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

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1. Introduction

An increasing epidemic of obesity has become a public health priority that requires solutions not only among adults but also among children and adolescents. Unhealthy eating habits in children, especially a high intake of energy-dense foods, are considered to promote childhood obesity. Evidence has shown that maintaining energy balance by regulating appetite is an effective strategy to prevent weight gain. Meanwhile, pulses, the dried seeds of legumes, represent an important component of the traditional diet of many regions in the world while underconsumed in North America. Pulses are packed with plenty of protein, dietary fibre and a variety of macronutrients as well as being low in fat and energy density, and those nutritional attributes may be beneficial for appetite control. Therefore, the proposed study examines whether cooked whole pulses have an influence on subjective appetite and food intake among children.

2. Literature review

2-1. Obesity

2-1-1. Obesity prevalence and trends

Obesity has been a major health hazard in the world over the past 20 years in both developed and developing countries (Lau et al., 2007). Body mass index (BMI), defined as the weight in kilograms divided by the height in meters squared (kg/m^2), is a commonly used measurement of overweight and obesity. World Health Organization (2016) and (Centers for Disease Control and Prevention, 2016) defined overweight as having a BMI between 25.0 and 29.9 kg/m^2 and obesity as having a BMI greater than 30.0 kg/m^2 for adults aged 20 years or over. For children and youth aged between 5 to 19 years, overweight is defined as having a BMI at or above the 85th percentile and below the 95th percentile of the same age and sex. Obesity is defined as having a BMI at or above the 95th percentile of the same age and sex. The worldwide prevalence of obesity increased more than two-fold from 1980 to 2014 reaching 13% among adults globally. In addition, 38% of men and 40% of women were overweight in 2014 (World Health Organization, 2016). Weight problems are no longer a concern only among adults but also among children and adolescents; 42 million infants and young children were overweight or obese worldwide in 2013 and the WHO estimates that the number will achieve 70 million by 2025 if current trends continue (World Health Organization, 2015). Canadian society is facing a growing problem with childhood obesity as well. The Public Health Agency of Canada (2011) reported that the prevalence of overweight and obesity among those aged 2 to 17 years increased from 15% in 1978/79 to 26% in 2004. The biggest surge was seen in the prevalence among 12 to 17-year-old youth, an increase from 14% to 29%. In 2012, at least 25% of children and youth in Canada were overweight or obese.

2-1-2. Health and social risks associated with childhood obesity

Childhood obesity is of particular concern regarding the health and well-being of the child. It will increase the likelihood of weight problems in adolescence and adulthood and bring both immediate and long-term negative health consequences including a higher risk of premature onset of chronic diseases (Childhood Obesity Foundation, 2015). Obesity itself is a significant risk factor for a range of serious health conditions such as hypertension, dyslipidemia, type II diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis (a breakdown of cartilage and bone within a joint), sleep apnea, breathing problems, some cancers (endometrial, breast, colon, kidney, gallbladder, and liver), mental illness (clinical depression, anxiety, and other mental disorders, etc.), body pain and difficulty with physical functioning, (Centers for Disease Control and Prevention, 2015).

Apart from serious health issues, overweight and obese individuals face harmful stigmas which are widespread in North American society. Such stigmas are called weight bias, the assumption or conclusion that those who are overweight and obese are lazy, sloppy, less competent, lacking in self-discipline, disagreeable, less conscientious, and poor role models. These judgements bring inequities in various aspects of the social lives of people with excessive weights (Puhl & Heuer, 2010). For instance, in employment settings, obese individuals have less job opportunities (especially jobs that involve direct interactions with the public), lower wages, less chance of receiving promotions, and increased risk of job termination due to their body weight. Even professionals in health care settings such as physicians and nurses ascribe stereotypes to their obese patients, that their overweightness and obesity is a result of behavioral problems such as lower self-restraint (Puhl & Heuer, 2009). Many trials evidenced that such weight biases cause stress in obese people and lead them to embrace a fat-shaming feeling. This

often ends in over-calorie consumption and further weight gain, creating a vicious cycle (Tomiyama, 2014). Moreover, overweight and obese children, adolescents and even preschoolers at age three can be the brunt of weight stigma; they are perceived as lazy, stupid, ugly and undesirable playmates by their peers (Puhl & Latner, 2007). Such negative attitudes can also worsen as children get older. Neumark-Sztainer et al. (2002) found that approximately 30% of overweight girls and 24% of overweight boys in middle and high school reported weight-based teasing from peers; the prevalence of weight-based bullying jumped to approximately 60% for both obese male and female students. Weight bias also influences academic success. Teachers and other educators have lower expectations for students with weight problems compared with thinner students. This makes them less willing to accept obese students for admission into college, regardless of their comparable academic performance (Washington, 2011). As a consequence of weight-related discrimination, the children and adolescents are more likely to skip school and experience symptoms of depression, low self-esteem and suicidal thoughts (Washington, 2011).

Obesity also places great economic pressures on a country. Canada's economic burden due to overweight and obesity was estimated at 4.3 billion dollars in 2011, accounting for 2.6% of all health care costs in Canada (Katzmarzyk & Janssen, 2004). In addition, Cawley, Rizzo, and Haas (2007) examined data from the Medical Expenditure Panel Survey for 2000–2004 and reported that job absenteeism is associated with obesity, costing a total \$4.3 billion annually in the United States. Gates, Succop, Brehm, Gillespie, and Sommers (2008) also demonstrated that obese workers were less efficient because of longer time required to finish tasks and less ability to perform physical job demands compared to other employees. This was reflected in a 4.2% health-related loss in productivity, which was 1.18% more than that of all other employees,

corresponding to \$506/year of loss in productivity per worker. Meanwhile, findings from research by the Trust for America's Health (TFAH) concluded that strategic investments (\$10 per person a year) in proven community-based programs to promote healthy livings can yield significant savings of over \$16 billion within five years (Trust for America's Health, 2008).

2-2. The regulation of appetite and food intake in children

2-2-1. Homeostatic factors

Considerable evidence supports the theory that body weight and fat content are well regulated within our body system; despite the fluctuation of daily food intake, body weights tend to remain within comparatively narrow ranges in adult animals and humans (Havel, 2001). Numerous peripheral signals such as nutrients, nutrient metabolites, or hormones are considered to be involved in energy homeostasis, and they are categorized into short-term and long-term signals (Havel, 2001).

In short-term regulation of food intake and energy balance, changes in plasma glucose levels appear to evoke meal initiation and termination. It was demonstrated that spontaneous feeding in rats was followed by small transient decreases in blood glucose (10-15mg/dl), and meal initiation was prevented when the declines were inhibited (Campfield & Smith, 1990; Havel, 2001). This transient decrease in blood glucose are detected and recognized by the populations of glucose-sensitive neural elements in the ventromedial and lateral hypothalamus, which transforms the signal to meal requests in humans (Campfield & Smith, 2003). Other nutrients, such as protein (Porrini et al., 1997) and fat (Friedman, Harris, Ji, Ramirez, & Tordoff, 1999), and metabolites including lactate and pyruvate (Nagase, Bray, & York, 1996) are also involved in short-term regulation on food intake.

In addition, gastrointestinal (GI) peptide hormones have been implicated in food intake regulation, and most GI peptides uniformly inhibit food intake. Glucagon-like peptide (GLP-1) is released by endocrine L cells of the small intestine in response to the entry of nutrients (Hellstrom, 2009; Stanley, Wynne, McGowan, & Bloom, 2005). GLP-1 can enhance all phases of insulin biosynthesis, even prior to the elevation of blood sugar levels, and therefore it is considered as an incretin hormone (Hellstrom, 2009; Stanley et al., 2005). As its main action, GLP-1 inhibits gastrointestinal motility and delays the gastric emptying within a few minutes after a meal. About 30 to 40 minutes later, insulin-dependent glucose control, promoted by GLP-1, takes place in order to digest nutrients (Hellstrom, 2009; Stanley et al., 2005). A meta-analysis of the studies on GLP-1 infusion and ad libitum food intake indicated a dose-dependent inhibitory effect of GLP-1 on food intake both in lean and overweight subjects (Verdich et al., 2001).

Cholecystokinin (CCK) is a more well-known GI hormone, secreted from enteroendocrine cells in the duodenum (the first segment of the small intestine) rapidly after meal ingestion (Hillebrand, de Wied, & Adan, 2002). CCK is also synthesized in central nervous system (CNS) and released from hypothalamic neurons during feeding (Havel, 2001). CCK strongly affects meal size by increasing satiety following ingested and digested nutrient stimulants such as long chain fatty acids, amino acids and small peptides (Havel, 2001; Hillebrand et al., 2002). There are two kinds of receptors for CCK. The CCKA receptor is found in the pancreas, stomach, enteric neurons, nervous vagus and nucleus of the solitary tract (NTS), and activated by CCK to inhibit food intake (Hillebrand et al., 2002). Otsuka Long-Evans Tokushima Fatty rats lacking CCKA receptor exhibited an increased food intake and weight gain (Moran, Katz, Plata-Salaman, & Schwartz, 1998), and blocking this receptor in rats attenuated

satiety actions of CCK (Moran, Ameglio, Schwartz, & McHugh, 1992). Another receptor, CCKB is widely distributed in the brain, such as NTS, the paraventricular nucleus (PVN), and ventromedial hypothalamus (VMH), and subtly in the stomach (Hillebrand et al., 2002). In the study conducted by Figlewicz, Sipols, Porte, Woods, and Liddle (1989) using baboons, only intraventricular infusion of CCK reduced food intake while both intraventricular and intravenous infusion regulated gastric emptying.

In contrast to the anorexigenic effects of other GI hormones, ghrelin has orexigenic effects. A majority of circulating ghrelin derives from the stomach, with a smaller proportion from duodenum (Ariyasu et al., 2001). Ghrelin expression has also been identified in the hypothalamus, in the internuclear space between the lateral hypothalamus, the arcuate nucleus (ARC), the ventromedial nucleus (VMN), the dorsomedial nucleus (DMN), PVN, and the ependymal layer of the third ventricle. (Korbonits, Goldstone, Gueorguiev, & Grossman, 2004). Endogenous ghrelin levels largely depend on acute and chronic nutritional status, fluctuating throughout the day. There are especially high concentrations of ghrelin before eating and during the night and these decrease immediately after eating or with the presence of nutrients in the stomach (Ariyasu et al., 2001; Havel, 2001; Korbonits et al., 2004). Cummings, Frayo, Marmonier, Aubert, and Chapelot (2004) found a positive correlation between plasma ghrelin levels and hunger scores at voluntary meal initiation without time- or food-related cues in humans, which indicates a role of ghrelin in meal initiation. Besides short-term regulation of food intake, ghrelin might also play a role in long-term regulation (see the section below).

These short-term signals of nutrients and hormones by themselves are insufficient to maintain energy balance and body adiposity; however, it can be achieved through interactions between short and long-term regulators such as leptin and insulin.

In 1994, the human obese (OB) gene was discovered to encode leptin and to be exclusively expressed in white adipose tissues. Leptin is also synthesized in small amounts in other tissues such as the stomach, mammary epithelium, placenta and heart (Klok, Jakobsdottir, & Drent, 2007). The plasma leptin levels are proportional to body fat mass; Schwartz, Peskind, Raskind, Boyko, and Porte (1996) showed that subjects with higher BMI and total body fat rate had higher plasma and cerebrospinal fluid (CSF) leptin levels. After released from adipose tissues, leptin signals to brain by crossing the blood-brain barrier (BBB) and binds to leptin receptors, which are highly expressed in the hypothalamus and cerebellum. This signal affects the activity of various hypothalamic neurones and the expression of orexigenic and anorexigenic neuropeptides, which are found all over the hypothalamic regions and interact with each other (Klok et al., 2007). Orexigenic peptides include neuropeptide Y (NPY), melanin-concentrating hormone, agouti-related protein (AgRP), galanin, orexin and galanin-like peptide (GALP), and anorexigenic peptides include pro-opiomelanocortin (POMC), cocaine- and amphetamine-regulated transcript (CART), neurotensin, corticotropin-releasing hormone (CRH) and brain-derived neurotrophic factor (BDNF). The plasma concentrations of orexigenic and anorexigenic neuropeptides are modulated by leptin (Klok et al., 2007). Both rodent and human studies demonstrated that the secretion of leptin decrease food intake and increase energy expenditure (Licinio et al., 2004; Pelleymounter et al., 1995).

It has been known since 1970s that the pancreatic hormone insulin is related to a long-term regulation of energy balance and body adiposity (Havel, 2001). Similar to leptin, the plasma

insulin concentrations depend on total body fat stores and fat distribution, particularly visceral fat. While plasma leptin levels are relatively stable to meal ingestion, however, insulin levels are drastically affected by food intake (Stanley et al., 2005).

The insulin receptor (IR) is expressed in various regions of the brain, particularly in hypothalamic nucleus, implicated in food intake, amongst others ARC, DMH and PVN. Insulin enters CNS through BBB by receptor-mediated transport, proportionally to circulating insulin concentrations, to regulate energy metabolism (Plum, Schubert, & Bruning, 2005). The direct infusion of insulin to the brain has been reported to produce an anorexigenic effect, leading to body weight loss, whilst the inhibition of brain insulin signaling carries an orexigenic effect to increase body weight linked to peripheral insulin resistance (Plum et al., 2005).

Recent experimental studies using rats have demonstrated that centrally administered insulin inhibits the gene expression of orexigenic peptide NPY, in the hypothalamic arcuate nucleus, which results in an increased secretion of the anorexigenic peptide CRH and CKK in the paraventricular nucleus (Schwartz, Seeley, Campfield, Burn, & Baskin, 1996; Schwartz et al., 1992). Not only the NPY but also melanocortin systems appear to be key mediators for insulin's effects on energy homeostasis. Administration of insulin into the third cerebral ventricle of fasted rats increased anorexigenic POMC levels, and melanocortin antagonist prevented the catabolic actions of insulin (Benoit et al., 2002).

Besides short-term food intake regulation, ghrelin may also be involved in long-term control of energy homeostasis. From a review by Klok et al. (2007), there is an inverse association between circulating ghrelin concentrations and BMIs in humans. Additionally, ghrelin levels increase as obese individuals lose weight while levels decrease when anorexia

nervosa patients gain weight. This indicates that the secretion of ghrelin is sensibly adjusted in response to body weight changes.

The role of ghrelin in long-term energy stabilization may be largely mediated by the hypothalamus. Several pathways are proposed for orexigenic effects of ghrelin. The first is that after the release into the bloodstream by the stomach, ghrelin may cross the BBB and bind to its receptors in the hypothalamus. Another possibility is that ghrelin is also produced locally in the hypothalamus, which directly affects the various hypothalamic nuclei (Klok et al., 2007). It is reported that ghrelin stimulates the activity of neurons expressing NPY, AgRP and orexin (Nakazato et al., 2001), while ghrelin has an inhibitory effect on POMC neurons and CRH-producing neurons (Cowley et al., 2003).

2-2-2. Hedonic factors

A growing body of evidence indicates that the homeostatic pathway can be overruled by neuronal mechanisms which together are called the hedonic pathway; the pathway is activated by addictive properties of palatable foods including visual and sensory cues, even without energy needs (Lutter & Nestler, 2009). Especially, palatable foods high in fat and sugar cause rapid dopamine release from the nerve terminals in the ventral tegmental area (VTA) to the neurons in the nucleus accumbens, which thereby facilitates behaviors that are oriented toward obtaining the rewarding stimuli (Lutter & Nestler, 2009).

Evidence proved that the brain regions activated by a food reward stimulus are the same as those responsive for drug abuse (Benite-Ribeiro, Putt, Soares-Filho, & Santos, 2016; Hyman, Malenka, & Nestler, 2006). The growing prevalence of obesity indicates that a greater proportion of human food consumption is driven by craving for highly-palatable foods and not just by the

need for calories (Lowe & Butryn, 2007). Furthermore, food craving and the ability to regulate it are correlated with age and children are relatively vulnerable to the visibility of tempting foods. Silvers et al. (2014) conducted a study to examine differences in the ability to cognitively regulate craving between those aged 6 to 23 years, and found that older participants showed more cognitive control on food cravings recruiting dorsolateral prefrontal regions and more attenuation of ventral striatum responses involved in the rewarding pathway. Therefore, the addictive potential for palatable foods combined with their widespread availability makes them a possible contributor to the obesity epidemic, more likely among children.

2-2-3. The role of social environment factors

Home environment

Environmental characteristics significantly influence children's eating behavior, especially the home environment. Appetite control and food preferences are established early in life (Gluckman, Nishtar, & Armstrong, 2015), and children consume approximately two-thirds of meals at home despite the increasing consumption of fast or convenience food and trends towards eating away from home (Rosenkranz & Dzewaltowski, 2008). An analysis based on the data from the United States National Longitudinal Study of Adolescent involving grade 7 to 12 students revealed that the risk for excessive weight among female adolescents can be reduced with fulfilled parental education, a strong awareness that parents care about them, and a high self-esteem (Crossman, Anne Sullivan, & Benin, 2006). Moreover, the frequency of sharing a meal with family proved to be associated with children's health condition and eating habits. Children who shared family meals three or more times per week were more likely to be within a normal weight

range, to have healthier eating patterns and less risk of developing an eating disorder than those who shared meals fewer than three times (Hammons & Fiese, 2011).

Food insecurity

Food insecurity occurs in a household when access to healthy foods is limited mainly by a strict budget and proximity of food sources (Statistics Canada, 2015b). According to the 2011-2012 Canadian Community Health Survey (CCHS), 8.3% of Canadian households (approximately 1.1 million households) experienced food insecurity. Among the different demographics of households, single parent families with child(ren) have the highest rate of food insecurity, (22.6%) (Statistics Canada, 2015b). Recent studies provide evidence of a significant relationship between food insecurity and obesity. For instance, children and adolescents aged 12 to 18 years in families experiencing moderate low, low, and very low food security had 1.4 to 1.5 times greater possibilities of central obesity compared to those with high food security, based on a national survey from 1999 to 2006 in the United States (Holben & Taylor, 2015). There are several environmental factors related to this association of food insecurity with obesity. In most cases, lower income neighborhoods lack full-service grocery stores and farmers' markets, where a variety of wholesome fruits, vegetables, whole grains, and low-fat dairy products are available (Beaulac, Kristjansson, & Cummins, 2009; Larson, Story, & Nelson, 2009). Instead, residents in those areas, especially with poor transportation services, can only access small neighborhood convenience stores or corner shops, where there is a poor selection of fresh products and low-fat items. Even if healthy foods are available, those items are often more expensive (Beaulac et al., 2009; Larson et al., 2009). For low-income households, it is more reasonable to purchase cheap foods with high energy density, which are often high in refined sugar and fat and low in nutritional quality (Beaulac et al., 2009). Moreover, low-income

communities tend to have more easy access to fast food restaurants, which typically serve energy-dense, nutrient-poor foods at relatively low prices (Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011). Fast food consumption is associated with a diet high in calories and low in nutrients, and frequent consumption of fast food leads to weight gain (Pereira et al., 2005).

2-2-4. Physical inactivity

Body weight will increase primarily when energy intake exceeds energy expenditure over a given period of time. Physical activity is the most variable component of energy expenditure (Hill, Wyatt, & Peters, 2012). Numerous studies have already evidenced that a decrease in physical activity is a key contributor to the global obesity epidemic and consequential chronic disease (Daniels et al., 2005; Dietz, 2004; Koplan, Liverman, Kraak, Committee on Prevention of Obesity in, & Youth, 2005).

A comprehensive review of published studies examining potential correlates of physical activity of youth (children aged 3 to 12 years and adolescents aged 13–18 years) found variables that were consistently and positively associated with physical activity. These included sex (male), ethnicity (white), perceived activity competence, intentions, previous physical activity, community sports, sensation seeking, support from parents and others, sibling physical activity, direct help from parents, and opportunities to exercise. Inverse associations were also found in variables of age, depression, and being sedentary after school and on weekends (Sallis, Prochaska, & Taylor, 2000). According to the Canadian Health Measures Survey (2012 and 2013), children and youth spent the majority of their time being sedentary; children aged 12 to 17 were sedentary for 9 hours and 16 minutes per day, which was nearly two-thirds of their waking hours, while only 50 minutes were allocated to moderate-to-vigorous physical activity

(Statistics Canada, 2015a). Although the WHO recommends the equivalent of at least one hour of moderate aerobic physical activity per week for children (World Health Organization, n.d.), only about 6% of 12 to 17- year-old children achieved the daily recommendation. This age group was also significantly more sedentary and less active than their 5 to 11-year-old counterparts.

2-2-5. Unhealthy eating habits

Evidence has shown that healthy eating habits in children are strongly correlated with their proper growth and development as well as the reduced risk of obesity and chronic diseases in adulthood (Health Canada, 2012b). Eating habits developed at a young age are vulnerable to change by influences from families, schools and communities, and are likely to continue into adulthood (Van Cauwenberghe et al., 2010). However, findings from the CCHS indicated that Canadian children and adolescents aged 9 to 18 years may be making unhealthy food choices (Health Canada, 2012a). Firstly, based on the overweight/obese proportion, three out of ten adolescents were estimated to have consumed excessive energy compared to their energy requirements. In addition, while grain products like bread, cereals, pasta and rice were a primary energy provider, supplying 31% of calories at ages 4 to 18, the foods categorized “other foods” ranked second, providing 22% of daily calories on average. The "other foods" group covers foods that do not belong to one of the four food groups in Canada’s Food Guide including foods that are mostly fats and oils (butter, margarine, vegetable oil, etc.), foods that are mostly sugar (jam, honey, syrup, candies, etc.), snacks such as chips (potato, corn, etc.) that are high in fat and salt, beverages (soft drinks, tea, coffee, etc.), and herbs, spices and condiments (Statistics Canada, 2007). In the “other foods” group, sugar sweetened beverages were the most consumed food by

children. Moreover, according to the survey, the proportion of daily energy intake from snacks among children and adolescents was 27 %, which was more than the calories taken from breakfast and nearly the same as that taken from lunch. While Statistics Canada defines snacks as foods or drinks consumed between meals and therefore fruits and milk can be considered as snacks as well, children mostly consumed energy-dense and nutrient-poor foods for snacks, such as sugar-sweetened beverages, cookies, candies, pizza and hot dog (Gilbert, Miller, Olson, & St-Pierre, 2012; Statistics Canada, 2007). Large consumption of high-energy dense food may contribute to the positive energy balance in children and adolescents. While children were overconsuming nutrient-poor snack foods, they were not reaching the recommended daily intake of vegetable and fruits. Canada's Food Guide recommends a minimum of six to eight daily servings of vegetables and fruit for those who aged 9 to 14 years (Health Canada, 2011). One serving would be, for example, a medium-sized apple, two stalks of broccoli, or 125 milliliters (1/2 cup) of juice. However, in 2004, 62% of girls and 68% of boys aged 9 to 13 years consumed less than five servings of vegetables and fruits. This may contribute to the reported inadequate intake of some macronutrients and dietary fibre. Specifically, there was widespread underconsumption of vitamin A (for girls aged 9 to 13 years and both genders aged 14 to 18 years), vitamin D (for both genders, in all ages), magnesium (for both genders aged 14 to 18 years), phosphorous (for girls aged 9 to 18 years), and calcium (for both genders, in all ages). Moreover, the median intake of potassium did not reach the Adequate Intake (AI) of 4500 to 4700 mg/day among children and adolescents aged 9 to 18 years while more than 80% of girls and 97% of males consumed sodium in amounts above the Tolerable Upper Intake Level (UL) of 2300 mg/day. In terms of dietary fibre, the AI is 26 g/day for girls aged 9 to 18 years, 31 g and 38 g/day for boys aged 9 to 13 and 14 to 18 years, respectively. However, the reported daily

median fibre intakes for these age groups were 14.0 g/day (girls) and 16.3 g/day and 18.2 g/day (boys) respectively: almost half of the AI values. Thus, Canadian children need more foods with low-energy density and high amounts of dietary fibre and macronutrients.

2-3. Pulses and their role in the metabolic regulations

2-3-1. Pulses: definition and production

According to the Food and Agriculture organization (FAO), pulses are a type of legume that are harvested exclusively for the dry grain, including dried beans, lentils and peas. Legume crops that are harvested green (e.g. green peas and green beans), those that are primarily used for their oil content (e.g. soybean and groundnuts) and those that are mostly used for planting purposes (e.g. seeds of clover and alfalfa) are not considered pulses (Food and Agriculture Organization, 2015). The first cultivation of pulses dates back to thousands of years ago and nowadays they are produced all over the world, including countries such as India, Canada, China, Myanmar, and Brazil (Food and Agriculture Organization of the United Nations, 2016; India Pulses and Grains Association, 2015)

Pulse Canada reports that Canada has been significantly contributing to the production and exportation of pulses worldwide (Pulse Canada, n.d.-b). It was shown that Canada exported 6 million tons of pulses in 2015, with estimated profits of over \$4.2 billion. Currently Canada's pulse export accounts for approximately 35% of the annual global pulse trade. In the lentils and peas production industries, Canada accounted for 55% and 50% of world trades in 2008, respectively (Pulse Canada, n.d.-b). In addition, as shown in the survey, Canada is a top five exporter of both dry beans and chickpeas.

2-3-2. Current consumption of pulses

Pulses represent an important component of the traditional diet of many regions across the world, especially in Asia, India, South America, the Middle East, and Mexico (M. J. Messina, 1999). In many Western countries, on the other hand, beans play a less significant dietary role.

Few adults in North America may be consuming pulses in their usual diet. It was estimated that 30% of U.S. adults were legume consumers and only about 40 to 45% of them achieved the USDA-recommended intake of legumes (three cups /week) (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009; McCrory, Hamaker, Lovejoy, & Eichelsdoerfer, 2010). According to McCrory et al. (2010), the weighted average intake of legumes among U.S. adults is approximately 0.15 cup (36 mL)/day. In Canada, only 20% of adults consumed some kind of pulse on a weekly basis at home (IPSOS REID, 2010). Furthermore, households spent annually an average of \$4 on peas (bottled or canned), \$6 on beans (bottled or canned) and \$7 on dried vegetables and legumes from a total of \$ 8,629 average annual food expenditure (Statistics Canada, 2017). Although pulse consumption among children in Canada has not been extensively reported, poor consumption of pulses can be presumed for children based on the expenditure data above. A study reported that only 8.2% of children aged 2 to 18 years in Manitoba consumed pulse/soy products on any given day (Mudryj, Aukema, Fieldhouse, & Yu, 2016). According to the Canada's Food Guide, the age group between 9 to 13 years is recommended to consume one to two servings of meat and alternatives, especially plant-based foods such as beans, lentils and tofu. One serving of cooked legumes is 3/4 cup (175 mL) (Health Canada, 2011).

2-3-3. Nutritional characteristics of pulses

Pulses are a rich source of protein, dietary fibre, B vitamins (folate, thiamin and niacin), minerals (iron, potassium, magnesium and zinc) and relatively low in fat.

Protein

The protein content of pulses typically ranges from 21 to 26%, which is comparable to the protein content of meats (18 to 25%), while cereals only have a protein content of 7 to 13% (Pulse Canada, n.d.-a; Rebello, Greenway, & Finley, 2014). Protein obtained from pulses is significantly more affordable compared to animal-sourced foods, and this fact makes pulses a practical dietary choice for people in food insecurity. According to Pulse Canada, for instance, the cost per serving of lentils is about \$0.10 whilst that of beef, pork and chicken is \$1.49, \$0.73, \$0.63 respectively (Pulse Canada, n.d.-d).

In evaluating the quality of protein from food sources, Protein Digestibility-Corrected Amino Acid Score (PDCAAS) is a commonly used measurement based on both the amino acid requirements of humans and how readily amino acids are digested (Schaafsma, 2012). In the latest study, navy beans, whole green lentils and yellow split peas showed the highest PDCAAS values (0.63 to 0.67), while black, kidney and pinto beans, chickpeas, split green peas and red lentils scored between 0.50 and 0.59 out of 1.00 (Pulse Canada, n.d.-a). Although the protein in pulses is typically lower in sulphur amino acids such as methionine, cysteine and tryptophan, protein can be nutritionally complemented through being combined with other protein sources (Pulse Canada, n.d.-a). For instance, the addition of lentil, black bean or pea, containing high amount of lysine but lacking sulphur amino acids, to cereal grains such as wheat or rice, which are low in lysine and rich in sulphur amino acids increase the overall PDCAAS values. While in the individual pulse or cereal components values range from 0.43 to 0.64, in blends, the value

can reach 0.71 to 0.75 (Pulse Canada, n.d.-a). Moreover, combining pulses with meat products (e.g., burgers, sausages, nuggets, etc.) not only improves the nutritional profile but also can create more satisfying texture and appearance. This results from functional properties of pulses including solubility, water and fat binding capacity and foaming (Boyea, Zareb, & Pletchc, 2010).

Carbohydrated

Tosh and Yada (2009) reported that 100g of pulses contain 14 to 32g fibre including both soluble and insoluble fibres. Soluble fibre can help to lower blood cholesterol levels and aid in blood glucose control. Oligosaccharides, a soluble fibre, also act as prebiotics. They nourish bacteria in the colon playing an important role to maintain a healthy digestive system (Eat Right Ontario, 2016; McCrory et al., 2010). On the other hand, insoluble fibre improves laxation by promoting more smooth transit of food materials through the digestive system. It can also provide more satiety and decrease subsequent food intake through its gastro-intestinal bulking effects (Saris, 2003). Resistant starch, which is neither degraded nor absorbed at digestive tracts, functions in a similar way to soluble fibre and carries positive health implications including an improvement of insulin sensitivity, lower blood sugar levels and regulated appetite (Nugent, 2005). Hoover, Hughes, Chung, and Liu (2010) reported that 22 to 45% of fibre in pulses consists of this indigestive starch.

Fat

Padhi, Liu, Hernandez, Tsao, and Ramdath (2016) analyzed fatty acid composition of 14 commercially-available cooked Canadian pulses, including three cultivars of pea (whole yellow pea, split yellow and green pea), three cultivars of lentils (large and small green lentil and split red lentil), four cultivars of bean (dark red kidney bean, navy bean, cranberry bean and, black turtle bean) and four cultivars of chickpea (Frontier chickpea [Kabuli], Leader chickpea [Kabuli],

Consul chickpea [Desi] and Cozy chickpea [Desi]). The fat content for most pulses was less than 3% in dry weight, with exception of chickpeas with approximately 8%, on average. Unsaturated fatty acids accounted for the greatest part of the fat content. These include polyunsaturated fatty acids (PUFA, 46.81 to 66.88% of total lipids), especially linoleic acid (18:2n-6, 27.09 to 60.75% of total lipids) and α -linolenic acid (18:3n-3, 2.64 to 37.47%), and monounsaturated fatty acids (MUFA, 10.25 to 34.21%), especially oleic acid (18:1 c Δ 9, 7.29 to 30.29%). The saturated fatty acid content, on the other hand, ranged from 14.25 to 20.64% including palmitic acid (16:0, 9.99 to 14.71%), stearic acid (18:0, 1.25 to 3.40%) and myristic acid (14:0, 0.3 to 3.46%). Moreover, pulses are free of trans fats and cholesterol (Pulse Canada, n.d.). In their dietary and lifestyle recommendations for general heart health, the American Heart Association recommends choosing foods low in saturated fat, trans fat, and cholesterol such as lean meats, meat alternatives such as beans, fish and non/low-fat dairy products (American Heart Association Nutrition et al., 2006). Furthermore, in the 2016 Canadian Cardiovascular Society Guidelines, dietary patterns that are high in legumes (four servings per week) are recommended for the management of dyslipidemia for the prevention of cardiovascular disease in adults (Anderson et al., 2016).

Energy density

Energy density is the amount of energy or calories per unit of weight and it is generally presented as the number of calories in a gram (kcal/g) (Rolls, 2009). It ranges from 0 kcal/g for water to 9 kcal/g for fat, varying depending on the macronutrient composition and water content of foods and beverages. Pulses have a relatively low-energy density (1.3 kcal/g) resulting from their high fibre content (McCrorry et al., 2010; Rebello et al., 2014). Recent research has

indicated that choosing foods with low energy density can be an effective strategy for the prevention and treatment of obesity as it reduces daily energy intake (Vernarelli, Mitchell, Hartman, & Rolls, 2011).

Vitamins and macronutrients

Legumes are rich in vitamins and minerals. Pulses, especially, contain substantial amounts of B vitamins such as riboflavin, thiamin, niacin, pyridoxine, which are essential for a fully functioning metabolism of carbohydrates, fats, and proteins (Campos-Vegaa, Loarca-Piña, & Oomah, 2010; Rebello et al., 2014). Although only 70 to 75% of B vitamins are generally retained after cooking, legumes can still make a substantial contribution to meeting dietary requirements for those nutrients (Augustin, 1981; Campos-Vegaa et al., 2010). According to Campos-Vegaa et al. (2010), lentils have 0.647, 0.062, and 0.93 mg 100 g⁻¹ d.m. (dry matter) of thiamine, riboflavin, and niacin, and broad beans have 0.253, 0.123, and 2.233 mg 100 g⁻¹ d.m. respectively. In addition, a half cup (one serving) of dried lentils, pinto beans, chickpeas, navy beans can provide 179, 147, 141, and 127 µg of folates respectively, and two or more servings of legumes is considered to meet the daily requirement intake of folates, approximately 400 µg (V. Messina, 2014; Rebello et al., 2014). Other vitamins which pulses contain are Vitamin E and A (Mudryj, Yu, & Aukema, 2014). Pulses also provide a significant amount of minerals, especially iron, zinc magnesium, and copper. While the bioavailability of minerals may be reduced by the presence of phytates in legumes, as phytates typically inhibit the absorption of essential dietary minerals, biological food processing techniques such as soaking, germination, hydrothermal treatment and fermentation have been shown to significantly promote phytates degradation (Sandberg, 2002). Beans and lentils have particularly high iron (110 and 122 µg g⁻¹, respectively) and zinc content (44 and 48 µg g⁻¹, respectively), although iron content varies

significantly depending on the variety. For example, white beans contain almost twice as much iron as black beans (Campos-Vegaa et al., 2010; Mudryj et al., 2014). The mean content of other minerals in dried pulses, expressed as $\mu\text{g g}^{-1}$ of the edible portion, generally range between 1.7 to 4.3 for copper, 0.08 to 0.31 for Chromium, 4.0 to 30.2 for aluminum, 0.05 to 0.26 for Nickel, and 0.37 to 0.69 for lead (Cabrera, Lloris, Gimenez, Olalla, & Lopez, 2003).

Mudryj et al. (2012) showed that, among Canadian adults who reported pulse consumption on any given day, fewer individuals were below the Estimated Average Requirement (EAR) for thiamin, vitamin B6, folate, iron, magnesium, phosphorus, and zinc compared with non-consumers. Similarly, preliminary findings have also shown that bean-consuming children reported greater intakes of magnesium and potassium as well as protein and fibre compared to non-consumers (Fulgoni, Papanikolaou, Fulgoni, Kelly, & Rose, 2006). The evidence above is consistent with the macronutrient profile of pulses mentioned earlier.

Phytochemicals

Pulses, especially black beans and red kidney beans, are rich in phytochemicals - the bioactive non-nutrient compounds found in plant foods - such as tannins, flavonoids and polyphenols (Liu, 2003; McCrory et al., 2010). It is evident that polyphenols inhibit the sodium dependent glucose transporter (SGLT1) on the small intestine, which may slow glucose absorption (Kobayashi et al., 2000); the potential positive effect of this slowing will be discussed in a later section.

2-3-4. The known effects of pulse consumption on the risk factors associated with metabolic syndrome

*** The effect of pulse consumption on anthropometric parameters**

Consumption of pulses can aid in the management of obesity and related co-morbidities due to their nutritional components acting in concert to increase a feeling of fullness resulting in regulation of overall food intake. (Rebello et al., 2014). As mentioned above, pulses are high in protein and fibre. Dietary protein has been proven to encourage weight loss by increasing energy expenditure primarily through its effects on diet-induced thermogenesis and by promoting satiety (Rebello, Liu, Greenway, & Dhurandhar, 2013; Weigle et al., 2005). Fibre can also slow down energy production from ingested meals and delay the occurrence of hunger sensation. This is a crucial factor in losing and maintaining body weight (Foster-Powell, Holt, & Brand-Miller, 2002; McCrory et al., 2010; Roberts, 2000). Furthermore, both epidemiological and experimental studies evidenced that high consumption of low-energy density foods such as legumes can be associated with significant weight loss (Rolls, 2009).

Many experimental studies demonstrated legumes may assist with weight loss and maintenance although the majority of these studies targeted obese or overweight individuals. In a nutritional intervention trial conducted by Abete, Parra, and Martinez (2009), 35 obese women were individually instructed by a trained dietitian to follow the prescribed dietary regime for one of four kinds of treatments (control, legume, fatty fish, and high-protein diet) for 8 consecutive weeks. Participants in the legume-diet group consumed legumes four days per week and accordingly had more vegetable protein than animal protein during the intervention period. The high-protein diet and legume diet achieved a greater body weight reduction ($8.4 \pm 1.2\%$ and $8.3 \pm 2.9\%$, respectively) as compared to the control diet. Similarly, 14 overweight and obese adults

who consumed five cups of canned navy beans per week for four weeks experienced an average reduction of waist circumference by 2.5 cm for women and 2.1 cm for men (Luhovyy et al., 2015). Moreover, Papanikolaou and Fulgoni (2008) conducted a secondary data analysis of the data from National Health and Nutrition Examination Survey (NHANES) between 1999 and 2002, and found that those who ate beans on a regular basis had lower body weights, smaller waist circumferences and a 22% reduced incidence of obesity compared to non-consumers.

*** The effect of pulse consumption on blood glucose control**

Blood glucose control is the process by which circulating glucose concentrations are maintained within a relatively narrow range by numerous hormones, primarily glucagon and insulin (Aronoff, Berkowitz, Shreiner, & Want, 2004). During short-term fasting periods, hepatic cells convert stored glycogen to glucose to release in response to a gradual decrease in blood sugar levels. The process is called gluconeogenesis that is stimulated by glucagon, a hormone produced in the α -pancreatic cells (Aronoff et al., 2004). On the other hand, when blood glucose levels increase due to the gluconeogenesis or digested meal, they are controlled by a pancreatic β -cell hormone called insulin in three ways: it signals to cells of insulin-sensitive peripheral tissues (primarily skeletal muscle) to increase uptake of glucose; promotes glycogen synthesis in the liver (glycogenesis); and inhibits gluconeogenesis (Aronoff et al., 2004).

The glycemic index (GI) has been commonly used to describe how rapidly a food increases plasma glucose levels after ingestion. GI is calculated by dividing the area under the curve of blood glucose response over time after ingestion of test food (which always contains 50g of carbohydrates), by that of white bread or glucose (Ludwig, 2000). Many factors, including carbohydrate type, fibre, protein, fat, food form and method of preparation, determine

the GI of a particular food (Ludwig, 2000). High-GI foods are digested and absorbed rapidly and increase the demand for insulin secretion because of the high glycemic load. Foods common in Western diets such as potatoes, breads and low-fat cereal products are categorized as high GI foods (Brand-Miller, Holt, Pawlak, & McMillan, 2002). The post-prandial spikes in blood glucose cause an overstimulation of insulin secretion, which can lead to pancreatic beta cell dysfunction (Hodge, English, O'Dea, & Giles, 2004) and the development of type II diabetes (Pi-Sunyer, 2002). On the other hand, low-GI foods, such as those that are high in dietary fibre, are gradually absorbed and release glucose to the blood at a slower rate, which has been reported to improve the overall blood sugar control in both normal subjects and patients with diabetes (Trinidad, Mallillin, Loyola, Sagum, & Encabo, 2010). Pulses have lower GIs due to their high indigestible carbohydrate content, from a GI of 39 for chickpeas to 55 for pinto beans, compared to 100 for white bread and 121 for baked potato (Pulse Canada, n.d.-c). Thus, currently, Diabetes Canada (formerly the Canadian Diabetes Association) recommends eating greater amounts of high fibre foods such as whole grains, legumes (lentils, dried beans and peas), vegetables and fruits. Similarly, the American Diabetes Association suggests that vegetables, fruits, whole grains, legumes and dairy products should be a major carbohydrate source (Gray, 2015).

Pulse Canada (n.d.-c) reviewed over 30 published postprandial studies that compared pulses or pulse products (dose ranging from 30 to 762 g) to controls (potatoes, rice, white bread, pasta, grains, glucose, isolated fibre and others), and reported that significant reductions in postprandial peak glucose were seen compared to the control in the majority of those studies. Sievenpiper et al. (2009) conducted a meta-analysis of a total of 41 randomized controlled experimental trials and demonstrated that pulses, both alone and in low-GI/high fibre diets, can

improve long-term biomarkers for assessing glycemic control in humans such as fasting blood glucose levels, insulin, and glycosylated blood proteins (measured as HbA1c or fructosamine). Among those studies, 11 trials investigated the effect of pulses alone such as chickpeas, black-eyed peas and various beans (red and white kidney, black, pinto, fava and white [white, navy and haricot]), and the average dosage among the trials was 152.1 g/day (range 15.5 to 465 g/day). A total of 253 participants, which included diabetics with/without dyslipidemia, were followed up for 6.7 weeks on average (range 1 to 96 weeks). It was demonstrated that pulses can lower fasting blood glucose and insulin levels. Moreover, for pulses consumed in low-GI and high-fibre meals, the author reported a significant reduction in the marker of HbA1c among people with type II diabetes (~0.48%) which was also above the clinically meaningful threshold ($\geq 0.3\%$) proposed by the US Food and Drug Administration and comparable to that achievable by oral agents.

There has been little evidence for the role of pulses in the aetiology and management of type II diabetes from epidemiological studies, possibly due to the relatively small intake of legumes in the populations involved (Venn & Mann, 2004). However, the latest prospective cohort study conducted by Becerra-Tomas et al. (2017) found that individuals in the highest quartile of total legume and lentil consumption had a lower risk of diabetes than those in the lowest quartile (hazard ratio (HR): 0.65 and 0.67, respectively). Moreover, in the same research, the replacement of several foods with pulses had a potential impact on type II diabetes development. When half a serving/day of total legumes was substituted for half a serving/day of eggs, wholemeal bread, white bread, rice, and baked potato, a 44%, 47%, 52% and 51% lower risk of type II diabetes was observed.

*** The effect of pulse consumption on satiety and food intake**

Appetite control is one of the sophisticated physiological mechanisms that have been developed to keep a balance between energy intake and expenditure (Benelam, 2009). Satiating and satiety are involved in the system of appetite regulation and both play an important role to determine total energy intake. Satiating refers to the process that promotes the cessation of eating and is controlled when a food or beverage is consumed. Satiety, on the other hand, follows satiation and is a physical feeling of fullness that prevents further consumption and persists until the foods are digested and absorbed in the gastrointestinal tract (Benelam, 2009).

Satiety can be affected by various factors of consumed foods or beverage, including nutrients such as carbohydrate, protein, fat and fibre, energy density, palatability, portion size and others (Benelam, 2009). He reported that high protein or fibre content, or low-energy density significantly increases satiety. As mentioned above, pulses have those nutritional characteristics. Li et al. (2014) conducted a meta-analysis on nine controlled trials to investigate the effect of dietary whole pulses on subjective appetite and subsequent food intake compared with isocaloric controls. Non-human trials, trials using only protein or fibre isolates of pulses, and those containing confounding variables that may increase fibre content such as whole grains were excluded from the analysis. The result showed that dietary pulse treatments led to a 31% greater incremental area under the curve for satiety (feelings of satiety vs time) compared to non-pulse treatments; however, the subsequent food intake was not affected. A possible reason is that seven out of nine studies used processed pulses or mixed them with other foods. For instance, Winham, Hutchins, and Melde (2007) used pulse spread made from canned pulses; Mollard, Wong, Luhovyy, and Anderson (2011) replaced 42% of total calories of macaroni with tomato sauce with commercially available canned pulses (chickpea, lentil, yellow split pea).

Additionally, there has been little research that examined the effect of pulses on appetite in children. A study by Yu (2015) explored the effects of pureed navy beans and yellow peas added to cooked pasta on satiety and short-term food intake among children aged 9 to 14 years using randomized controlled cross-over design. While the two kinds of pulse treatments similarly increased satiety after the dietary treatment, no treatment effect was found in subsequent food intake. In this study, it is possible that the amount of pureed pulses added to the pasta was lower than that recommended by Canada's Food Guide (3/4cup/day, 175 mL). Also, Chiu (2017) explored the effects of cooked whole navy beans and yellow peas mixed with cooked rice on satiety and short-term food intake in children aged 12 to 14 years. All treatments were isocaloric (300kcal), and the navy bean treatment and yellow pea treatment contained 93.6g and 85.9g of cooked whole navy beans and yellow peas respectively. It was found that the control treatment significantly increased the satiety compared to the pulse treatments while there was no effect of treatment on food intake.

Thus, few studies have been conducted to examine the effect of meals consisting of only cooked whole pulses, with the amounts meeting the recommended daily intake of $\frac{3}{4}$ cup, on short-term satiety and subsequent food intake. In addition, data among children is lacking. More research is needed in the short-term effects of cooked whole pulses on subjective appetite and energy intake in children.

3. Rationale, research objectives and hypothesis

Unhealthy eating habits among children may lead them to overconsume energy-dense and nutrient-poor foods, which possibly results in body weight gain. One solution can be to increase consumption of pulses, whose nutrient attributes may be beneficial for appetite regulation and body weight control. Although the effects of pureed or cooked whole pulses added to a mixed meal on short-term satiety and food intake were examined in the previous studies, no study was conducted to examine the effect of meals consisting of only cooked whole pulses (and the sauce). The objective of the proposed study is therefore to explore the short-term effects of cooked whole pulses, with the amounts meeting the recommended daily intake by Canada's Food Guide, on subjective appetite, energy intake and physical comfort in children.

We hypothesize that the consumption of the meal (300 kcal) with whole pulses will result in reduced appetite and short-term food intake compared to a control meal (rice) of the same energy density (kcal/g). It is because whole pulse meals provide substantial amounts of protein and dietary fibre compared to the control meal, and diets high in those nutrients have been reported to promote satiety (Clark & Slavin, 2013; Veldhorst et al., 2008).

4. Methodology

4-1. Study participants

Normal-weight 34 children (including both boys and girls) aged 12 to 14 years were recruited through advertisements in local newspapers, MSVU Facebook pages, and some public resources such as Halifax Kijiji website, and by word of mouth. Small card-sized flyers were also distributed in public areas, including but not limited to grocery stores, libraries, community centres, and malls. Our rationale for using children of this age is explained by the lack of intervention studies showing the effect of pulses on food intake in this cohort. The number of participants takes into account the attrition rate of 20% and is based on the sample size calculation ($\alpha=0.05$, $\beta=0.80$, to detect the effect size of 10% (~76.5 kcal as per our previous study by Patel, Luhovyy, Mollard, Painter, and Anderson (2013)) in ad libitum food intake).

4-2. Treatments

The dietary treatments are: 1) cooked rice with tomato-based sauce (control); 2) cooked whole navy beans with tomato-based sauce; 3) cooked whole yellow split peas with tomato-based sauce. All treatments were isocaloric (300kcal) with the same total weight (228g) adjusted with added water (Table 1, 2). The rationale of using medium-grain white rice as a control is that white rice serves as a staple food source for many populations in the world and it has a higher GI value (64) compared to that of pulses (Izadi & Azadbakht, 2015). In our previous study being analyzed, whose dietary treatments are rice and rice partially replaced (44% energy) with cooked whole navy beans/yellow split peas, the same white rice was used.

All dietary treatments were freshly prepared from commercially available food products or with ingredients that are of food grade on each session day by a research conductor.

4-3. A research protocol

Screening session

After the children's parent(s) initiate contact with our research group by phone or e-mail, children's eligibility was determined by using a Telephone Screening Questionnaire (Appendix 1). Their BMI was assessed according to WHO Growth Charts for Canada (Dietitians of Canada and Canadian Paediatric Society, 2014), and children were excluded from the study if they have food sensitivities or allergies, dietary restrictions, health problems which may affect their appetite and food intake, and learning, emotional or behavioral difficulties. If the child meets eligibility, he/she was invited for a screening visit with the parent(s). In the screening at the Department of Applied Human Nutrition of the Mount Saint Vincent University, the basic information obtained from the telephone screening (e.g. body weight, height) was reviewed and validated, and the research protocol was explained. Body fat was measured with non-invasive tetrapolar bioelectrical impedance analysis (Tanita Body Composition Analyzer TBF 300A, Tanita Corporation, Tokyo, Japan). After informed consent and signatures on related forms (Appendix 2a-c) are obtained from parents and children, the children were be asked to fill out a Physical Activity Questionnaire (Appendix 3), a Dutch Eating Behaviour Questionnaire (Strien, T. V., & Oosterveld, P., 2008), a Puberty Questionnaire (Appendix 4), a Tanner Staging Assessment (Tanner, 1962) and a Menstrual Cycle Questionnaire (Appendix 5) that were used for the secondary data analyses. The reason for assessing the pubertal stage is justified by the fact that the energy intake regulation varies on different stages of the puberty, as it was recently shown (Patel, Bellissimo, Thomas, Hamilton, & Anderson, 2011). In the end of the screening session, the first experimental session was scheduled and the following sessions were scheduled after one-week wash out period.

Experimental session

One short-term trial was conducted, and a single blinded, crossover repeated-measures design was applied. On the session day, children were asked to fast overnight (12 hours) and consume the standardized breakfast (Honey Nut Cheerios, 2% milk and orange juice) at 8:00 am, and a snack (granola bar and water) at 10:00 am, which were previously provided to them by our team. After arrival to the lab at 11:00 am, children completed Recent Food Intake and Activity Questionnaire (Appendix 6) and rate their baseline appetite and physical comfort using visual analogue scales. Then the children were provided with a test meal at 12:00 pm and were asked to consume it at their own pace but to finish within 10 min. Immediately before (0 min) and 15, 30, 45, 60, 90, 120, 150 minutes after the treatment was initiated, visual analogue scale questionnaires for appetite and physical comfort were completed. Ad libitum food intake was measured with a pizza meal at the point of 120 min (2:00 pm) and was expressed as a total energy (kcal) obtained from a pizza meal.

4-4. Study outcomes

In order to measure the subjective appetite, sensory characteristics of the treatment (pleasantness and sweetness), and physical comfort, visual analogue scales (VAS) was used (Appendix 7a-d). The VAS is a quick and easy way of measuring subjective variables, and best used in a within-subject, repeated-measures design because it allows the comparison of different treatments under similar conditions (Stubbs et al., 2000). The VAS is in the form of a 100mm-long straight line with two extreme states anchored at either end, and participants were asked to mark an “X” on the line to indicate their feelings at the given moment. The distance from the left starting point of

the line to the intersection with the “X” was measured in millimeters to get individual scores (Stubbs et al., 2000). The subjective appetite was measured through the four questions related to desire to eat (“How strong is your desire to eat?”), hunger (“How hungry do you feel?”), fullness (“How full do you feel?”), and prospective food consumption (“How much food do you think you could eat?”). The questions are weighted with the extremes at each end (0 = not at all/nothing at all and 100 = extremely/a large amount). An average appetite score was calculated at each time of measurement for each treatment based on the following formula: Appetite score = [desire to eat + hunger + (100 – fullness) + prospective consumption] / 4 (Anderson, Catherine, Woodend, & Wolever, 2002). Since appetite scores were not independent each other, the AUC was used as it allows for the analysis of subjective appetite data throughout all time points and not just at a single time point. The taste, mouthfeel and flavor of each treatment were also measured with hedonic scales (Appendix 8a-c). Ad libitum food intake was measured with pizza meal at the point of 120 min (2:00 pm) and the data was expressed as total energy (kcal) of pizza meal consumption using the consumed weight and the compositional information.

4-5. Data analysis

Statistical Analysis Systems (SAS) version 9.2 (SAS Institute Inc., Cary, NC, USA) was used for all data analyses. All ANOVA included sessions as repeated data to control for within-subject variability. Two-way repeated-measures ANOVA was used to examine 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 determined 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 $P < 0.05$. Pearson correlation coefficients were used for the correlation analyses among treatments and outcome measures.

4-6. Safety and ethical considerations

This study was conducted in accordance with guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the University Research Ethics Board (UREB) at Mount Saint Vincent University. In order to ensure the safety of the children, the access to the laboratory facilities were restricted only to lab personnel and children was constantly supervised during the session. All lab personnel also completed Workplace Hazardous Materials Information System (WHMIS) training, and a child and lab safety orientation session. food grade. A research conductor, who prepared foods, has obtained a food safety training. In addition, the use of Puberty, Tanner Staging and Menstrual Cycle questionnaires can be considered as sensitive data. Although these questionnaires had no personal identifiers, research personnel was trained how to present these questionnaires to parents and then, if parents agree, to their children. A corner of the lab was sectioned off using the blue screens that provided privacy for the child and their parents, if required.

5. Results

5.1 Subject Baseline Characteristics

Sixty-seven subjects were recruited and fifty-three (25 boys and 28 girls) properly completed the whole study sessions. Forty-one subjects were between the 0th and 85th (light-to-normal weight), and twelve were between the 85th and 100th (heavier) age-and sex-specific BMI percentiles. On average, participants rated their likelihood of restrained, emotional and external eating behaviors as between "no" and "sometimes". This indicates that they did not display any restrained eating behaviors. All baseline characteristics of the participants are listed in **Table 5.1** and **Table 5.2**.

Table 5.1.a Subject Baseline Characteristics

Subject Characteristics	Mean (n=53)
Age (years)	13.2 ± 0.9
Body Weight (kg)	52.4 ± 13.3
Height (m)	1.6 ± 0.1
BMI ¹ (kg/m ²)	19.9 ± 4.0
BMI%ile (CDC)	51.9 ± 31.5
FM ² (kg)	12.4 ± 8.8
FFM ³ (kg)	40.1 ± 6.6
TBW ⁴ (kg)	29.3 ± 4.9
Restrained Eating Score	2.1 ± 0.7
Emotional Eating Score	2.1 ± 0.9
External Eating Score	3.1 ± 0.7
Average DEBQ ⁵	2.4 ± 0.5

Data are means ± standard deviation (SD). ¹BMI, body mass index; ²FM, fat mass; ³FFM, fat-free mass, ⁴TBW, total body water; ⁵DEBQ, Dutch Eating Behaviour Questionnaire.

Table 5.1. b Subject Baseline Characteristics

Subject Characteristics	Mean Light-to-Normal (n=41)	Mean Heavier (n=12)
Age (years)	13.3 ± 0.84	12.8 ± 0.9
Body Weight (kg)	47.3 ± 8.2	70 ± 12.6
Height (m)	1.6 ± 0.84	1.7 ± 0.8
BMI ¹ (kg/m ²)	18.2 ± 2.1	25.5 ± 3.7
BMI%ile (CDC)	39.9 ± 25.1	93 ± 5.5
FM ² (kg)	8.8 ± 5.1	24.4 ± 8.0
FFM ³ (kg)	38.4 ± 5.8	45.6 ± 6.6
TBW ⁴ (kg)	28.1 ± 4.2	33.4 ± 4.9
Restrained Eating Score	2.0 ± 0.7	2.5 ± 0.8
Emotional Eating Score	2.0 ± 0.8	2.4 ± 1.1
External Eating Score	3.1 ± 0.7	3.0 ± 0.6
Average DEBQ ⁵	2.3 ± 0.5	2.6 ± 0.6

Data are means ± standard deviation (SD). ¹BMI, body mass index; ²FM, fat mass; ³FFM, fat-free mass, ⁴TBW, total body water; ⁵DEBQ, Dutch Eating Behaviour Questionnaire.

Table 5.2 Sex and Weight Status of All Study Participants

		Weight Status		Participants (n)
		Light-to-Normal	Heavier	
Sex	Boys	18	7	25
	Girls	23	5	28
Participants (n)		41	12	53

Light-to-Normal Weight: between the 0th and 85th age-and sex-specific BMI percentiles

Heavier: between the 85th and 100th age-and sex-specific BMI percentiles

5.2. Ad libitum Food and Water Intake

5.2.1 Food and Water Intake

There was no effect of treatment on energy & weight intake and water intake during pizza meal (**Table 5.3**).

There was an effect of weight status on energy ($P=0.01$) and weight intake ($P=0.01$) with pizza meal (**Table 5.4**). It was found that the lighter-to-normal weight group (including underweight and normal weight) had a significantly lower energy and weight intake compared to the heavier group (including overweight and obese). There was also an effect of weight status on water intake during pizza meal ($P=0.02$). It was found that the lighter-to-normal weight group had a significantly lower water intake compared to the heavier group.

In the lighter-to-normal weight group, there was a significant effect of treatment on weight intake at pizza meal ($P=0.048$). It was found that the navy bean treatment led higher pizza intake (g) compared to the yellow pea treatment.

There was a significant effect of sex on energy ($P<0.01$) and weight intake ($P<0.01$) with pizza meal (**Table 5.5.a**). It was found that girls had a significantly lower energy and weight intake compared to boys. There was no effect of sex on water intake. Among the girls, there was a significant effect of treatment on energy ($P<0.01$) and weight intake ($P<0.01$) with pizza meal. However, the post hoc tests could not determine which means differ probably due to the large deviation of the data. When the effect of the treatment in light-to-normal weight girls was examined, there was a significant effect of the treatment on energy intake ($p<0.01$) and weight intake ($p<0.01$) with pizza meal (**Table 5.5.b**). It was found that the navy bean meal led higher energy and weight intake compared to the control and yellow pea meal.

There was no session effect on energy intake with a pizza meal (**Table 5.6**). There was also no effect of menarcheal status in girls and no effect of Tanner stage in boys on energy, weight and water intake at the pizza meal. There was no interaction between treatment and weight status, treatment and sex, treatment and menarcheal status, and treatment and Tanner's stage on energy, weight and water intake at the pizza meal.

5.2.2 Cumulative Food and Water Intake

There was no effect of a treatment on cumulative energy intake, cumulative solid weight intake and cumulative solid and water weight intake with the pizza meal (**Table 5.3**). There was also no treatment effect on cumulative water intake during the pizza meal.

There was an effect of weight status on cumulative energy intake ($P=0.01$), cumulative solid weight intake ($P=0.01$) cumulative solid and water weight intake ($P<0.01$) with pizza meal (**Table 5.4**). It was found that the lighter-to-normal weight group had a significantly lower cumulative energy and weight intake compared to the heavier group. There was also an effect of weight status on cumulative water intake at the pizza meal ($P=0.02$). It was found that the lighter-to-normal weight group had a significantly lower water intake compared to the heavier group.

In the lighter-to-normal weight group, there was a significant effect of treatment on cumulative solid food intake (g) ($P=0.048$). It was found that the navy bean treatment led higher cumulative solid food intake (g) compared to the yellow pea treatment.

There was a significant effect of sex on cumulative energy ($P<0.01$), cumulative solid weight intake ($P<0.01$) and cumulative solid and water weight intake ($P=0.01$) with pizza meal (**Table 5.5.a**). It was found that girls had a significantly lower cumulative energy and cumulative weight intake compared to boys. There was no effect of sex on cumulative water intake. Among

girls, there was a significant effect of the treatment on cumulative energy ($P < 0.01$) and cumulative solid weight intake ($P < 0.01$) with pizza meal. However, the post hoc tests did not determine which means differ probably due to the large deviation of the data. When the effect of the treatment in light-to-normal weight girls was examined, there was a significant effect of the treatment on cumulative energy intake ($p < 0.01$) and cumulative solid weight intake ($p < 0.01$) with pizza meal (**Table 5.5.b**). It was found that the navy bean meal led higher cumulative energy and cumulative solid weight intake compared to the control and yellow pea meal.

There was no interaction between treatment and weight status, treatment and sex, treatment and menarcheal status, and treatment and Tanner's stage on cumulative energy intake, cumulative solid weight intake, cumulative solid and water weight intake and cumulative water intake of the pizza meal.

Table 5.3 Energy and Weight of Food Intake and Water Intake

Treatment	Pizza Meal			Cumulative			
	Energy (kcal)	Weight (g)	Water Volume (g)	Energy (kcal)	Weight (solid) (g)	Weight (solid + water) (g)	Water Volume (g)
CON	674.9	303.1	237.7	974.9	515.3	1003.1	487.7
	±	±	±	±	±	±	±
	76.5	35.3	49.5	76.5	35.3	71.2	49.5
NB	704.9	316.6	241.6	1004.9	528.8	1020.4	491.6
	±	±	±	±	±	±	±
	66.8	31.1	44.5	66.8	31.1	63.7	44.5
YP	662.3	297.2	230.4	962.3	509.4	989.7	480.4
	±	±	±	±	±	±	±
	66.9	30.5	46.3	66.9	30.5	60.8	46.3
<i>P(treatment)</i>	0.2	0.2	1.0	0.2	0.2	0.6	1.0

All values are means ± 95%CI, n=53.

Two-way (treatment and sex) repeated measures ANCOVA (BMI %ile as covariate).

CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Table 5.4 Food and Water Intake Categorized by Weight Status

		Treatments					
		Weight Status	CON	NB	YP	P value (treatment)	P value (weight status)
Pizza Meal	Energy (kcal)	Lighter to Normal (n=41)	626.8 ± 82.4	673.0 ± 65.0	608.1 ± 66.7	0.051	0.01
		Heavier (n=12)	839.4 ± 160.5	813.7 ± 188.2	847.7 ± 150.0	0.8	
	Weight (g)	Lighter to Normal (n=41)	281.3 ^{ab} ± 38.1	301.7 ^a ± 30.3	272.4 ^b ± 30.4	0.048	0.01
		Heavier (n=12)	377.8 ± 73.9	367.6 ± 87.0	381.9 ± 68.9	0.8	
	Water Volume (g)	Lighter to Normal (n=41)	211.1 ± 53.6	210.0 ± 48.5	205.9 ± 49.7	0.9	0.02
		Heavier (n=12)	328.9 ± 108.2	349.5 ± 82.1	313.9 ± 104.4	0.8	
Cumulative	Energy (kcal)	Lighter to Normal (n=41)	926.8 ± 82.4	973.0 ± 65.0	908.1 ± 66.7	0.051	0.01
		Heavier (n=12)	1140 ± 160.5	1114 ± 188.2	1148 ± 150.0	0.8	

Weight (solid) (g)	Lighter to Normal (n=41)	493.5 ^{ab} ± 38.1	513.9 ^a ± 30.3	484.6 ^b ± 30.4	0.048	0.01
	Heavier (n=12)	590.0 ± 73.9	579.8 ± 87.0	594.1 ± 68.9	0.8	
Weight (solid + water) (g)	Lighter to Normal (n=41)	954.5 ± 76.3	973.9 ± 67.1	940.5 ± 66.1	0.3	<0.01
	Heavier (n=12)	1169 ± 145.6	1179 ± 131.6	1158 ± 100.4	0.9	
Water Volume (g)	Lighter to Normal (n=41)	461.1 ± 53.6	460.0 ± 48.5	455.9 ± 49.7	0.9	0.02
	Heavier (n=12)	578.9 ± 108.2	599.5 ± 82.1	563.9 ± 104.4	0.8	

All values are means ± 95%CI, n=53.

Two-way (treatment and weight status) repeated measures ANOVA with Tukey Kramer post-hoc test. No significant interaction between treatment and weight status.

CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Table 5.5. a Food and Water Intake Categorized by Sex

		Treatments					
		Sex	CON	NB	YP	P value (treatment)	P value (sex)
Pizza Meal	Energy (kcal)	Male (n=25)	779.3 ± 108.3	799.2 ± 88.2	761.5 ± 99.9	0.3	<0.01
		Female (n=28)	581.7 ± 97.1	620.6 ± 89.3	573.8 ± 77.5	<0.01*	
	Weight (g)	Male (n=25)	351.6 ± 50.2	360.3 ± 40.9	343.5 ± 45.3	0.3	<0.01
		Female (n=28)	259.8 ± 44.6	277.7 ± 41.6	255.8 ± 35.4	<0.01*	
	Water Volume (g)	Male (n=25)	251.2 ± 73.5	273.9 ± 68.3	252.2 ± 71.4	0.8	0.2
		Female (n=28)	225.8 ± 67.8	212.7 ± 57.0	210.8 ± 60.4	0.7	
Cumulative	Energy (kcal)	Male (n=25)	1079 ± 108.3	1099 ± 88.2	1062 ± 99.9	0.3	<0.01
		Female (n=28)	881.7 ± 97.1	920.6 ± 89.3	873.8 ± 77.5	<0.01 *	

Weight (solid) (g)	Male (n=25)	563.8 ± 50.2	572.5 ± 40.9	555.7 ± 45.3	0.3	<0.01
	Female (n=28)	472.0 ± 44.6	489.9 ± 41.6	468.0 ± 35.4	<0.01*	
Weight (solid + water) (g)	Male (n=25)	1065 ± 99.0	1096 ± 85.7	1057.9 ± 83.1	0.4	0.01
	Female (n=28)	947.8 ± 99.1	952.6 ± 87.0	928.9 ± 82.9	0.1*	
Water Volume (g)	Male (n=25)	501.2 ± 73.5	523.9 ± 68.3	502.2 ± 71.4	0.8	0.2
	Female (n=28)	475.8 ± 67.8	462.7 ± 57.0	460.8 ± 60.4	0.7	

All values are means \pm 95%CI. Two-way (treatment and sex) repeated measures ANCOVA (BMI %ile as covariate) with Tukey Kramer post-hoc test. No significant interaction between treatment and sex, and treatment and BMI%ile.

One-way (treatment) repeated measures ANCOVA (BMI %ile as covariate) was conducted for each sex. An asterisk (*) indicates significant interaction between treatment and covariate ($p < 0.01$).

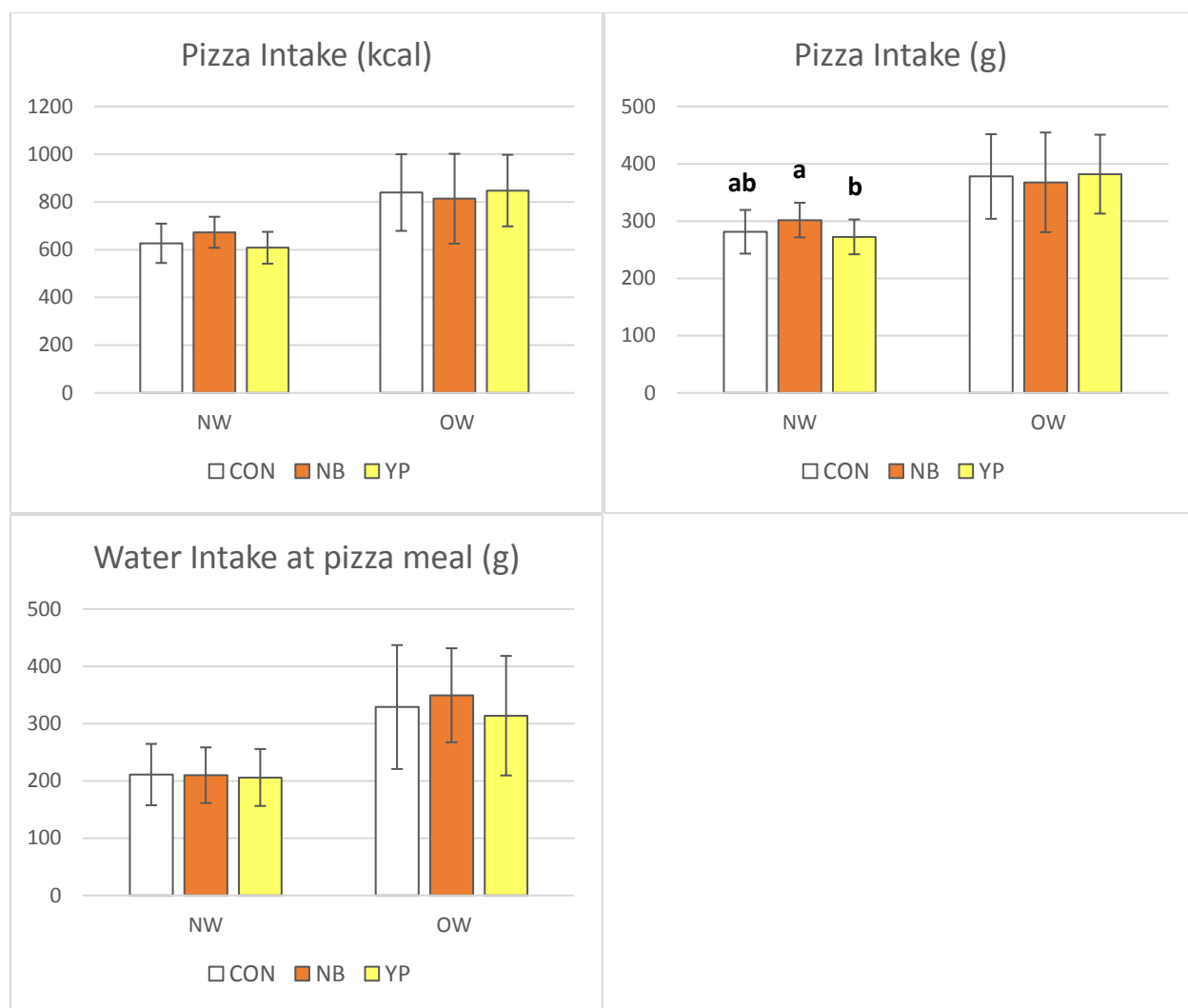
CON: control, NB: navy bean treatment, and YP: yellow pea treatment

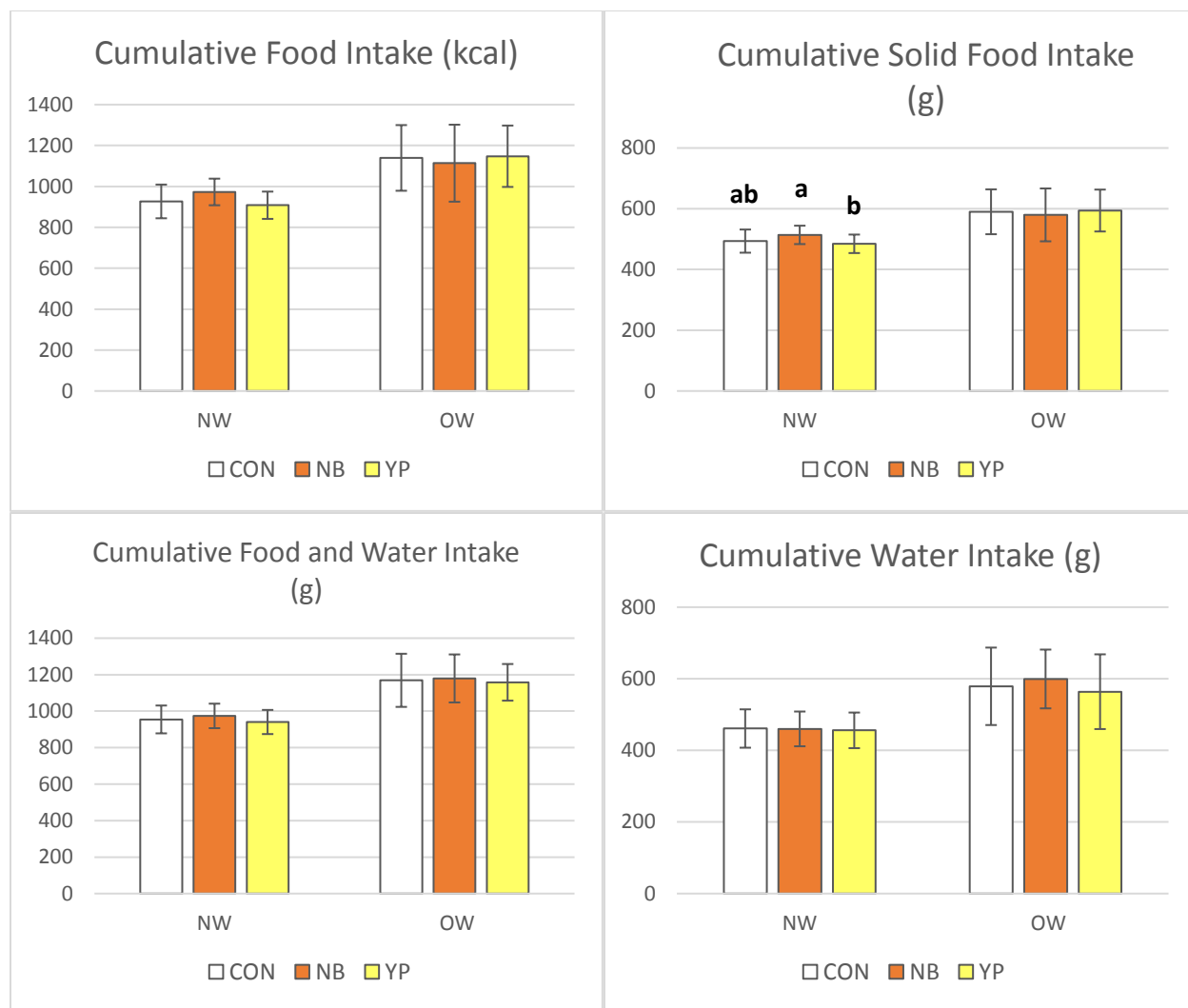
Table 5.5. b Food and Water Intake in Light-to-Normal Weight Girls

		Treatments			
		CON	NB	YP	P value (treatment)
Pizza Meal	Energy (kcal)	511.6 ^b ± 97.1	592.5 ^a ± 89.3	525.1 ^b ± 77.5	<0.01
	Weight (g)	228.5 ^b ± 40.2	264.7 ^a ± 39.0	234.0 ^b ± 34.3	<0.01
Cumulative	Energy (kcal)	811.6 ^b ± 88.4	892.5 ^a ± 84.6	825.0 ^b ± 75.5	<0.01
	Weight (solid) (g)	440.7 ^b ± 40.2	476.9 ^a ± 39.0	446.2 ^b ± 34.3	<0.01

All values are means ± 95%CI, n=23. One-way (treatment) repeated measures ANOVA with Tukey Kramer post-hoc test.

CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Figure 5.1 Food Intake at the Ad Libitum Pizza Meal



*CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Table 5.6 Effect of Session Order on Food Intake at the Ad Libitum Pizza Meal

Session	Pizza Intake (kcal)
1	678.2 ± 61.5
2	686.3 ± 71.8
3	677.5 ± 77.0
<i>P(treatment)</i>	0.9

All values are means ± 95%CI, n=53. One-way repeated measures ANOVA.

5.3 Subjective Appetite Scores

5.3.1 Average Appetite (AA)

There was no effect of treatment on subjective feeling of AA while there was a significant effect of time ($P < 0.001$) (**Table 5.7**) (**Figure 5.2**). There was no effect of weight status, sex and the interaction between treatment and time, treatment and weight status, and treatment and sex on AA scores.

5.3.2 Desire to Eat (DTE)

There was no effect of treatment on subjective feeling of DTE while there was a significant effect of time ($P < 0.001$) (**Table 5.7**) (**Figure 5.2**). There was no effect of weight status, sex and the interaction between treatment and weight status, and treatment and sex on AA scores.

However, there was a significant interaction between treatment and time ($P = 0.03$). When comparing the effect of treatment on DTE scores at each time point, the control treatment significantly led to a higher DTE score at 15 min compared to the navy bean treatment and the yellow pea treatment ($P = 0.02$) (**Figure 5.3**).

5.3.3 Hunger

There was no effect of treatment on subjective feeling of hunger while there was a significant effect of time ($P < 0.001$) (**Table 5.7**) (**Figure 5.2**). There was no effect of weight status, sex and the interaction between treatment and time, treatment and weight status, and treatment and sex on hunger scores. When comparing the effect of treatment on hunger scores at each time point, the control treatment significantly led to a higher hunger score at 15min compared to the navy bean treatment ($P = 0.02$) (**Figure 5.3**).

5.3.4 Fullness

There was no effect of treatment on subjective feeling of fullness while there was a significant effect of time ($P < 0.001$) (**Table 5.7**) (**Figure 5.2**). There was no effect of weight status, sex and the interaction between treatment and time, treatment and weight status, and treatment and sex on hunger scores.

5.3.5 Prospective Food Consumption (PFC)

There was no effect of treatment on subjective feeling of PFC while there was a significant effect of time ($P < 0.001$) (**Table 5.7**) (**Figure 5.2**). There was no effect of weight status, sex and the interaction between treatment and time, treatment and weight status, and treatment and sex on PFC scores. When comparing the effect of treatment on PFC scores at each time point, the control and yellow pea treatments significantly led to a higher PFC score at 30min compared to the navy bean treatment ($P = 0.03$) (**Figure 5.3**).

Table 5.7 Subjective Appetite Scores over 2 Hours

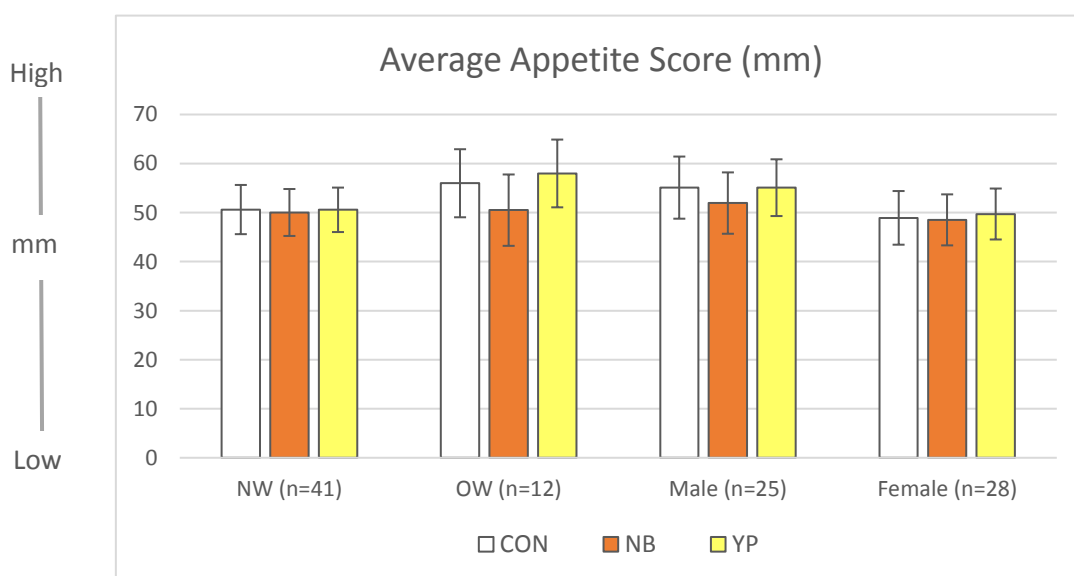
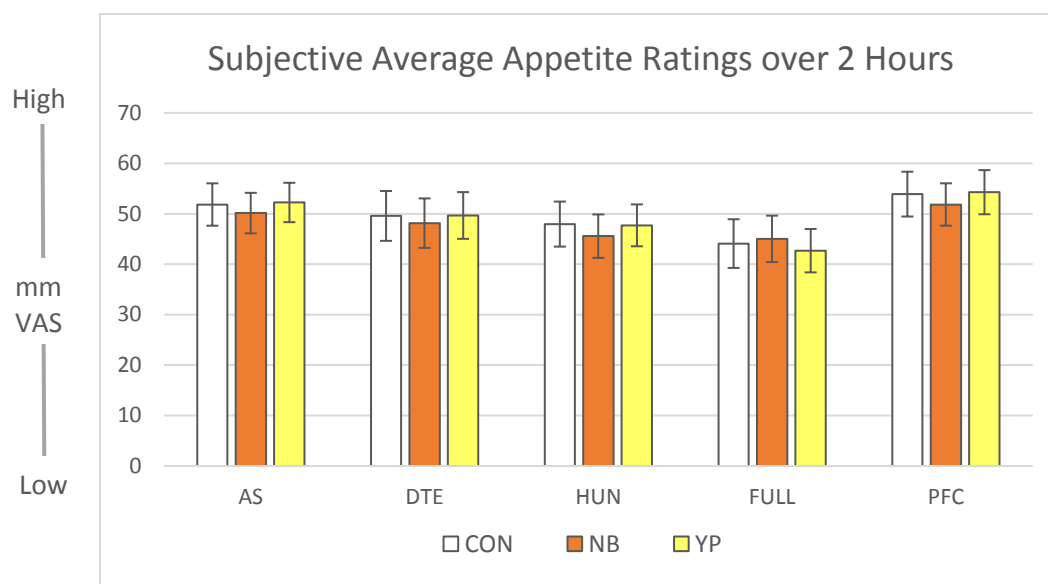
	CON	NB	YP	P value (treatment)
Average Appetite (mm)	51.8 ± 4.2	50.1 ± 4.0	52.2 ± 3.9	0.4
Desire to Eat (mm)	49.6 ± 4.9	48.1 ± 4.9	49.7 ± 4.6	0.7 ¹
Hunger (mm)	48.0 ± 4.5	45.6 ± 4.3	47.7 ± 4.2	0.3
Fullness (mm)	44.1 ± 4.8	45.0 ± 4.6	42.7 ± 4.3	0.4
Prospective Food Consumption (mm)	53.9 ± 4.4	51.8 ± 4.2	54.3 ± 4.4	0.3

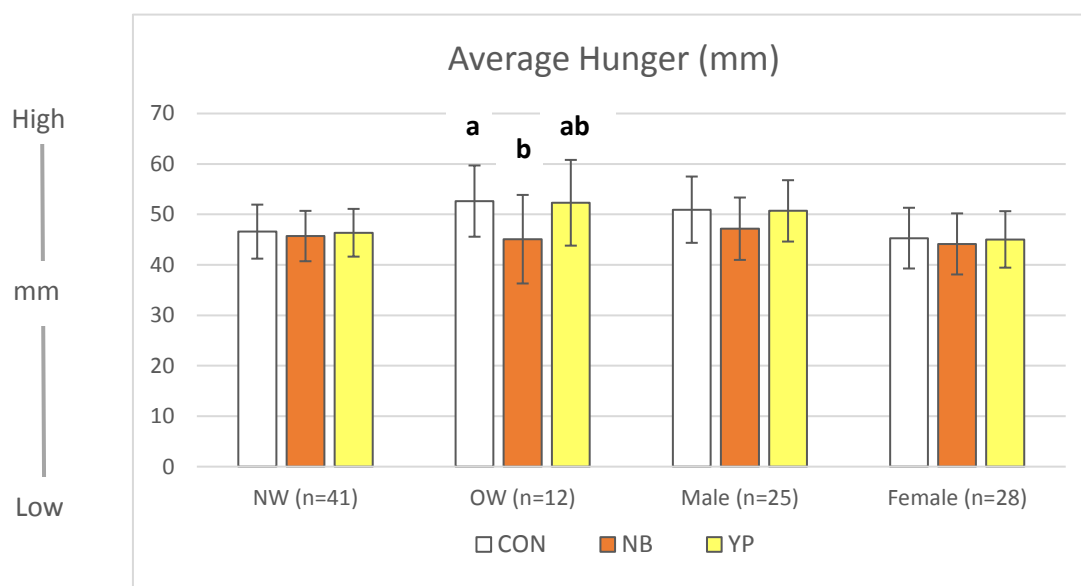
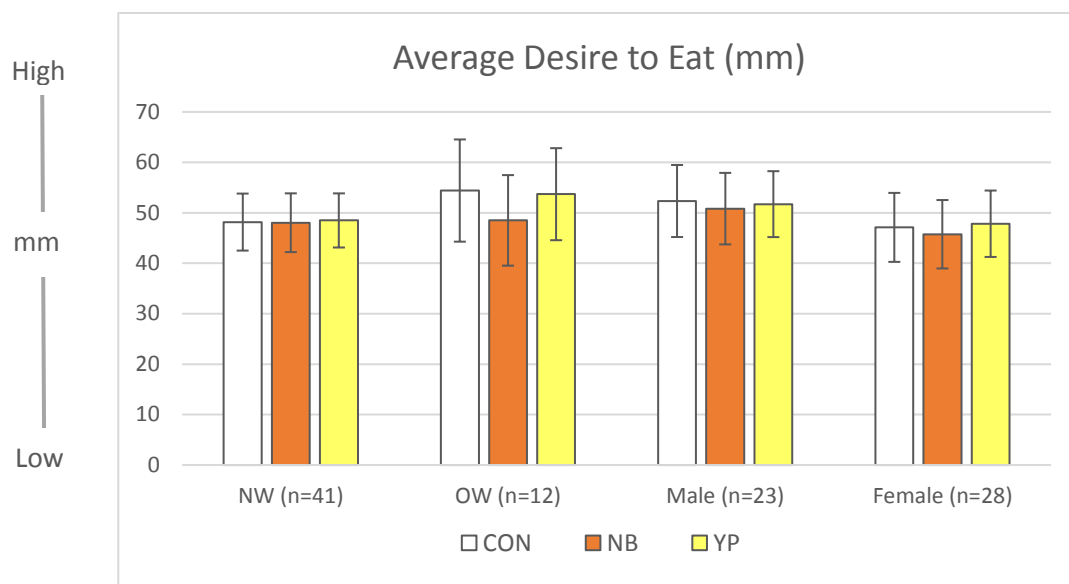
All values are means ± 95%CI, n=53.

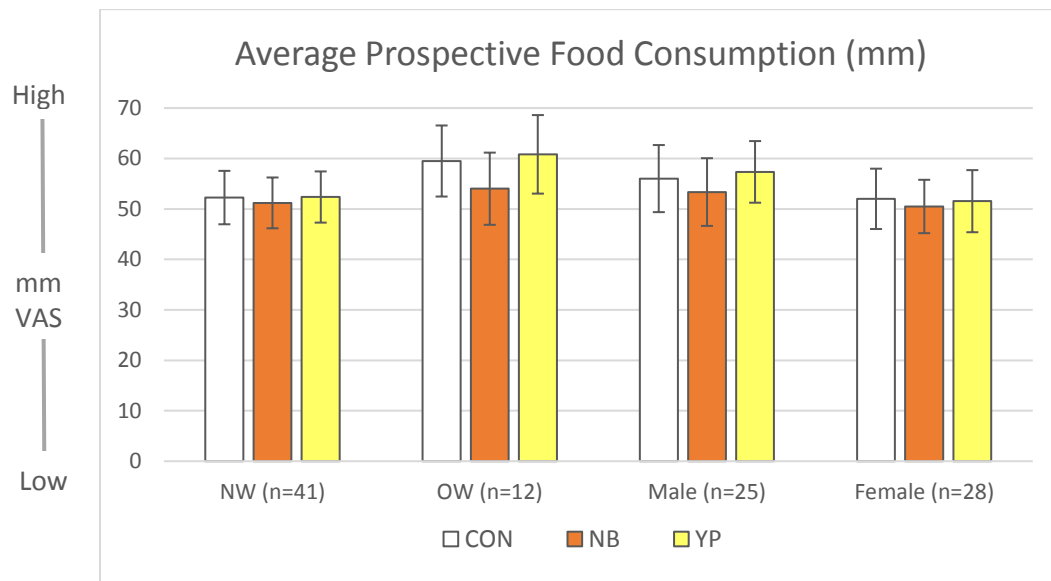
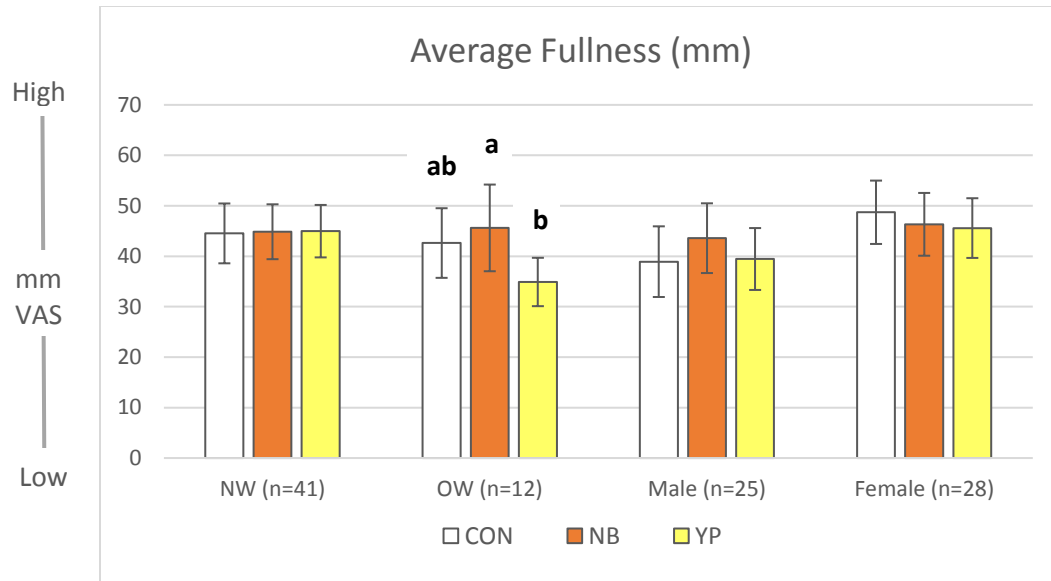
Two-way (treatment and time) repeated measures ANOVA. ¹Significant interaction between treatment and time.

*CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Figure 5.2 Subjective Average Appetite Scores over 2 Hours





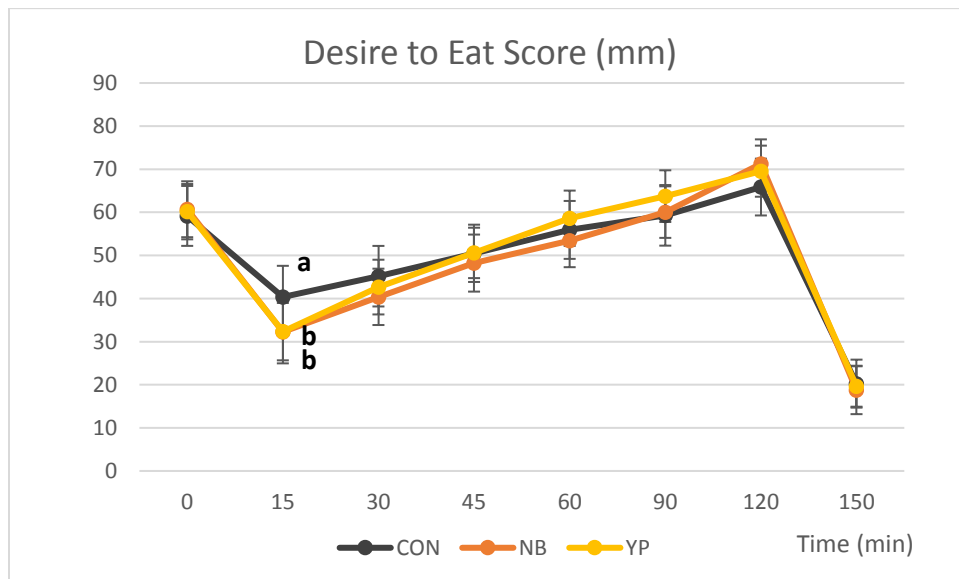
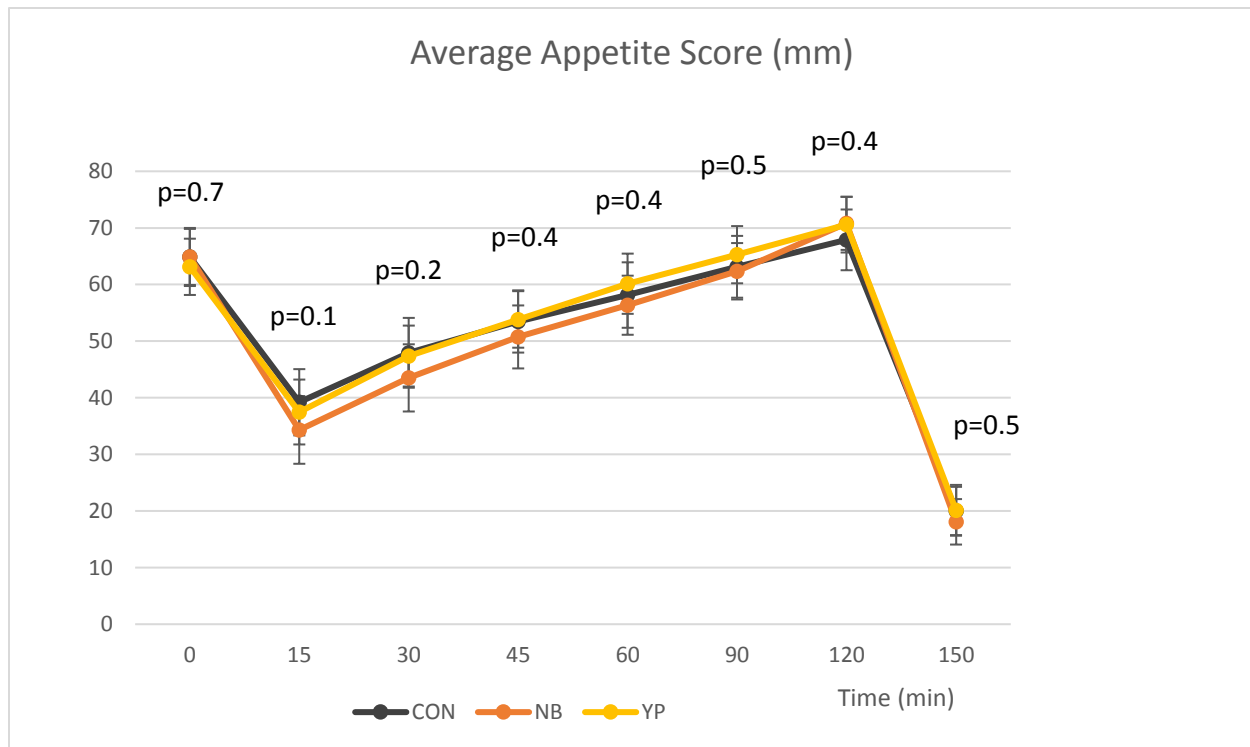


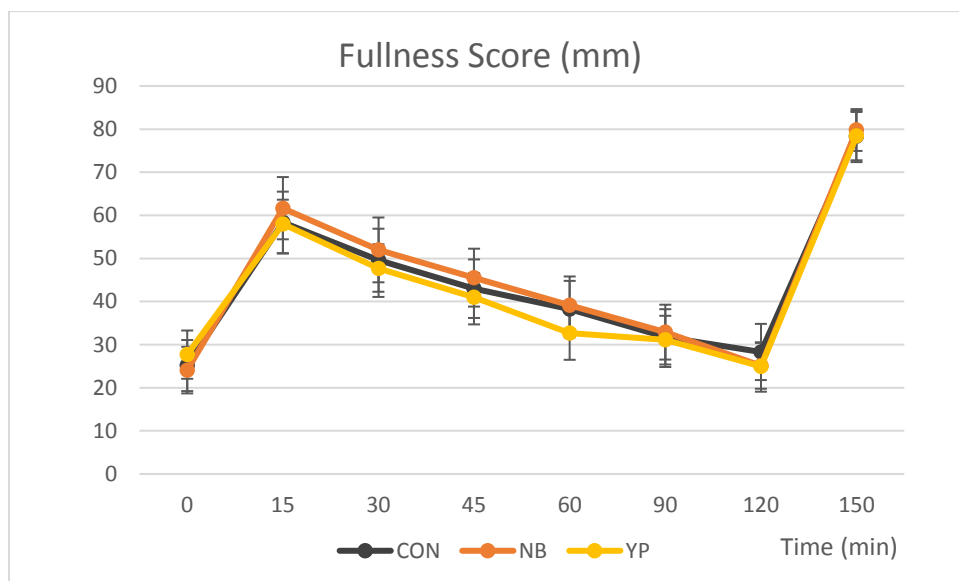
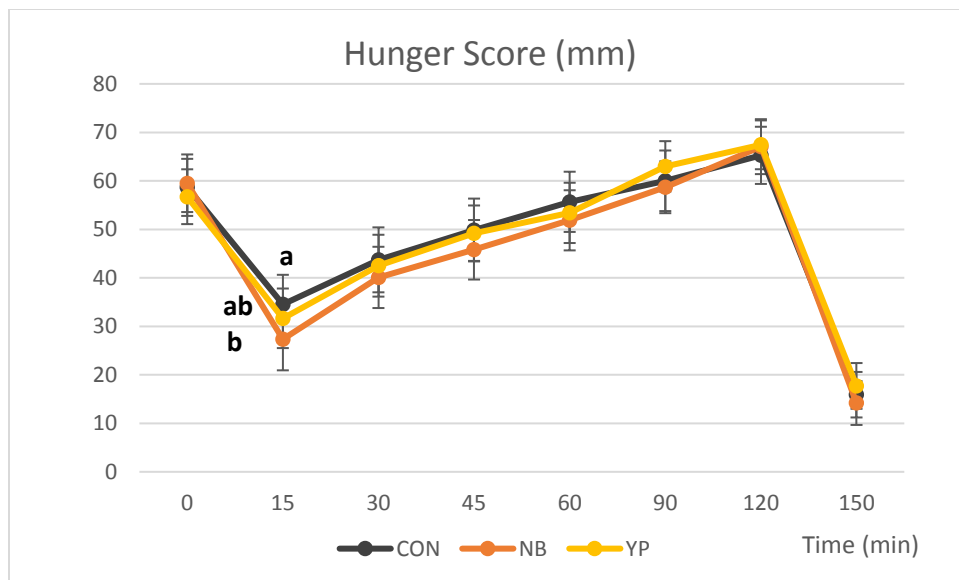
AS: Appetite Score, DTE: Desire to Eat, HUN: Hunger, FULL: Fullness, PFC: Prospective Food Consumption

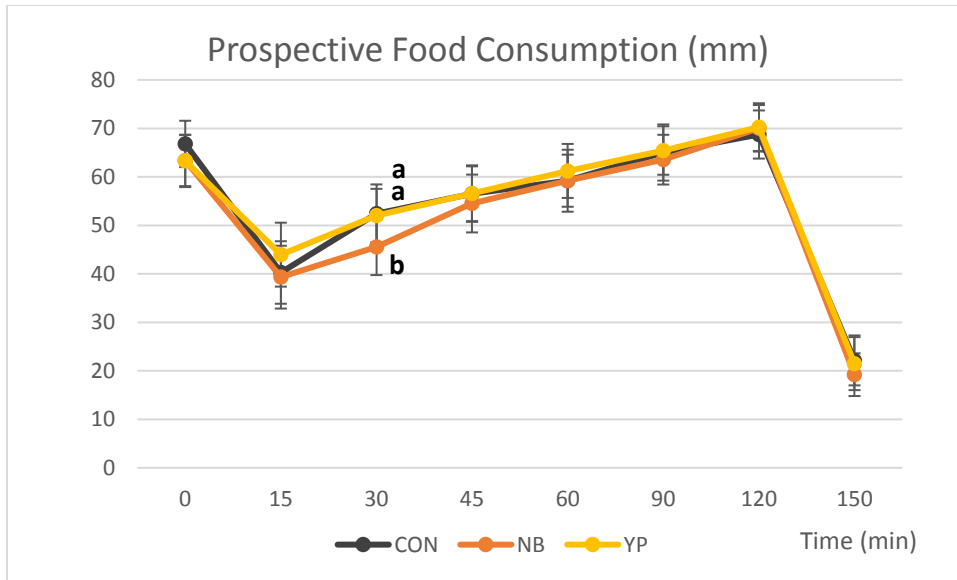
CON: control, NB: navy bean treatment, and YP: yellow pea treatment

NW: Light to Normal Weight, OW: Overweight to Obese

Figure 5.3 Absolute Subjective Average Appetite Scores over 2 Hours







All values are means \pm 95% CI, n=53. Treatment effects were analyzed using one-way repeated measures ANOVA with Tukey Kramer post hoc test.

*CON: control, NB: navy bean treatment, and YP: yellow pea treatment

5.4 Gastrointestinal Comfort Scores

5.4.1 Average Physical Comfort (APC)

There was no effect of treatment on the subjective feeling of APC (**Table 5.7**) (**Figure 5.4**). It indicates that the consumption of 3/4 cup of cooked pulses do not cause physical discomfort in children. There was also no effect of time, weight status, sex and the interaction between treatment and time, treatment and weight status, and treatment and sex on APC scores.

5.4.2 Nausea

There was no effect of treatment on the subjective feeling of nausea (**Table 5.7**) (**Figure 5.4**).

The score for the yellow pea treatment at 0min was significantly higher than that for the control and navy bean treatment (P=0.03).

5.4.3 Stomachache

There was no effect of treatment on the subjective feeling of stomachache (**Table 5.4**) (**Figure 5.4**).

5.4.4 Wellness

There was no effect of treatment on the subjective feeling of wellness (**Table 5.7**) (**Figure 5.4**).

There was also no effect of time, weight status, sex and the interaction between treatment and time, treatment and weight status, and treatment and sex on wellness scores.

5.4.5 Flatulence (Gas)

There was no effect of treatment on the subjective feeling of flatulence (**Table 5.7**) (**Figure 5.4**).

5.4.6 Diarrhea

There was no effect of treatment on the subjective feeling of diarrhea (**Table 5.7**) (**Figure 5.4**).

When comparing the effect of treatment on diarrhea scores at each time point, the navy bean treatment significantly led to a higher diarrhea score at 150min compared to the control treatment ($P < 0.01$) (**Figure 5.5**).

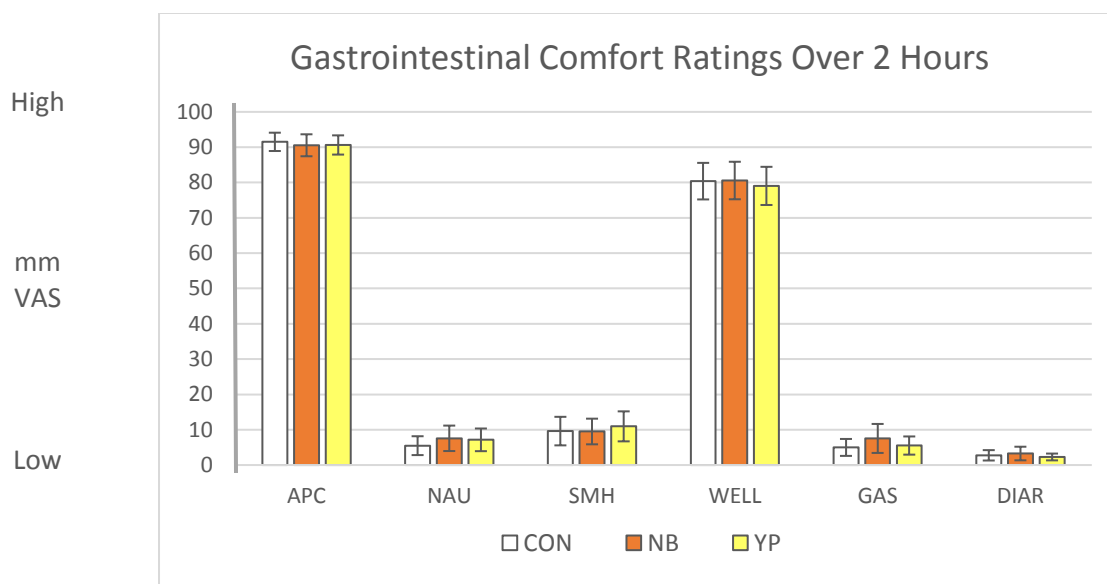
Table 5.8 Gastrointestinal Comfort Scores

	CON	NB	YP	P value (treatment)
Average Physical Comfort (mm)	91.5 ± 2.6	90.5 ± 3.1	90.6 ± 2.7	0.5
Nausea (mm)	5.5 ± 2.7	7.6 ± 3.6	7.1 ± 3.2	0.6
Stomachache (mm)	9.6 ± 4.0	9.5 ± 3.6	11.0 ± 4.2	0.9
Wellness (mm)	80.4 ± 5.2	80.6 ± 5.3	79.0 ± 5.4	0.6
Flatulence(mm)	5.0 ± 2.4	7.5 ± 4.1	5.5 ± 2.6	0.5
Diarrhea (mm)	2.8 ± 1.5	3.3 ± 1.9	2.3 ± 1.0	0.7

All values are means \pm 95%CI, n=53.

Two-way (treatment and time) repeated measures ANOVA for Average Physical Comfort and Wellness. No significant effect of time and no significant interaction between treatment and time. Friedman's one-way Nonparametric ANOVA for Nausea, Stomach Discomfort, Flatulence and Diarrhea.

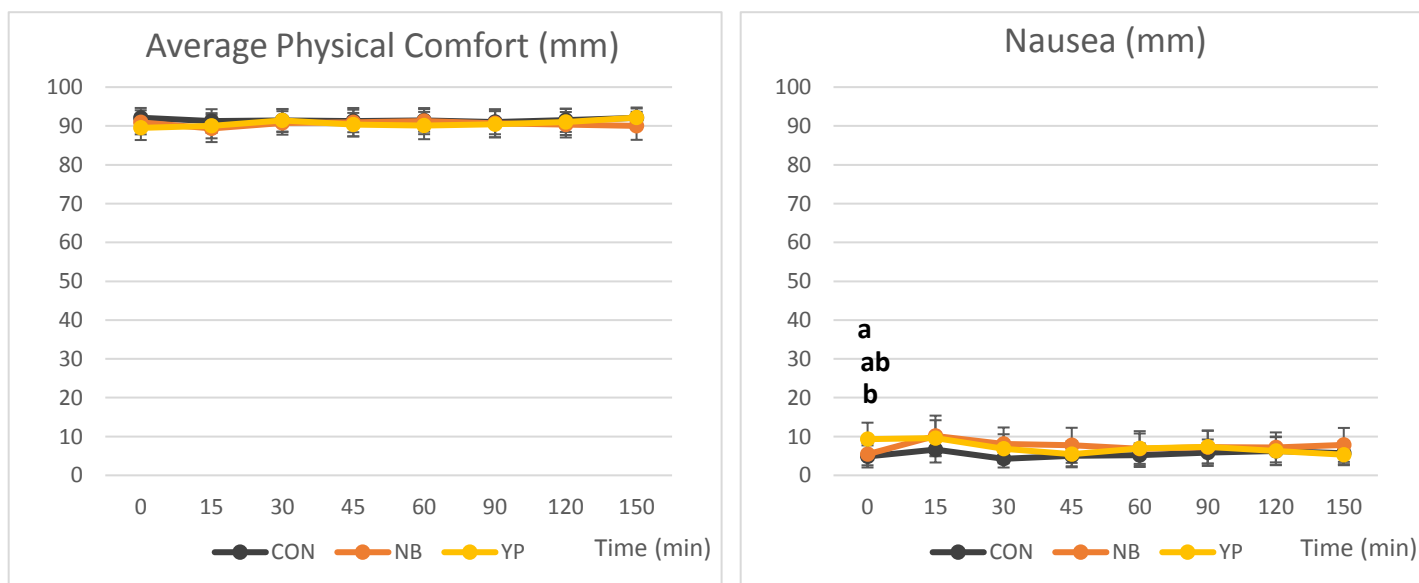
Figure 5.4 Gastrointestinal Comfort Ratings over 2 Hours

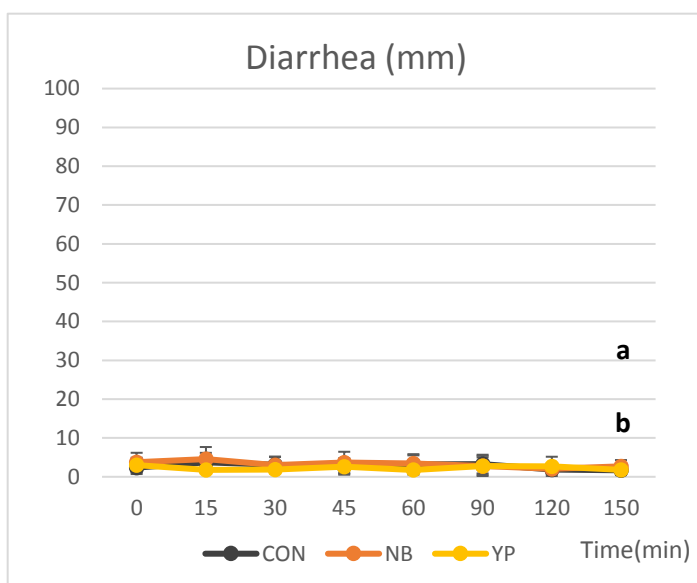
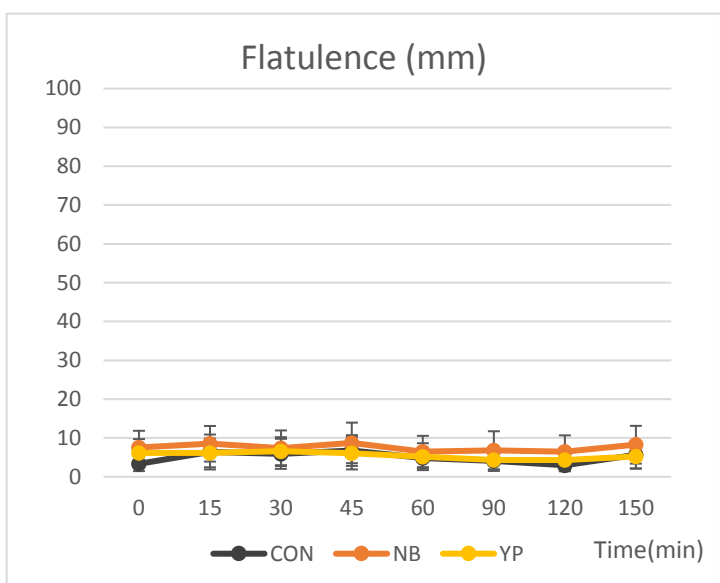
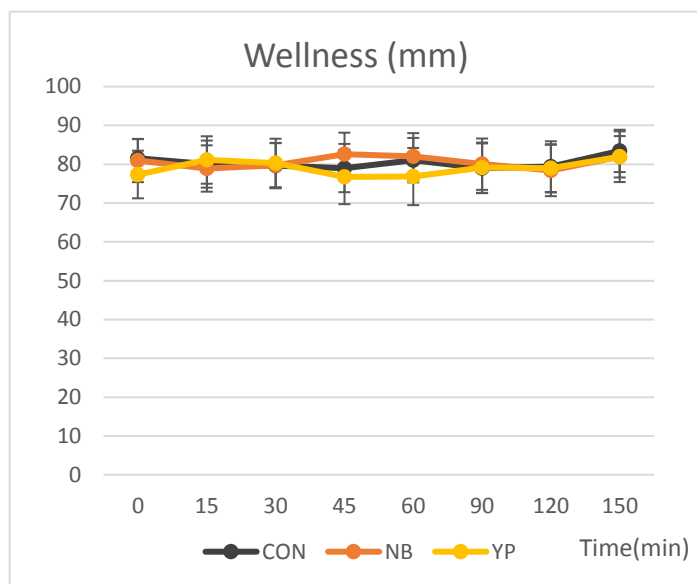
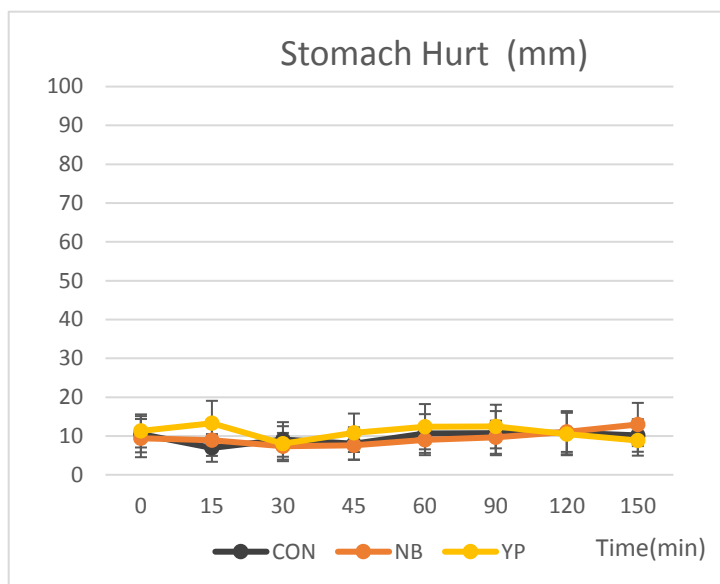


*CON: control, NB: navy bean treatment, and YP: yellow pea treatment

APC: Average Physical Comfort, NAU: Nausea, SMH: Stomach Hurt, WELL: Wellness, GAS: Flatulence, and DIAR: Diarrhea

Figure 5.5 Subjective Gastrointestinal Comfort Ratings over 2 Hours





*CON: control, NB: navy bean treatment, and YP: yellow pea treatment

5.5 Palatability of Treatments

Taste

There was an effect of treatment ($P=0.02$) on taste scores of treatments (**Table 5.9**). The taste of the control treatment was more liked than that of the yellow pea treatment (**Figure 5.6**).

Mouthfeel

There was an effect of treatment ($P=0.02$) on mouthfeel scores of treatments (**Table 5.9**). The mouthfeel of the control treatment was more liked than that of the navy bean treatment and yellow pea treatment (**Figure 5.6**).

Flavour Intensity

There was no difference in flavor intensity between treatments (**Table 5.9**) (**Figure 5.6**).

Sweetness

There was no difference in sweetness between treatments (**Table 5.9**) (**Figure 5.6**).

5.6 Pleasantness of Treatment and Pizza

Pleasantness of Treatment

There was a significant difference in pleasantness between treatments ($P=0.04$) (**Table 5.10**).

The control treatment was perceived as more palatable than the navy bean treatment and yellow pea treatment (**Figure 5.7**).

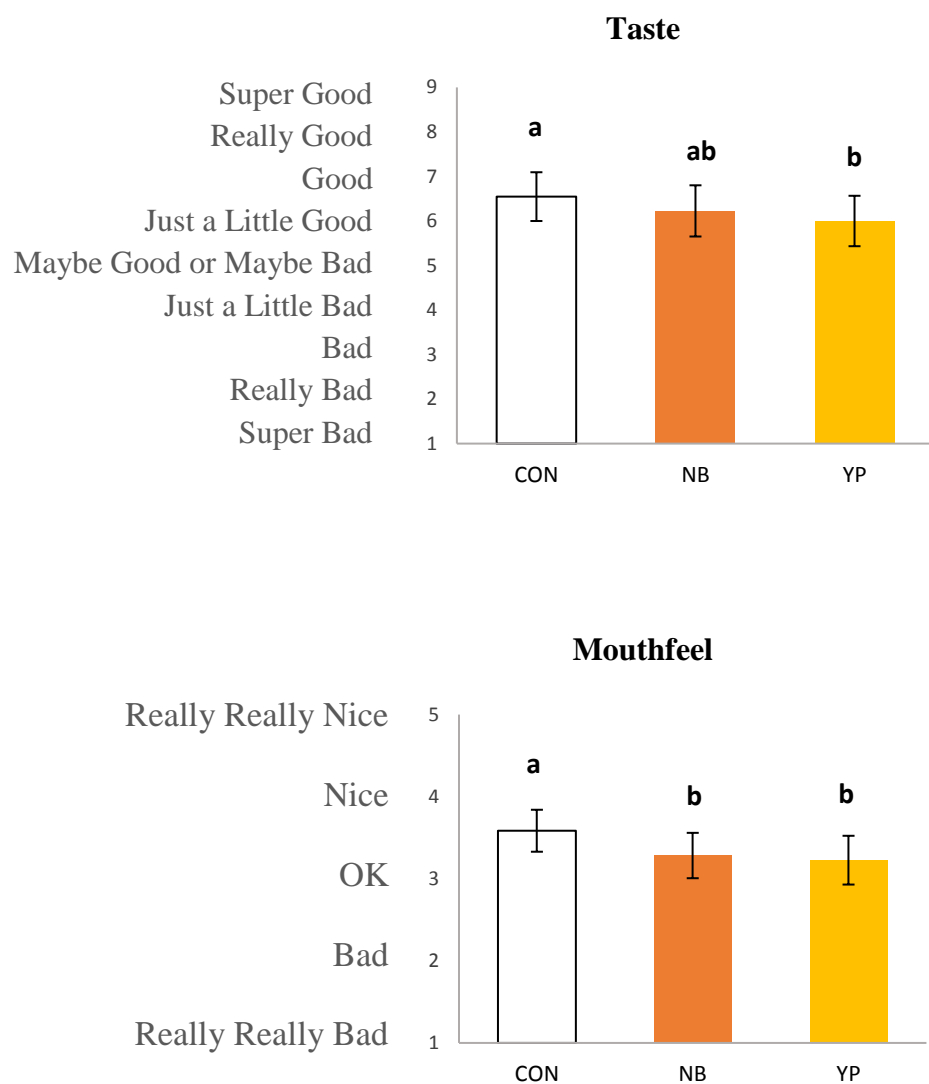
Pleasantness of Pizza

There was no effect of treatment on the pleasantness of pizza (**Table 5.10**) (**Figure 5.7**).

Table 5.9 Overall Mean of Palatability of the Treatments

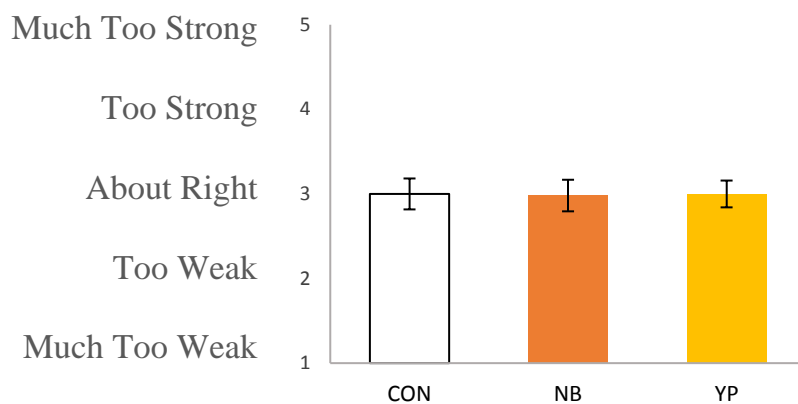
	Treatments			p-value (treatment)
	CON	NB	YP	
Taste (1-9)	6.5 ^a ± 0.5	6.2 ^{ab} ± 0.6	6.0 ^b ± 0.6	0.02
Mouthfeel (1-5)	3.6 ^a ± 0.3	3.3 ^b ± 0.3	3.2 ^b ± 0.3	<0.01
Flavour Intensity (1-5)	3.0 ± 0.2	3.0 ± 0.2	3.0 ± 0.2	1.0
Sweetness (mm)	42.5 ± 7.0	38.1 ± 6.3	39.0 ± 6.9	0.2

All values are means ± 95%CI, n=53. One-way (treatment) repeated measures ANOVA.
CON: control, NB: navy bean treatment, and YP: yellow pea treatment

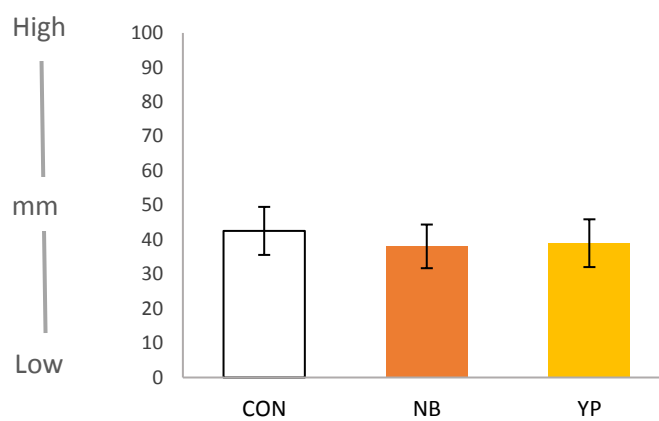
Figure 5.6 Palatability of Treatments

* CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Flavor Intensity



Sweetness



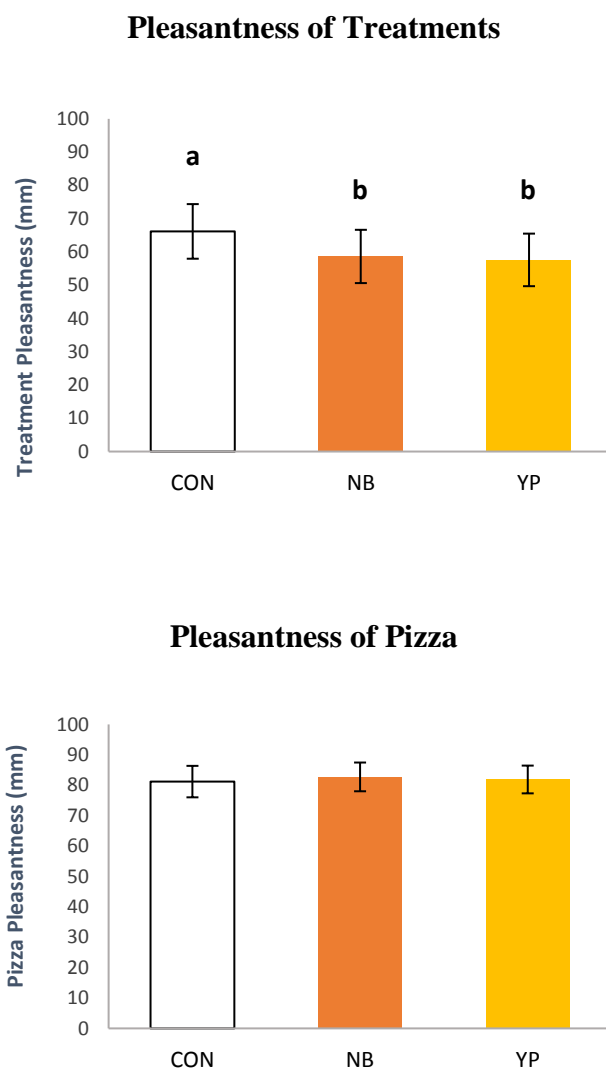
* CON: control, NB: navy bean treatment, and YP: yellow pea treatment

Table 5.10 Pleasantness of Treatment and Pizza

	Treatments			
	CON	NB	YP	p-value (treatment)
Treatment	66.2	58.6	57.6	0.04
Pleasantness (mm)	± 8.2	± 8.0	± 7.9	
Pizza	81.2	82.7	81.9	0.8
Pleasantness (mm)	± 5.2	± 4.7	± 4.6	

All values are means ± 95%CI, n=53.

One-way (treatment) repeated measures ANOVA.

Figure 5.7 Overall means of Pleasantness of Treatments and Pizza

* CON: control, NB: navy bean treatment, and YP: yellow pea treatment

5.7 Relations among Dependent Variables

Food intake was positively related to desire to eat ($r=0.30$, $P=0.03$) and prospective food consumption ($r=0.28$, $P=0.04$) (**Table 5.11**). There was a trend for a weak, positive relationship between food intake and average appetite ($r=0.26$, $P=0.06$), hunger ($r=0.27$, $P=0.05$), nausea ($r=0.18$, $P=0.2$), stomach discomfort ($r=0.34$, $P=0.1$), flatulence ($r=0.18$, $P=0.2$), diarrhea ($r=0.18$, $P=0.2$), sweetness of treatment ($r=0.15$, $P=0.3$), and pleasantness of pizza ($r=0.17$, $P=0.2$). There was also a trend for a weak, negative relationship between food intake and fullness ($r= -0.11$, $P=0.5$), wellness ($r= -0.2$, $P=0.2$), average physical comfort ($r= -0.27$, $P= 0.05$). Food intake was not related to taste of treatment ($r= -0.02$, $P=0.9$), mouthfeel of treatment ($r=0.03$, $P=0.8$), flavor intensity of treatment ($r= -0.08$, $P=0.6$) and pleasantness of treatment ($r= -0.002$, $P=1.0$).

Table 5.11 Correlations of Dependent Variables with Food Intake

Variables	Food Intake (kcal)	
	Correlation (r)	p-value
Average Appetite	r= 0.26	0.06
Desire to Eat	r= 0.30	0.03
Hunger	r= 0.27	0.05
Fullness	r= -0.11	0.5
Prospective Food Consumption	r= 0.28	0.04
Nausea	r= 0.18	0.2
Stomach Discomfort	r= 0.34	0.1
Wellness	r= -0.2	0.2
Flatulence	r= 0.18	0.2
Diarrhea	r= 0.18	0.2
Average Physical Comfort	r= -0.27	0.05
Taste of Treatment	r= -0.02	0.9
Mouthfeel of Treatment	r= 0.03	0.8
Flavor Intensity of Treatment	r= -0.08	0.6
Sweetness of Treatment	r= 0.15	0.3
Pleasantness of Treatment	r= -0.002	1.0
Pleasantness of Pizza	r=0.17	0.2

Pearson Correlation Coefficients.

6. Discussion

The results of the present study do not support the hypothesis that whole pulse meals will reduce appetite and decrease subsequent food intake in 12-to-14-year-old children compared to the control (rice) meal when provided on an isocaloric basis. Against the hypothesis, the navy bean treatment significantly led to higher weight intake of the pizza meal and cumulative solid weight intake compared to the yellow pea treatment in the light-to-normal weight group. However, as there has been no study that proved the consumption of navy beans can increase food intake, this finding can be interpreted that the yellow pea treatment significantly led to lower weight intake of the pizza meal and cumulative solid weight intake compared to the navy bean treatment. In addition, the control and yellow pea treatment significantly led to lower energy and weight intake of the pizza meal and lower cumulative energy and solid weight intake in the girls with light-to-normal weights, compared to the navy bean treatment.

Dose

In the present study, pulse treatments contained approximately 3/4 cup of cooked navy beans (175ml, 180kcal) or cooked yellow peas (185ml, 180kcal). According to the Canada's Food Guide, 1-2 servings (each serving is 175 ml or 3/4 cup) of meat and alternatives are recommended per day for the age group of 9-to-13-year olds. Furthermore, it took over 10 minutes for many participants to finish pulse treatments, and three children could not finish it as they became full. Therefore, although satiating effects of pulses were not observed in the present study, the amount of pulses provided in the study was enough and should not be increased any more.

Protein content

In the present study, the control, navy bean and yellow pea treatment contained 5g, 13.2g and 16.9g of protein respectively. The finding, the pulse treatments did not increase short-term satiety compared to the control, is inconsistent with that of the study conducted Yu (2015) in which the control treatment (cooked durum wheat pasta, 250kcal), navy bean treatment (pureed navy beans added to the control as 44% of energy) and yellow pea treatment (pureed yellow peas added to the control as 44% of energy) contained 10.4g, 12.7g and 13.0g of protein respectively. Although the protein content between treatments did not largely differ, the pulse treatments significantly increased short-term satiety in children aged 9 to 14 years compared to the control. Thus, the protein content itself may not be effective in increasing short-term satiety, and combination of protein (pulses) and carbohydrate may be important.

Dietary Fibre content

In the present study, the navy bean and yellow pea treatments, containing 12.8g and 14.9g of dietary fibre respectively, did not reduce ad-libitum food intake 120min later compared to the control treatment containing 0g of fibre. This finding is consistent with that of the study conducted by Smith et al. (2012), in which no effects were detected on ad-libitum food intake after the consumption of 12g or 22g of isolated yellow pea fibre treatment. They explained that the duration of the study (120min) may not be sufficient to see satiating effects associated with fibre consumption. It is because that fibres are basically fermented by bacteria producing short-chain fatty acids (SCFA) in the large intestine (Nilsson et al., 2008 and Wong et al., 2006) with beneficial outcomes such as suppression of appetite and glycaemia. Therefore, even though the fibre content was significantly higher in both navy bean and yellow pea treatments, the duration of the present study session was not long enough for the food to reach the colon where the

fermentation process takes place. Thus, the satiating effect associated with fibre consumption was not seen.

Postprandial Glycemia

In non-diabetic individuals, blood glucose concentrations peak in one hour after the start of a meal and return to preprandial levels within two to three hours. The control treatment had a higher carbohydrate content (47.7g) compared to the navy bean treatment (36.2g; 12.8g of dietary fiber) and yellow pea treatment (40.7g; 14.9g of dietary fiber), and the medium grain rice used in the control treatment has high glycemic index (GI). Therefore, the control treatment could cause a rapid rise in the blood glucose level after the consumption. In addition, the fat content (more than 10.0g) of the treatment, provided by tomato-based sauce, can also modify postprandial glycemia. As fat delays gastric emptying, the addition of dietary fat retards an increase in postprandial glucose levels (Bell et al., 2015). It is assumed that relatively high plasma glucose level was maintained for a longer time in 120min after the participants consumed the control treatment, which possibly prolonged satiety and led to less (or equal) ad libitum food intake compared to the pulse treatments.

Chewing (mastication) frequency

Although there was no significant difference in the mouthfeel between the navy bean and yellow pea treatment, it was seemed that cooked yellow peas absorbed more tomato-based sauce after mixed with the sauce than cooked navy beans did. Thus, the navy bean treatment was slightly saucier than the yellow pea treatment. The yellow pea treatment also had more grains compared to the navy bean treatments when providing the same volume, due to their smaller size of grains. Therefore, the participants possibly chewed more when consuming the yellow pea treatment

while chewed less when consuming the navy bean treatment. According to (Miquel-Kergoat et al., 2015), chewing during an eating occasion would enhance satiation and satiety and reduce food intake, possibly by elevating (or suppressing) relevant gut hormone, such as postprandial insulin, glucose, CCK and GLP-1. This can be the cause of more food intake after the navy bean treatment and less after the yellow pea treatment in the present study.

Sex Difference

Fasting plasma glucose levels and glycemic response to ingested foods are known to be different between non-diabetic men and women. With the oral glucose tolerance test in healthy young adults aged 22 to 30 years, Horie and colleagues (2018) found that the plasma glucose levels at 120 min were significantly higher in women than men, and insulin secretion was also significantly greater at 30, 90 and 120 min from baseline in women than men. Yet, glucagon was suppressed more at 30 and 120 min from baseline in men than women. As mentioned, since appetite and food intake are carefully regulated by a variety of hormones including insulin and plasma glucose levels, these differences can result in the finding of the present study that there was a treatment effect (the control and yellow pea treatment vs the navy bean treatment) on energy and weight intake of the pizza meal and cumulative energy and solid weight intake, only in the girls with light-to-normal weights.

As future directions, firstly, further research is needed to examine the effect of cooked whole pulses on longer-term (e.g. 3-5hours) satiety and subsequent food intake. At the same time, the postprandial glycemia should be measured in order to see the effect of each treatment on the changes of plasma glucose. Moreover, since the present study found a significant effect of weight status and sex on food intake, and since there may be an effect of sex on postprandial

glycemia and relative hormones, weight status (light to normal weight or heavier) and sex of eligible participants should be determined in order to decrease the deviation of data.

Although the present study indicated that the consumption of cooked whole pulse treatments may neither increase satiety nor reduce subsequent food intake in two hours, 3/4 cup of cooked whole pulses greatly increase protein and fibre content of the meal. Therefore, consuming 3/4 cup of cooked pulses on a daily basis can be beneficial for the regulation of food intake and weight loss in the long term.

6. References

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Appendix

treatment	Energy (kcal)	Fat (g)	Sodium (mg)	Carbohydrate (g)	Fiber (g)	Protein (g)	Iron (%)	Folate (%)	Mg (%)
Rice	300.0	10.5	348.0	47.7	0.0	5.0	5.8	0.0	0.0
NB*	300.0	11.2	350.3	36.2	12.8	13.2	20.6	75.0	37.5
YP*	300.0	11.1	357.3	40.7	14.9	16.9	20.4	0.0	27.9

Table1: Nutritional of dietary treatments (*NB: navy beans, YP: yellow split peas)

Control	g	kcal	NB	g	kcal	YP	g	kcal
Rice cooked	110.7	180.0	NB cooked	126.7	180.0	YP cooked	131.6	180.0
Rosee sauce	57.6	63.0	Rosee sauce	57.6	63.0	Rosee sauce	57.6	63.0
Extra salted butter	6.0	42.0	Extra salted butter	6.0	42.0	Extra salted butter	6.0	42.0
Unsalted butter	2.0	14.0	Unsalted butter	2.0	14.0	Unsalted butter	2.0	14.0
Broth	15.0	1.0	Broth	15.0	1.0	Broth	15.0	1.0
Water	20.9	0.0	Water	4.9	0.0	Water	0.0	0.0
Total	228.3	300.0	Total	228.3	300.0	Total	228.3	300.0
			Cooked NB	175ml		Cooked YP	185ml	

Table2: Dietary treatment formulation

Appendix 1
The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term 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

Appendix 1
The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term 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
- Honey Nut Cheerios: Yes/No
- Orange juice: Yes/No
- Granola bar (peanut free): Yes/No
- Beans: Yes / No
- Peas: Yes / No
- Tomato based (Rosée) sauce: Yes / No
- Rice: Yes / No
- Pizza: Yes / No

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

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

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

Is your child following a special diet? Yes / No

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

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

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

Education: Grade: _____ Special Class? Yes / No

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

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

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

Include in study? Yes / No

Appointment scheduled for: (date and time)

Investigator/Date screened:



Appendix 2a

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

Recruitment Letter for Parents

Dear Parent,

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

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

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

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

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

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

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

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

Thank you for your support in this important research.

Sincerely,
Kana Inagaki



Appendix 2b

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

Study Information Sheet and Parent's Authorization Form

Investigators:

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INTRODUCTION

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

Why are the researchers doing the study?

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

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

This experiment is being conducted through the Department of Applied Human Nutrition at Mount Saint Vincent University. Your son/daughter will be asked to attend three experimental sessions conducted over a 3-week period and one screening session for a total of 4 visits (1 screening session + 3 experimental sessions) to the Mount Saint Vincent University campus. This study is a randomized clinical trial which means that your child will be asked to consume a randomly selected food product (cooked rice, whole navy beans, and whole yellow peas with tomato based sauce). For example, your child will be asked to consume seasoned rice on the first session and seasoned whole yellow peas on the second session or opposite seasoned yellow peas on the first session and seasoned rice 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 3.5 hours.

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

We anticipate having about 34 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:

Screening:

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

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

- Menstrual Cycle Questionnaire:

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

- Tanner Staging:

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

- Body Composition Assessment:

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

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

Experimental sessions:

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

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

After your child has completed questionnaires, he/she will be given spring water and the meal or cooked rice or cooked beans and peas. At 0, 15, 30, 45, 60, 90, 120, 150 min, your child will be asked to complete the questionnaire rating his/her appetite, and another questionnaire rating the level of physical comfort will be provided simultaneously with appetite questionnaire at similar times. McCain pizza (purchased at grocery store) and spring water will be served at 120 minutes after the first meal). Your son/daughter will be told that he/she may eat as little or as much pizza as they like. We use pizza as a research tool to find out whether the cooked rice or cooked beans or peas will lead to lower calories eaten with pizza. The amount of the test meal and pizza eaten by your child throughout the session will be measured and we will know how much calories were eaten by your child during the session.

Your child will be fully supervised during the study sessions. He/she will be involved in age appropriate entertainment (as distraction) e.g.: reading, cards, educational games and activities, and arts and crafts before lunch. There will be other children there

participating in the study. You can pick your child up in 3 hours or you have an option to stay with your child if you wish.

Approximate Time and Activity Schedule for Each Experimental Session:

Time	Activity
Day before: 8:00 pm	The last meal of the day. No food or beverages (except water) should be consumed in the following 12 hours.
Session day: 8:00 am	At home: consume the standardized breakfast provided by research staff.
10:00 am	At home: consume snacks provided by research staff (one granola bar and water).
11:00 am	Arrive to the lab. (Bring checklist).
11:05 – 11:25 am	Complete stress/activity questionnaires, recent food intake.
11:30 – 11:45 am	Complete baseline questionnaires for appetite and physical comfort.
12:00 pm	Consume a test meal (seasoned rice with or without beans or peas).
12:15 am – 1:45 pm	We will ask you to complete questionnaires about the taste of the meal you just ate, your appetite and how you feel at certain time points.
2:00 pm	Pizza meal is provided. You can eat as much as you want until you feel comfortably full.
2:30pm	Fill out the questionnaires about the taste of the pizza.
2:30 pm	The session is completed.
Total hours in the lab: 3 hours	

CONFIDENTIALITY:

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

RISKS:

There is very little risk related to this study. The provided meals are/or prepared from commercially available food products and are safe for human consumption. Children

may feel dizzy following the overnight fast, but this is rare. If this happens, they will likely feel fine once they consume the breakfast meal provided. There is a possibility of other unexpected risks.

BENEFITS:

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

QUESTIONS AND FURTHER INFORMATION:

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

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

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

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

RESEARCH RIGHTS:

Your signature on the form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree that your child will participate as a subject. In no way does this waive your legal rights nor release the investigator(s), sponsors, or involved institution(s) from their legal and professional responsibilities. **Your child is free to withdraw from the study at any time. Withdrawal from the study does not have any consequences.**

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

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

RESEARCH RESULTS:

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

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

Participant ID: _____

PARENT AUTHORIZATION:

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

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

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

Name of Participant: (Print) _____

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

Date: _____ Time: _____ Participant ID: _____

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

STATEMENT BY PERSON PROVIDING INFORMATION ON STUDY AND OBTAINING CONSENT

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

Name: (Print) _____

Signature: _____ Position: _____

Date: _____ Time: _____



Appendix 2c

The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term Satiety and Food Intake in Children **Child's Assent Form**

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

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

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

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

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

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

Signature: _____

Name of the person who obtained assent: _____

Appendix 4

Puberty Questionnaire (Self-administered)

ID: _____ Date: _____

Would you say that your growth spurt (height):

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

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

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

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

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

FOR GIRLS:

Have your breasts started to develop?

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

FOR BOYS:

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

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

Have you started to have hair on your face?

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

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

Appendix 5
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
The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term 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 7a
Visual Analogue Scale
Motivation to Eat

DATE: _____

Session _____

Treatment ID _____

ID: _____

Time point: ____ min

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

1. How strong is your desire to eat?

Very _____ Very
 WEAK STRONG

2. How hungry do you feel?

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

3. How full do you feel?

Not full _____ Very full
 at all

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

NOTHING _____ A LARGE
 at all amount

Appendix 7b
Visual Analogue Scale
Physical Comfort

DATE: _____

Session _____

Treatment ID _____

ID: _____

Time point: ____ min

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

1. Do you feel nauseous?

NOT at all _____ VERY
 much

2. Does your stomach hurt?

NOT at all _____ VERY
 much

3. How well do you feel?

NOT well at _____ VERY well
 all

4. Do you feel like you have gas?

NOT at all _____ VERY
 much

5. Do you feel like you have diarrhea?

NOT at all _____ VERY
 much

Appendix 7c

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

**Visual Analogue Scale
Pleasantness**

DATE: _____

Session _____

Treatment ID _____

ID: _____

Actual time _____

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

How pleasant have you found the food?

NOT at all
pleasant

VERY
pleasant

Appendix 7d

The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term 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 _____ VERY
sweet sweet

Appendix 8a

The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term Satiety and Food
Intake in Children
Peryam & Kroll hedonic scale

DATE: _____

Session _____

Treatment ID _____

ID: _____

Actual time: _____

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

SUPER GOOD

REALLY GOOD

GOOD

JUST A LITTLE GOOD

MAYBE GOOD OR MAYBE BAD

JUST A LITTLE BAD

BAD

REALLY BAD

SUPER BAD

Appendix 8b

The Effect of Cooked Whole Navy Beans and Yellow Peas on Short-term 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 8c

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

Hedonic scale: flavour

DATE: _____

Session _____

Treatment ID _____

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