference in average physical comfort score between yellow pea and the other two treatments **(Table 5.11)**. This observation proved that VAS was a precise research tool in measuring subjective feelings of physical comfort. All differences of gastrointestinal discomfort parameters were in the lowest decile (<10%), therefore, 1.2% to 3% differences were not meaningful either clinically or practically.

The results of the study support the hypothesis that the pureed pulses (beans or peas) added to a meal will have acceptable palatability. The study results did not find a significant difference in the rating of taste, mouthfeel, sweetness and pleasantness among the treatments

(Table 5.12& 5.13). The control treatment was rated as having a higher flavour intensity compared to the navy bean treatment, however, all three types of treatments received an average score between "about right" and "too strong" **(Table 5.12, Figure 5.8C)**. Therefore the significant difference was not meaningful in a practical setting.

There was a moderate and positive correlation between average appetite, desire to eat, hunger, prospective food consumption and food intake. This indicated that VAS was a precise tool in measuring all components of subjective appetite, and they did predict food intake in children. Normal physiological response was reflected in the correlation that when children were hungry, they ate more and when they felt full, they decreased their food intake. Two components of gastrointestinal comfort, including wellness and average physical comfort, had a negative correlation with food intake, however the strength of the correlation was weak due to the small r values **(Table 5.14)**. Among all sensory characteristics of the treatment, only sweetness had a weak and positive correlation with food intake. This indicated that the sensory properties of treatment did not predict subsequent food intake two hours later in children.

Participants were divided into two categories by median score in terms of restrained, emotional and restrained eating behaviours on the DEBQ. There was no difference found in food intake with a pizza meal between the two groups of participants for all three types of eating behaviours. This is not surprising as the average of all three times of eating was between "no" and "sometimes", which meant that they did not display any restrained eating behaviours.

One of the study limitations was that there was a session effect in both pizza intake and cumulative food intake in terms of weight and energy. Session effect on food intake was prominent in the present study. Children had a higher food intake at the pizza meal during the first study session compared to the second session regardless of the types of treatments **(Table 5.7)**. There was a higher level of excitement when participants were exposed to ad libitum pizza for the first time, this effect was especially prominent in this age group in the present study. Session effect acted as a confounding variable and it was included in the model for all data analysis. Randomization of the order of the treatments was employed in the present study, however, randomization did not eliminate session effect. For future nutrition clinical trials, it is helpful to employ a strict balanced design to avoid session effect. Another factor that could affect the accuracy of the results was the level of comprehension about VAS by the participants. There was thorough instructions provided to the participants at the screening session about how to complete the VAS properly, however, due to the young age of some participants, they may not fully comprehend the instructions. As a result, data may have been skewed due to their misinterpretation. As discussed above, the time between the treatment meal and the test meal was too short to observe an effect of pulses on subsequent food intake. The length of the study session could be increased in order to see an effect of higher level of fibre and protein content in meals formulated with pulses on subsequent food intake, additional time required ranges from 4 to 12 hours (143). However, this study was designed to reflect normal eating behaviour in children and adolescents aged 9 to 14 years, the results are applicable to real life setting.

In conclusion, the results of the present study support the hypothesis that pureed navy beans and yellow peas added to whole pasta and sauce are well tolerated and have acceptable palatability. However, adding pulses to a meal did not decrease subsequent food intake in children aged 9 to 14 years compared to a pulse-free meal.

Chapter 7: Future Directions

The present study indicates that when treatments were presented on an isocaloric basis, there was no effect of treatments on subsequent food intake in two hours. It's worth to note that in the present study, the control was high protein grain product – pasta made from durum wheat which is known to be a healthier alternative to other grain products with high GI. Therefore in the future studies, pulses should be compared to the regular pasta and other grain products with higher GI. Another limitation of the current study was the difference in volume between the treatments. Thus, the control had the highest volume of solid food due to the lower energy density of pasta compared to pulses. Although the approach used in this study reflects the usual practice of replacement (part of pasta were replaced with pulses), it cannot be excluded that the lack of difference between pulses and pasta control was due to the higher degree of gastric distension after control. Hence it will be important to study the difference in food intake after the isovolumetric treatments.

This study showed that pureed pulses added to a meal did not alter the taste, mouthfeel, sweetness and pleasantness of the meal. To determine if the preparation of pulses affects the palatability of the treatments, a study with whole pulses added to whole pasta and sauce could be conducted. This would represent a real-world situation where parents do not have time to puree pulses for their children at every meal. The study could also be designed to compare the effect on palatability and subsequent food intake between pureed and whole pulse treatments. Moreover, the present study only investigated two types of pulses: navy beans and yellow peas. In the next study, more types of pulses could be included as Canada is one of the largest pulse producers in the world, Canadians have access to a wide variety and adequate amount of pulses.

As mentioned in the discussion section, the amount of pulses provided in this research was less than one serving of recommended amount. In future clinical trials, exactly one serving of pulses could be provided to participants to investigate their physiological response. This will be clinically relevant as dietitians use Canada's Food Guide as a basis to teach their patients or clients about healthy eating.

In the present study, it is worth to note that alphabet pasta was used as part of the base of the treatment meal. This type of pasta is usually catered towards children because of its appearance. Parents of children need to consider how foods incorporated with pulses are presented to children in order to elicit their interest of consumption.

Canada is a multi-cultural country, not every culture consumes pasta and tomato sauce on a daily basis. In future studies, rice, noodles and mashed potatoes could be used as the base of the meal when mixing with pulses. This would be a more culturally diverse approach in terms of assessing tolerability of a treatment meal. The treatment meal and water were provided separately in the present study, it is helpful to incorporate water into the treatment in order to investigate if there is a difference in satiety and subsequent food intake among treatments in future studies.

There is an opportunity for the food industry to help children increase their fibre and protein intake from pulses by incorporating them in food products that are commonly consumed by children of different age. Possible products include snack bars, brownies and other types of snacks with the addition of either whole or pureed pulses. The purpose is to increase the availability of food products formulated with pulses in order to target a wider range of children.

Chapter 8: Conclusion

Adding pulses to the meals with pasta and tomato sauce resulted in their increased energy density and lower weight and volume compared to the pulse-free meal of the same energy content. Although the intake (g) of the treatments with added pulses was lower compared to pulse-free control, there was no difference in subsequent food intake in two hours despite the decreased subjective appetite (~2.5%) after the pulse-free control compared to the treatments with added pulses. The results from this study show that if provided on an isocaloric basis, meals formulated with pulses led to similar suppression of short-term food intake as the pasta control despite their higher energy density and lower weight. Pureed pulses (beans or peas) added to durum wheat pasta and tomato sauce were well tolerated, had acceptable palatability and led to increased fibre intake when consumed by 9-14 y children.

Adding pureed navy beans and yellow peas to durum wheat pasta presents an effective and practical approach to improve nutrient intake, reduce the serving of food with high level of available carbohydrate, such as pasta, and maintain the appetite suppression in children and adolescents.

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Appendices

Appendix 1

Appendix 2


ATTENTION!
Have a Child 9-14 years old ?
Why Participate?
FREE:
BREAKFAST
LUNCH
FUN ACTIVITIES!
A CHANCE TO MAKE FRIENDS!

Appendix 3

The Effect of Mixed Meals with Added Pureed Beans and Peas on Satiety and 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

The Effect of Mixed Meals with Added Pureed Beans and Peas on Satiety and 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
- Beans: Yes / No
- Peas: Yes / No
- Tomatoes and tomato juice: Yes / No
- Orange Juice: Yes / No
- Pasta: Yes / No
- Honey Nut Cheerios: Yes / No
- Apples: 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 behavioral or emotional problems? Yes / No
(If yes please explain:_______________ ____)
Include in study? Yes / No

Appointment scheduled for: (date and time)
____

Investigator/Date screened:
____

Appendix 4a

The Effect of Mixed Meals with Added Pureed Beans and Peas on Satiety and Food Intake in Children

Recruitment Letter for Parents

Dear Parent
A team of researchers from Mount Saint Vincent University 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 those people involved in the long-term health of Canadians.

We are asking the parents of girls and boys 9 - 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, holiday or summer mornings in our laboratory at 365 Evaristus Hall, Department of Applied Human Nutrition (166 Bedford Highway) MSVU. To determine your son/daughter's eligibility you will be asked first to attend a screening/information session.

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

- be between 9 to 14 years of age, and
- be healthy, and have been born at term, and
- not be taking medications.

As a reward for taking part, at each session the child will be given a movie pass or gift card to the bookstore ($10 gift certificate). In addition parents will be reimbursed for travel/parking expenses ($5 or bus tickets).

This study has been fully approved by the Research Ethics Board.

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. Connie Jing Nan Yu or Ms. Stephanie Keddy, 902-457-6378 at Mount Saint Vincent University (Department 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 and International 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 4b

The Effect of Mixed Meals with Added Pureed Beans and Peas on Satiety and Food Intake in Children

Study Information Sheet and Parent's Authorization Form

Investigators:

Ms. Connie Jing Nan Yu, M.Sc. AHN Student
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: (902)-457-6378
E-mail: appetite.study@msvu.ca

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

Dr. Bohdan Luhovyy, Principal Investigator
Department of Applied Human Nutrition, Mount Saint Vincent University
Phone: (902) 457-6256
Email: bohdan.luhovyy@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 = ¾ 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 3 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 type-2 diabetes.

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 pasta and tomato sauce with beans or with peas or without beans or peas) until they feel full. For example, your child will be asked to consume pasta and tomato sauce with pureed navy beans on the first session and pasta and tomato sauce with pasta on the second session or backward pasta and tomato sauce with pasta on the first session and pasta and tomato sauce with pureed 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 $10 gift card for each session and you will be compensated for the transportation ($5 per session day or bus tickets).

We anticipate having about 25 children enrolled in this study which is the part of large research project that is financially supported by Manitoba Pulse Growers Association. There are no conflict of interests between investigators and the sponsor.

PROCEDURE:

<u>Screening:</u>

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.

- <u>Menstrual Cycle Questionnaire:</u>

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.

- <u>Tanner's Staging:</u>

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's 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.

- <u>Body Composition Assessment:</u>

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.

<u>Experimental sessions:</u>

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 7:30 am (the time must be consistent for each session day). The children will arrive at MSVU at 10:00 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 and we will ask your son/daughter to eat and drink as little or as much meal and water as he/she wants. Once your child feels full and does not want to eat and drink anymore, we will remove the leftover of the meal and water, and will ask your child to complete the questionnaires rating the taste of the meal. At 15, 30, 60, 90, and 120 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 15, 30, 60, 90, and 120 min. 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 pasta and tomato sauce 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, puzzles, cards, 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: 7:30 pm	The last meal of the day. No food or beverages (except water) should be consumed in the following 12 hours.
Session day: 7:30 am	At home: consume the standardized breakfast we provided before
10:00 am	Arrive to the lab
10:05 – 10:25 am	Complete baseline questionnaires for recent food intake, appetite and physical comfort
10:30 am	Consume a test meal (pasta and tomato sauce with or without beans or peas). You can eat as much as you want until you feel comfortably full.
10:40 am – 12:30 pm	We will ask you to complete questionnaires about the taste of the meal you just ate, your appetite and how do you feel at certain time points.
12:30 pm	Pizza meal is provided. You can eat as much as you want until you feel comfortably full.
12:45 pm	Fill out the questionnaire about the taste of the pizza
12:50 pm	The session is completed
Total hours in the lab: less than 3 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 average 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 labeled. 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: Dr. Bohdan Luhovyy (902-457-6256). You can also contact our Study Coordinator Ms. Stephanie Keddy at (902) 457-6378 and leave a message. 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 $10 gift certificate to the theatre or bookstore. 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 around one year after the end of the study.

The Effect of Edible Beans and Peas on Satiation, Satiety and 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 4c

The Effect of Mixed Meals with Added Pureed Beans and Peas on Satiety and Food Intake in Children

Children's Assent Form

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

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 5a

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?

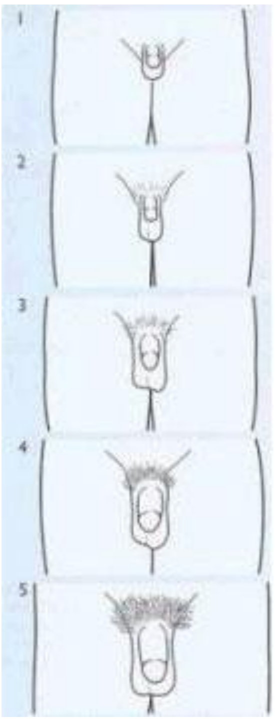
1. there have been no changes
2. changes have barely begun
3. changes are definitely underway
4. changes are already complete

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

Appendix 5b (For boy)

Tanner's Staging

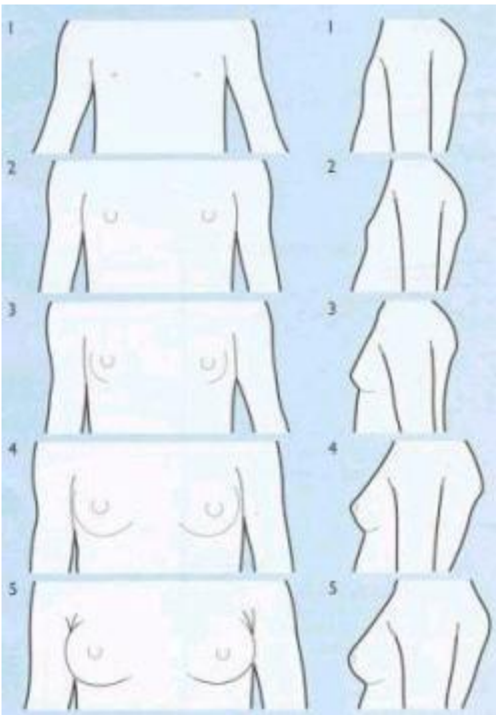
ID: ____________ Date:____________________



Appendix 5b (For girl)

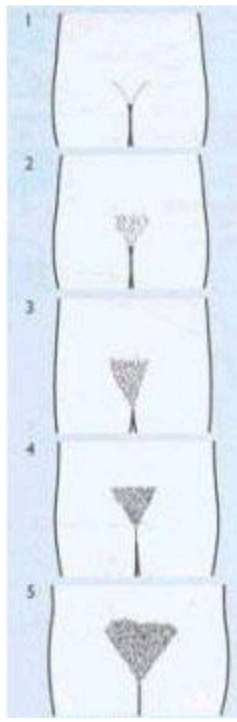
Tanner's Staging

ID: ____________ Date:____________________



Tanner's Staging

ID: ____________ Date:____________________



Appendix 5c

Menstrual 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 [menses] to the beginning of the next menstrual flow [menses])

   My average cycle length is _____ days.

7. 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

8. In the past 3 months, estimate how many menstrual cycles you have had?

   I have had _______cycles in the past 3 months

9. In the past 6 months, estimate how many menstrual cycles you have had?

   I have had _______cycles in the past 6 months

10. In the past 9 months, estimate how many menstrual cycles you have had?

    I have had _______cycles in the past 9 months

11. In the past 12 months, estimate how many menstrual cycles you have had?

I have had _______cycles in the past 12 months

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

    Circle one: Heavy Moderate Light

13. Do you experience cramps during menses?

    Circle One: Always Sometimes Never

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

    Circle one: Always Sometimes Never

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

    Circle one: Always Sometimes Never

Appendix 6
Physical Activity Questionnaire

PAST YEAR PHYSICAL ACTIVITY

Check all the activities that you did at least ten times in the **PAST YEAR**. Include times spent in school physical education classes. Make sure you include all sport teams that you participated in during the last year.

____ Aerobics
____ Band/Drill Team
____ Baseball
____ Basketball
____ Bicycling
____ Bowling
____ Cheerleading
____ Dance Class
____ Football
____ Garden/Yard Work
____ Gymnastics
____ Hiking
____ Ice Skating
____ Roller Skating
____ Running for Exercise
____ Skateboarding
____ Snow Skiing
____ Soccer
____ Softball
____ Street Hockey
____ Swimming (Laps)
____ Tennis
____ Volleyball
____ Water Skiing
____ Weight Training
____ Wrestling (Competitive)
____ Others
____
____
____

List each activity that you checked above in the "Activity" box below, check the months you did each activity and then estimate the amount of time spent in each activity.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Months Per Year	Days Per Week	Minutes Per Day

Appendix 7

Dutch Eating Habits Questionnaire **turn over.**

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 8

The Effect of Edible Beans and Peas on Satiation, Satiety and 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 9

Visual Analogue Scale
Motivation to Eat

DATE: ____________________ Treatment ID ____ Session ________

ID: ________________________ Time point: 0 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 10

Visual Analogue Scale
Physical Comfort

DATE: ____________________ Session ________

Treatment ID ____

ID: ________________________ Time point: 0 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 all ____ VERY well

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 11

The Effect of Edible Beans and Peas on Satiation, Satiety and Food Intake in Children

Visual Analogue Scale
Pleasantness (treatment)

DATE: ____________________ Treatment ID ____ Session ________

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

Appendix11a

The Effect of Edible Beans and Peas on Satiation, Satiety and Food Intake in Children

Peryam & Kroll hedonic scale

DATE: ____________________ Treatment ID ____ Session ________

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 11b

The Effect of Edible Beans and Peas on Satiation, Satiety and 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 11c

The Effect of Edible Beans and Peas on Satiation, Satiety and Food Intake in Children

Hedonic scale: flavour

DATE: ____________________ Treatment ID ____ Session ________

ID: ________________________ Actual time:________________

Was the flavour 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 11d

The Effect of Edible Beans and Peas on Satiation, Satiety and 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 12

Pleasantness (pizza)

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