Mount Saint Vincent University
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The development and sensory evaluation of puréed foods with added pulses

By

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Dedication

To God,

For, his endless love and grace, because YOU always have given me the strength. Without you, I wouldn't be here. Every little piece is yours.

Psalm 46:5.

Abstract

Background: Proper nutrition is necessary for people's physical and emotional well-being. The relationship between food and people's well-being is associated with nutrition, the pleasure of tasty food, and social components. Dysphagia is a condition that increases the risk of malnutrition and its consequences. Providing appropriate food for people with dysphagia prevents the risk of becoming malnourished. Puréed food may not appear appetizing or tasty enough. The novel aspect of this work is the use of pulses for purée formulations for the dysphagia population, and the sensory evaluation of the formulated recipes.

Objectives: to develop and formulate pulse-based purée recipes and evaluate their sensory perception by adults, senior adults, and children.

Methods: This study followed an open-label randomized control trial design. 86 participants, 35 adults (19-65y; 18 females, 17 males), 30 seniors ≥65y, (16 females, 14 males), and 21 children (9-15y; 11 females, 10 males) were recruited to evaluate the sensory characteristics using a 9-point hedonic scales and a 100 mm visual analogues scales. The analysis of pH, particle size, nutritional profile, and IDDSI tests were performed to evaluate the physio-chemical characteristics of puréed products. The effects of treatment, sex, and age on sensory perception were evaluated using the methods of parametric or nonparametric statistics.

Results: There was an effect of a treatment on perceived appearance, pleasantness, taste, texture, flavor, sweetness, smoothness, swallowness, mouthfeel, and aftertaste of puréed products. The effect of sex ($P=0.04$) and age ($P=0.02$) was seen on the perceived smoothness where a higher perception of smoothness was determined in males than females and a higher perception of smoothness was observed in adults compared to senior adults. The result of the IDDSI assessment showed that the samples fall into the Puréed Level 4. The pH of the samples resulted in an acidic pH ranging from 4.7- to 6.7. The particle size analysis resulted in a range of 566 – 1290 microns.

Conclusion: The development of the food recipes using blended pulses, in combination with other plant and animal ingredients, resulted in puréed products with acceptable sensory characteristics as evaluated by adult, senior adult, and children participants. The texture assessment and particle size analysis demonstrated that the developed recipes meet the criteria set by the International Dysphagia Diet Standardisation Initiative for purées. Future work is needed to reformulate the recipes to meet the regulations set for canned foods, and further improve the protein quality.

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List of Abbreviations

ANOVA	Analysis of variance
CASLPO	College of Audiologists & Speech-Language Pathologists of Ontario
CBPP	Canadian Best Practices Portal
CNF	Canadian Nutrient File
DRI	Dietary reference intakes
DSSC	Dartmouth Senior Service Centre
CSIR	Canadian Society of Intestinal Research
ICDEP	The Integrated Competencies for Dietetic Education and Practice
IDDSI	International Dysphagia Diet Standardization Initiative
NDD	National Dysphagia Diet
PFD	Pediatric feeding disorder
RD	Registered Dietitian
RCSL	Royal College of Speech & Language Therapist
TMF	Texture modified food.
UN	United Nations
VAS	Visual Analogue Scale
WHO	World Health Organization

1. Introduction

Proper nutrition is vital to physical and emotional well-being (Caviness, 2009). The World Health Organization (WHO) states that nutrition is the foundation for optimal growth, development, and overall health, protecting individuals against all forms of malnutrition (World Health Organization, 2020). The general audience is advised that eating well and getting adequate nutrition promotes brain health, improves gastroenterological function, and improves people's emotional health (Selhub, 2022).

The way food can impact an individual's life is positively related to mental and emotional health (Schnettler et al., 2015). It is worth noting that the relationship between food and people's well-being is associated not just with nutrition but with the pleasure of tasty food as well as the social components (Raats et al., 2017).

Canadian Best Practices Portal (Canadian Best Practices Portal, 2016) explains that there are different social determinants that can have an impact on the population's health. They include income, social status, education, working conditions, and social and physical environments, in addition to personal health practices and coping skills, healthy child development, gender, and culture. Therefore, these factors also influence people to choose a varied, accessible, and healthy diet (Raats et al., 2017). When one or more of these factors is affected, it impacts a person's quality of life (Costa et al., 2021). The ability to swallow properly for many people is unconscious, however, when this ability is affected, an unexpected new reality becomes part of their lives. Suddenly, struggling with swallowing food properly becomes a challenge (Aghaz et al., 2019).

Dysphagia is the medical term used for swallowing disorders (Logemann et. al, 2008; Cichero et al., 2017). Frequently, individuals with this condition are at risk of malnutrition and its consequences. As a result, poor quality of life is being experienced. Individuals that are diagnosed with a swallowing disorder are usually prescribed a texture-modified diet, which are the most used as a therapeutic diet, employing puréed food as a safe option for them (Aguilera & Park, 2016). Changing the texture of the food and providing a consistent intake of healthy food and essential nutrients can help reduce the risk of serious conditions. However, when the texture of the food is changed there are some new challenges to face.

When talking about texture modification diets, purées are the star of the dish. However, purées are unappetizing even when nutritionally adequate, causing people to gradually lose interest, appetite and will in eating (Raheem et al., 2021). One of the reasons is offering meals to patients that are visually unappealing and not tasty (Sura et al., 2012). Feelings of frustration, loneliness, and cultural disconnection are some of the consequences that people with swallowing disorder have to face impacting their social and emotional environment (Seibert, 2020, Smith et al., 2022).

Quality of life declines by the difficulty in having normal food intake, a decreased motivation to eat, and low appetite, which increases the time spent on meals (Garcia, 2010). For many people, it is usual to chew and swallow, eat tasty foods, and relax over a good meal. (Seibert, 2020). However, for people that present a swallowing disorder, getting adequate nutrition is just one of their challenges. When an individual is diagnosed with dysphagia the food experience radically changes going from a pleasant experience to a daily concern that only focuses on eating to meet nutritionalrequirements (Riquelme 2004; Seibert, 2020; Smith et al., 2022).

Currently, the treatment of dysphagia tries to address multiple angles for a better approach considering the nutritional content of food and the palatability of the meals (Butt & Lam, 2005; Ettinger et al., 2014). However, there are still many areas for improvement, so the individuals do not reject their food (Dietitians Of Canada, 2015).

To improve quality of life, appropriate strategies are needed to promote meals that can still be an enjoyable experience, while providing the adequate amount of nutrients. Those with dysphagia only eat small amounts, not because they do not have the appetite, but because the condition makes that a half-hour meal take longer (Canadian Society of Intestinal Research, n.d.). As a result, people are left exhausted, not consuming enough calories or protein because many meals are left unfinished (Azer et al., 2023). Meal replacements can properly address this need. Meal replacement is a term used to describe a formulated food that, by itself, can replace one or more daily meals (Canada Food Inspection Agency, 2014). It needs to have a minimum of 225 calories per serving and a specific amount and quality of protein (Canada Food Inspection Agency, 2014). Therefore, having an appropriate food that can be categorized as a meal replacement can help the existing protocols allowing patients not just being at risk when eating but also improving their daily intake (Tutor, 2017). Texture modified diets are designed to embrace this necessity (Raheem et al., 2021). Strategies where food can be modified to fulfill this task includes the development of puréed foods preventing the risk of becoming malnourished (Philpott et al., 2017).

Puréed food, even when nutritionally adequate, sometimes may not appear appetizing or tasty enough (Murphy & Vertrees, 2017; Wu et al., 2020). Nevertheless, there are foods such as pulses than can be included in the development of the formulations that helps improve both, the nutritional and sensory profile of purées.

Canadian health authorities have been promoting the use of plant-based foods for a while culminating it in 2019-edition of Canada's Food Guide and emphasizing that the consumption of plant-based foods is a way to improve the diet of the Canadian population (Health Canada, 2019). Health Canada indicates that eating plant-based foods more often results in higher intakes of fibre, protein, and good sources of fat which is associated with a lower risk of noncommunicable diseases and a lower consumption of processed foods high in saturated fats (Health Canada, 2019).

Pulses are excellent sources of protein, and they are also a low-cost and plant-based option (Pulse Canada, 2019). Pulses are defined as the edible dried seed of certain legume family plant. Some of the most common Canadian-grown pulses are chickpeas, lentils, peas, and red beans (Pulse Canada, 2019). Taking this into consideration, the use of pulses in formulations would be the most accurate option to address the protein gap that people with swallowing disorders face. Also, it would be a great option for individuals who are vegetarians. However, the current market does not offer this option. Although Pulse Canada (2019) has an extensive list of pulses and pulse-containing recipes, there are no specific products that can be used for people with dysphagia.

The current study aimed to develop and formulate pulse-based purée recipes to increase the protein value of the purées and its overall nutritional value. In addition, animal and vegetable ingredients were added to offer flavor and different sensory attributes providing a tasty meal replacement enriched with protein and other nutrients. Additionally, the study evaluated the sensory perception of purées containing pulses (beans, lentils, chickpeas, and peas) by adults, senior adults and children establishing the evidence for reaching a gratifying experience.

2. Literature Review

Dysphagia

Definition

The word dysphagia comes from the Greek words *dys* (difficulty) and *phagia* (to eat), defining this term as the difficulty or impairment in swallowing (Rommel & Hamdy, 2016) resulting in an irregular delay of food and drinks in its passage from the mouth to the stomach (Aslam and Vaezi, 2013). In other words, dysphagia can be described as the difficulty of eating or swallowing. This delay can occur during the oropharyngeal or esophageal phase of swallowing (Azer et al., 2023) affecting how a person is nourished (College of Dietitians of Ontario, 2019).

"Nutritional-related disorder" is a term that is used to refer to the relationship between a disorder, the treatment and the management used for addressing this condition. For example, the management of food and liquids that can maintain good health or texture modification for an alternative method for nutrition (College of Dietitians of Ontario, 2019).

There is also a subjective definition of dysphagia, and it is the sensation of delay that a person can feel when eating or drinking. Both are relevant since some may lose the sensation of a delay in swallowing, but objective tests could show that dysphagia is an actual condition (Azer et al., 2023). This condition can be caused by several factors either a medical condition or just an age-related symptom (Butt & Lam, 2005). Additionally, the individual's symptoms of a delay in swallowing may be potentiated or attenuated through sensory neural dysfunction (Azer et al., 2023).

Causes of dysphagia

Based on the location of the swallowing disorder, dysphagia can be classified into four categories which can occur in four different but continuous anatomic areas, oropharyngeal (location1), esophageal, esophagogastric, and paraesophageal areas (Wolf, 1990).

Types, symptoms, and risks of dysphagia

Oropharyngeal dysphagia is related to the initiation of the swallow, when there is difficulty moving the food bolus from the oral cavity to the cervical esophagus (Aslam & Vaezi, 2013). Normal swallowing requires a coordinated voluntary transfer of food from the mouth into the pharynx, followed by rapid transfer of the bolus into the upper esophagus. Symptoms relate to difficulty in the initiation or initial transport of a solid or liquid food bolus (Wolf, 1990). It could be due to three main subgroups: neurological, muscular, or anatomical (Rommel & Hamdy, 2016).

Table 2.1 Causes of oropharyngeal dysphagia

Type	Cause
Neurological	- Cerebrovascular accidents (post-stroke dysphagia) and brainstem infarctions - Parkinson disease - Injuries and surgery: head and neck - Multiple and amyotrophic lateral sclerosis - Central nervous tumour - Botulism
Muscular	- Polymyositis - Muscular dystrophy - Myasthenia gravis (a lesion at the neuromuscular junction).
Anatomical	- Zenker diverticulum - Enlarged thyroid - Tumors, abscess

Adapted from (Wolf, 1990)

Esophageal dysphagia occurs in the body of the esophagus and relates to difficulty in passing food to the stomach. Dysphagia may result either from mechanical obstruction or altered motor function along the area of food passage (Aslam & Vaezi, 2013). It results from either abnormal motility of this segment of the esophagus or physical obstruction (Wolf, 1990).

Table 2.2. Causes of esophageal dysphagia

Type	Cause
Mechanical obstruction	- Schatzki ring - Esophageal stricture - Esophageal carcinoma - Eosinophilic esophagitis
Motility disorder	- Esophageal spasm, - Achalasia - Ineffective esophageal motility - Scleroderma - Carcinoma

Adapted from (Wolf, 1990)

Table 2.3 lists the principal differences between the two most common dysphagia types and the associated symptoms are given in Table 2.6.

Table 2.3. Differences between oropharyngeal and esophageal dysphagia

Oropharyngeal *A person cannot swallow because of problems in the mouth or throat*	**Esophageal** *Food is unable to move down the esophagus*
Nerve damage from a brain or spinal cord injury, stroke, Parkinson's Disease, muscular dystrophy, or multiple sclerosis	A narrowing of the esophagus, also known as a stricture, which ultimately traps larger pieces of food. The esophagus narrows primarily because of scar tissue or tumors.
Tumors that obstruct the path of food	Gastroesophageal reflux disease, or GERD, can cause stomach acid to flow back into the esophagus, causing scarring.
Inflammatory or neuromuscular problems, such as dermatomyositis (an inflammatory disease) and myasthenia gravis	Blockage caused by food not being chewed properly (especially for older adults who have problems chewing because of dentures)

Adapted from Aslam & Vaezi (2013).

Esophagogastric dysphagia occurs when there is an impediment of passage from the lower esophageal sphincter into the gastric fundus due to motor or physical obstruction. The

causes include abnormalities of the lower esophageal sphincter, benign or malignant strictures of the distal esophagus, and mass lesions of the gastric cardia (Wolf, 1990).

Table 2.4. Causes of esophagogastric dysphagia

	Motor	Physical obstruction
Esophageal	Esophageal carcinoma	
	Achalasia	Reflux esophagitis
	Vigorous achalasia	Peptic stricture
	Scleroderma	Schatski ring
	Diabetes mellitus	

Adapted from (Wolf, 1990)

Paraesophageal dysphagia occurs when there is either physical interference on the esophageal wall and lumen or infiltration of the esophageal wall leading to obstruction (Wolf, 1990).

Table 2.5. Causes of paraoesophageal dysphagia

	Motor	Physical obstruction
Paraesophageal		Thyromegaly
		Cervical spine disease
		Left atrial enlargement
		Postsurgical scarring

Adapted from (Wolf, 1990)

Symptoms of dysphagia

People may experience a swallowing disorder for many different reasons. Usually, the signs and symptoms associated with this health condition may include inability to get food and/or liquids down, pain when swallowing, chest pressure, frequent heartburn, gagging, choking, or coughing when swallowing (Werstuck & Steel, 2021). Table 2. 6 summarizes the most common symptom attributed to dysphagia. The symptoms can become more severe over

time, and the severity may be largely contingent upon where the problem is occurring (Wrigh et al., 2005).

Table 2.6. Symptoms attributed to dysphagia

Symptom	Disorder
Difficulty initiating swallow	Oropharyngeal dysphagia
Coughing or choking with swallowing	
Nocturnal aspiration	
Dysphagia for solids is greater than that for liquids	Physical obstruction
Dysphagia for liquids is greater than or equal to that for solids	Motor disorder
Intermittent dysphagia	Motor disorder
	Schatski ring
Heartburn and dysphagia	Reflux esophagitis
	Reflux strictur

Adapted from (Wrigh et al., 2005)

Risk factors associated with dysphagia

For most people who face this health condition, swallowing is mild at first, with not many changes in its condition for some time. However, dysphagia can get more severe depending on what is causing the disorder (Narciso, 2022). Regardless of the severity of the disorder, it has a significant impact on the individual's life. Aging is one of the factors associated with presenting dysphagia (Werstuck & Steel, 2021). Natural aging, normal deterioration and damage to the esophagus, and several conditions set seniors at a higher risk of swallowing difficulties. However, dysphagia is not considered a normal sign of aging (Dietitians of Canada, 2015).

Health complications related to dysphagia

A swallowing disorder can impact an individual's physical and mental health and well-being. Currently, people with dysphagia might see a social and emotional impact. Frustration, disinterest in eating and drinking, increased feelings of loneliness, the lack of habitual meals and cultural disconnect might result in a negative relationship with food and mealtimes (Riquelme, 2004; Sura et al., 2012). When this condition is inadequately managed or untreated,

dysphagia can lead to more critical complications, including choking, aspiration pneumonia (a lung infection caused by food or liquid particles in the lungs), chest infection, loss of appetite, malnutrition, and dehydration (Riquelme, 2004) and this association might increase the morbidity and mortality, especially in seniors (Davis & Spicer, 2007).

Prevalence and incidence of dysphagia

Current evidence reports that the prevalence of dysphagia has been estimated based on the disease-specific case, age, source of information either self-reported or after an objective assessment and the place of assessment if it was in a hospital or by an ambulatory basis (Howden, 2004).

The prevalence of dysphagia is estimated to affect 8% of the world's population (590 million people) (Cichero et al., 2017). Dysphagia affects up to 35% of seniors living in the community (Khader & Mubeena, 2018) and approximately 50% of hospitalized older adults (Werstuck & Steel, 2021), impacting not only nutrition and hydration status but an overall quality-of-life (Keller & Goy, 2004). This geriatric condition affects 10% to 33% of seniors and is commonly seen in seniors who have experienced a stroke or neurodegenerative diseases such as Alzheimer's or Parkinson's disease (Royal College of Speech & Language Therapists, n.d.).

Although the exact prevalence of dysphagia across different settings is unclear, it is estimated that 15% of the elderly population is affected by dysphagia (Barczi et. al, 2000). The prevalence of dysphagia is approximately 10% to 22% in Americans aged 50 and over, which increases with advances in age, and it is approximately 40% in people over 60 years old (Azer et al., 2023).

Infants, children and young people with neuro-disability and those born prematurely are most likely to be at risk of dysphagia (Duffy, 2018). However, feeding difficulties also occur in typically developing children (Royal College of Speech & Language Therapists, n.d.). It was found that the incidence of feeding difficulties is between 25-45% in a typically developing paediatric population, between 31-99%, for children with cerebral palsy, between 21-44% for children with general neurodevelopmental disabilities, between 26.8-40% for infants born prematurely, and between 68-72% of children with acquired conditions during the acute phase of care (Royal College of Speech & Language Therapists, n.d.; Bernard-Bonnin, 2006).

In Canada, the prevalence of dysphagia in adults has been reported to be up to 50% in acute care facilities and up to 66% in long-term care facilities (Dietitians of Canada, 2015). Since the Canadian population is aging at a persistent rate, it is likely that the prevalence of dysphagia will increase (College of Dietitians of Ontario, 2019).

Finally, the scope of incidence and prevalence of dysphagia in the adult population is difficult to determine as this disorder is associated with other health problems, as shown in Table 2.7

Table 2.7. Scope of incidence and prevalence of adult population with dysphagia

Prevalence/ Incidence (%)	Health Condition/ Setting
Between 50% - 75%	Home residences
Between 50% - 60%	Head and neck survivors
Between 40% - 78%	Stroke survivor
48 %	Undergoing cervical discectomy
33 %	Multiple Sclerosis
27 %	Chronic obstructive pulmonary disease
10 %	Hospitalized Seniors
5 %	Adults with learning disabilities

Adapted from: (Royal College of Speech & Language Therapists, n.d.).

Dysphagia in age groups

Dysphagia is a swallowing disorder that affects children, adults and seniors and is a serious condition for all age groups (Royal College of Speech & Language Therapists, n.d.). The origin of the disorder and the approach to intervention may vary slightly depending on the population.

Infants, children, and young people

Since infants are born, they eat by sucking. Learning how to eat solids and drink from a cup is something that infants learn as they grow having trouble at the begging of supplementary feeding (Duffy, 2018). The food usually is pushed back when babies try new foods, and it is a normal behaviour that should go away over time (American Speech-Language-Hearing Association, n.d.). However, when a feeding disorder affects a child, it has trouble eating or drinking. Pediatric feeding disorder (PFD) is the term given for dysphagia at an early age. PDF is defined as the impaired oral intake that is not age-appropriate and is associated with medical, nutritional, and feeding skill, as well as psychosocial dysfunction (Goday et al., 2019). PFD may be associated with oral sensory function (Goday et al., 2019)

and can be characterized by one or more of the behaviours listed in Table 2.8 that also describes the signs and symptoms of PFD.

Table 2.8. Behaviours, signs, and symptoms of PDF

Behaviours	Signs and Symptoms
- Refusing age-appropriate or developmentally appropriate foods or liquids. - Accepting a restricted variety or quantity of foods or liquids. - Displaying disruptive or inappropriate mealtime behaviors for developmental levels. - Failing to master self-feeding skills expected for developmental levels. - Failing to use developmentally appropriate feeding devices and utensils. - Experiencing less than optimal growth	- Arch their back or stiffen when feeding. - Cry or fuss when feeding. - Fall asleep when feeding. - Have problems breastfeeding. - Have trouble breathing while eating and drinking. - Refuse to eat or drink. - Eat only certain textures, such as soft food or crunchy food. - Take a long time to eat. - Have problems chewing. - Cough or gag during meals - drool a lot or have liquid come out of their mouth or nose. - Get stuffy during meals. - Not gaining weight or growing.

Adapted from (Arvedson, 2008).

Dysphagia in infants, children and young people can be associated with several different conditions (Table 2.9) that sometimes may lead children to experience dysphagia when transitioning to adulthood.

Table 2.9. Conditions associated with PDF

Health conditions associated with PDF
- Being born prematurely - Neurological deficits - Oncology/tumours - Cerebral palsy - Infectious diseases, e.g., meningitis - Neuromuscular disorders, e.g., muscular dystrophy - Respiratory difficulties, e.g., chronic lung disease - Cardiovascular disorders, e.g., congenital heart disease - Gastrointestinal difficulties, e.g., gastro-oesophageal reflux - Craniofacial conditions - Congenital syndromes - Learning disability

Adapted from (Arvedson, 2008).

Adults

Eating and drinking are highly important factors for almost every social and cultural component (Namasivayam-MacDonald et al., 2023). Therefore, swallowing difficulties can have an extensive impact on an individual's physical and mental health and well-being. Adults with dysphagia may also experience disinterest, reduced enjoyment, embarrassment, and/or isolation related to eating or drinking (Bhattacharyya, 2014). Dysphagia falls across many diseases and age groups that its true prevalence in adult populations is not fully known and is often underestimated (Dietitians of Canada, 2015). As a result, there are a wide range of medical conditions that lead to dysphagia. Table 2.10 outlines the most common causes (Serra-Prat et al., 2011).

Table 2.10. Medical causes associated with dysphagia

Medical conditions
- Neurological disorders: stroke, dementia, Parkinson's Disease, multiple sclerosis. - Cancer: head and neck, laryngeal, lung cancer - Cardiopulmonary disorders - Chronic obstructive pulmonary disease - Autoimmune disorders: HIV, lupus, rheumatoid arthritis - Connective tissue disorders: scleroderma - Swallow disorders due to the surgery - Drug-related causes

Adapted from (Serra-Prat et al., 2011)

Seniors

Many changes come with age, most of them are briefly described above. Moreover, the presence of health conditions that primarily affect the senior population, called geriatric syndromes, directly influences the health and nutrition of this age group (Rodriguez et al., 2020). Dysphagia is a growing health condition that concerns the aging population (Bahat et al., 2019). There are many changes in the swallowing function that come with healthy aging that do not result in dysphagia, but the potential for developing dysphagia becomes increasingly common with advancing age (Barczi et al., 2000).

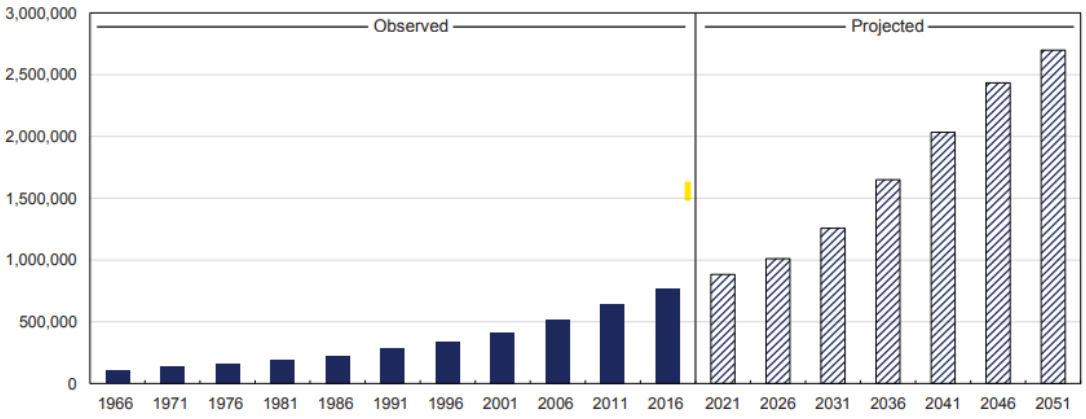
Age-related changes affect head and neck anatomy and physiology, increasing the risk of dysphagia. These include tongue pressure changes, slower swallowing, increased airway

penetration, sensory changes, and esophageal motility changes (Ney et al 2009). These changes contribute to older people being more vulnerable to dysphagia, as a result of a decreased functional reserve (Rats et al., 2017).

The senior population is a large and growing in Canada, the United States, and many other countries. According to the statistics from the World Health Organization (2021), the number and proportion of people aged 60 years and older is increasing all over the world. In 2019, the number of people aged 60 years was 1 billion and this number will increase to 1.4 billion by 2030 and 2.1 billion by 2050 (World Health Organization, 2021).

Furthermore, the pace of population aging is much faster than before, making all countries face a major challenge to ensure a healthy and secure life. (United Nations, 2019). Therefore, this demographic transition will have a remarkable impact in many aspects of the society. Indeed, this extraordinary change presents new opportunities for the whole society, but this depends heavily on one important factor that is health.

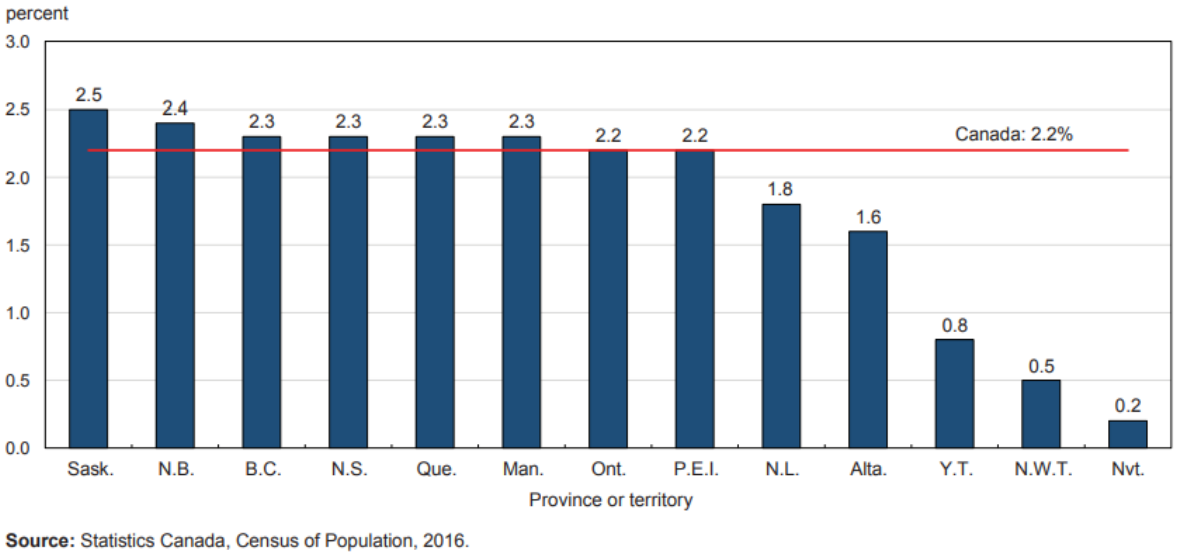
For instance, Canada is one of the countries that is currently facing a fundamental shift in their population. Seniors in Canada are a rapidly growing segment of the population that are currently living longer than previous generations. In 2016, there were over three-quarters of a million (770,780) people aged 85 and older living in Canada, representing 2.2% of the Canadian population overall and about 13.0% of the population aged 65 and older (Statistics, Canada, 2016). By 2051, slightly less than 2.7 million people, or 5.7% of the population in Canada, will likely be aged 85 and older (Statistics Canada, 2014) (Figure 2.1).



Sources: Statistics Canada, Census of Population, 1966 to 2016. Data for 2021 to 2061 are population projections from the M1 medium-growth scenario of national projections. The projection data have as a base population the population estimates based on the 2011 Census, adjusted for net undercoverage. For more information, see the report Population Projections for Canada (2013 to 2063), Provinces and Territories (2013 to 2038) (Statistics Canada Catalogue no. 91-520-X).

Figure 2.1 Population aged 85 and older, Canada, 1966 to 2051

The proportion of people aged 85 years and older is highest in Saskatchewan (2.5%) and New Brunswick (2.4%), closely followed by Nova Scotia, Quebec, Manitoba and British Columbia (all at 2.3%) (Statistics Canada, 2016). Differences between the provinces and territories are shown in Figure 2.2.



Source: Statistics Canada, Census of Population, 2016.

Figure 2.2. Proportion of the population aged 85 and older by province or territory

Despite this increased longevity, the statistics indicates that 90 percent of Canadians aged 65 and over live with at least one chronic disease or condition (Statistics Canada, 2016). Therefore, to ensure an effective health care support and good health management, health conditions require more focus than before.

The United Nations (UN) General Assembly in December 2020 declared the period of 2021-2030 as the "Decade of Healthy Ageing" with a purpose to support and improve the lives of older people, their families, and the communities. To make this possible, it is required that as a society we take actions that foster healthy ageing (World Health Organization, 2020). The UN states that every person should have the opportunity to have a healthy and a long well-lived life. For this reason, as a society, a big change will be required not only in the actions taken, but also in how we think about age, aging, and the diseases that age brings.

Getting older can bring several changes in seniors health. Dysphagia is a prevalent difficulty among seniors (Werstuck & Steel, 2021). At the same time, hearing loss, back and neck pain, chronic and obstructive pulmonary disease, stroke, Parkinson, Alzheimer, dementia, diabetes among other chronical diseases are some other factors inherent to aging (Keller & Goy, 2004). These leads to a gradual decrease in physical and mental capacity, a growing risk

of disease, and ultimately, death (World Health Organization, 2018). Additionally, food has a great impact on the nutritional status of seniors with a swallowing disorder. For this reason, securing nutrition is the key to improving their quality of life (Dietitians of Canada, 2015). It is well known that good nutrition and healthy food is the base for a good health. The kind of food available is not always suitable for seniors, and what seniors choose to eat will directly impact their health and nutritional status. (Costa et al., 2021). Therefore, developing good options for seniors with dysphagia will improve their overall health (Namasivayam et al. 2015).

Management of dysphagia

The correct approach for dysphagia management and treatment is essential for all individuals that have this condition. Currently, there is a wide range of modified foods mainly focused on consistency (Ettinger & Duizer, 2014). At the same time, a variety of diets for dysphagia have been developed to provide safe food that can be adapted to this health condition and allows better treatment of people with eating, drinking and swallowing disorders (Dietitians of Canada, 2015). However, research is needed to develop new strategies for those living with progressive chronic conditions to improve their nutritional intake (McCullough et al., 2018).

Methods of intervention for dysphagia are traditionally categorized into two major groups, compensatory or rehabilitative and each have their own advantages (Garo et al., 2004). Rehabilitative methods are intended to fix the swallowing impairment and include active and rigorous muscle strength-building exercises (Gosa et al., 2020). Compensatory methods are designed to provide immediate swallowing efficiency and safety but are not intended to remediate the swallowing impairment. Although multiple intervention methods may be utilized for the management of dysphagia, a modified textured diet is the most common compensatory treatment used in long-term care facilities (Namasivayam-MacDonald et al., 2023).

Dysphagia management is crucial to help individuals face this health condition. While promising treatments are being developed to improve function, the modification of food texture and liquid thickness has become the keystone for its management (Cichero & Lam, 2014) and in my opinion provide a quality life for older people. Treatment to rehabilitate swallowing function and swallowing difficulties are common pathways for managing dysphagia. Although promising research in dysphagia treatment is being pursued, the provision of texture-modified foods (e.g., purée) and thickened liquids remains a cornerstone of dysphagia management and occurs throughout the world (Cichero et. al, 2013).

Diet progression

Managing dysphagia can often be a great challenge. However, as the degree of swallowing difficulty increases, the diet also needs to progress (Raheem et al., 2021). This can be achieved through the texture modification to provide a diverse range of modified food consistencies (Keller et al., 2012). As a result, safe meals can be developed. The progression of the diets varies from two to five categories of altered food consistency illustrated in Table 2.11.

Table 2.11. Diet progression

Food grading	**Food texture description**
Liquid/Thin pure	Homogenous consistency which does not hold its shape after serving.
Thick pure, soft**,** and smooth	Thickened, homogenous consistency which holds its shape after serving, and does not separate into liquid and solid components during swallow.
Soft/ finely minced	Soft diet of cohesive, consistent textures requiring some chewing.
Minced/ normal	Normal foods of varied textures which require chewing, avoiding particulate foods which pose a choking hazard.

Adapted from Penman &Thomson, 2008.

Dietary modification

Dietary modification is among the most widely used compensatory measures to aid in the treatment of dysphagia (Groher & Crary, 2010).

To improve swallowing safety and avoid asphyxiation, foods are chopped, mashed, or puréed to compensate for chewing difficulties or fatigue (Cichero et.al, 2013). Liquids are typically thickened to slow their speed of transit through the oral and pharyngeal phases of swallowing (Cichero et.al, 2013). Making these modifications in the consistency of the food and liquids will allow a better transit and prevent aspiration of this food material into the airway and thus avoid possible suffocation (Pu et al., 2021).

There are some factors that needs to be considered when deciding how to approach an individual with dysphagia (Dibartolo, 2006). For instance, the level of patient distress for

continuing oral intake, the respiratory status, mobility, and physical condition are some of aspects that are needed to be considered (Table 12) (Dibartolo, 2006).

Table 2.12. Characteristics for dysphagia management

Factor	Cause/Impact/Risks
Distress	- Eating and drinking. - Artificial nutrition and hydration Feelings of hunger/thirst - Repeated hospital admissions/ changes of environment.
Respiratory Status	- Safe co-ordination of swallowing. - Nutrition and hydration requirements - Airway protection - Swallow comfort
Mobility	- Positioning - Chest status - Feeding dependence - Airway protection
Risks	- Aspiration (of oral intake and/ tube feeding) - Being Nil-By-Mouth - Oral hygiene - Reduced social well being. - Dehydration and under-nutrition

Adapted from (Dibartolo, 2006).

Diet-texture modification

Diet texture modification for dysphagia management is a common practice but is open to wide variation across facilities, dietitians, and physicians (Garcia & Chambers, 2010). Food and liquids require modification of texture to ensure a safe swallow. The food industry, foodservices facilities, and caregivers need quality control benchmarks to provide adequate nourishment and meet these new feeding challenges (Côté et al., 2020).

Developing a series of graded consistencies is a widely used format for textured modification as tool to address swallowing disorders (Raheem et al., 2021). The traditional classifications of modified diets are derived from the National Dysphagia Diet, where options for solid foods such as puréed, mechanically altered, advanced, and regular, and liquid consistency options are thin, nectar-thick, honey-thick, and pudding-thick (Shanojan et al., 2020).

The National Dysphagia Diet (NDD), published in 2002 by the American Dietetic Association, aims to establish standard terminology and practice applications of dietary texture modification in dysphagia management (McCullough et al., 2018).

Table 2.13. National Dysphagia Diet

NDD Level 1	Dysphagia-Puréed	Homogenous, very cohesive, pudding-like, requiring very little chewing ability.
NDD Level 2	Dysphagia-Mechanical Altered	Cohesive, moist, semisolid foods, requiring some chewing.
NDD Level 3	Dysphagia-Advanced	Soft foods that require more chewing ability.
Regular		All foods allowed.

Standardized terminology exists to reduce misunderstanding and ambiguity and improve communication efficiency.

(Cichero & Lam, 2014). For that reason, to maximize safety for people with dysphagia through common terminology for patients of all ages, in all settings, and of all cultural backgrounds, the International Dysphagia Diet Standardization Initiative (IDDSI) was developed (Gosa et al., 2020).

International Dysphagia Diet Standardization Initiative Framework

The IDDSI aimed to develop a globally standardized terminology to give definitions for texture-modified foods and liquids, that can be applicable to individuals with dysphagia of all ages, cultures and even any care facility (Cichero et. al, 2017). Figure 4 describes the categories for assessing the texture of food modification for dysphagia.

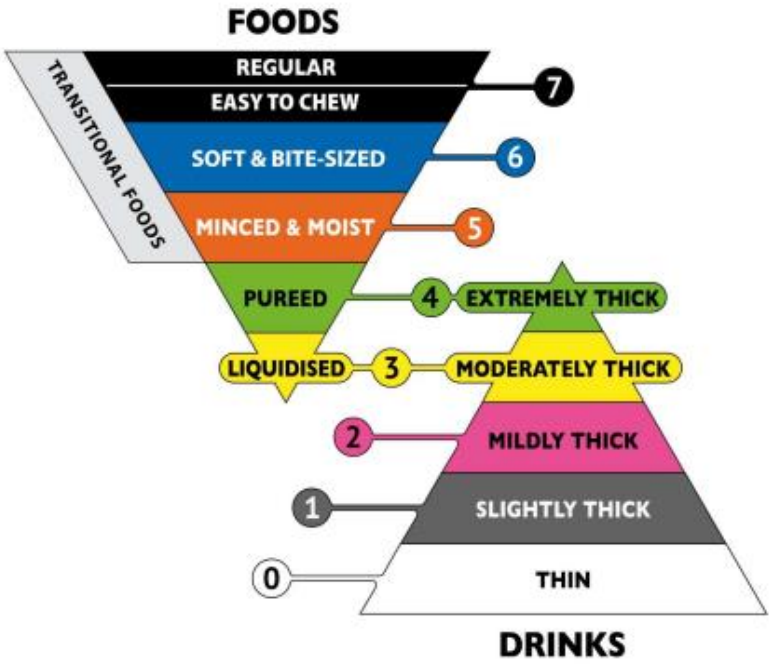


Figure 2.3. IDDSI Framework Graphic[1]

To measure liquid and food consistency different test and assessments are carried out to categorize the meal or product within IDDSI framework standards (see Table 14) (Gosa et al., 2020; *IDDSI - IDDSI Framework*, n.d.).

[1] The International Dysphagia Diet Standardization Initiative. https://iddsi.org/framework/ Licensed under the Creative Commons Attribution Sharealike 4.0 License *https://creativecommons.org/licenses/by-sa/4.0/legalcode*.

Table 2.14. IDDSI levels for food and drinks

Level	Foods	Characteristic	IDDSI Test	Physiological rationale for this level of thickness	Volume Remaining
0	Thin	Fast flow Can drink through any type of cup/straw appropriate for age and skills.	Flow Test Syringe 10 ml: slip tip syringe after 10 seconds of flow	Functional ability to safely manage liquids of all types	<1 mL
1	Slightly thick	Thicker than water Requires more effort to drink than thin liquids. Flows through a straw, syringe.	Flow Test	Used in pediatric and adult population as a thickened drink.	1–4 mL
2	Mildly thick	Flows off a spoon. Sippable, pours quickly from a spoon, but slower than thin drinks. Mild effort is required to drink this thickness through standard bore straw.	Flow Test	May be suitable if tongue control is slightly reduced.	4–8 mL
3	Liquidised Moderately thick	Can be drunk from a cup or moderate effort to suck through straw. Can be eaten with a spoon. Cannot be piped, layered, or molded on a plate. Smooth texture with no ‘bits’	Flow Test Fork Drip Test Spoon Tilt Test	Needs some tongue propulsion effort. Pain on swallowing	8–10 mL

4	Extremely thick Puréed	Usually eaten with a spoon/fork. Cannot be drunk from a cup. Cannot be sucked through a straw. Does not require chewing. Can be piped, layered, or molded. Retains shape. Falls off spoon, hold shape on a plate. No lumps, not sticky. Liquid must not separate solid.	Fork Drip Test Spoon Tilt Test Pressure Test	If tongue control is significantly reduced. Pain on chewing or swallowing. Missing teeth, poorly fitting dentures	10 mL
5	Minced and moist	Can be eaten with a fork or spoon. Could be eaten with chopsticks in some cases. Can be scooped and shaped on a plate. Soft and moist with no separate thin liquid. Small lumps visible within the food.	Fork Drip Test Spoon Tilt Test Fork Pressure Test	Minimal chewing is required. Tongue force is required to move the bolus. Pain or fatigue on chewing	
6	Soft and bite-sized	Can be eaten with a fork, spoon, or chopsticks. Can be mashed/broken down with pressure from fork, spoon, or chopsticks. Soft, tender, and moist. Chewing is required before swallowing.	Fork Pressure test Spoon Pressure test		
7	Regular/easy to chew	Normal, everyday foods of soft/tender textures that are developmentally and age appropriate. Any method may be used to eat these food	Fork Pressure test Spoon Pressure test		

Puréed Food

Puréed foods are a type of texture modification used to address problems related to chewing and swallowing (Brown, 2020). Furthermore, this term also refers to a texture-modified diet that consists of snacks and meals that do not have to be chewed. These kinds of food are mildly thick or soupy by nature, making them easy to swallow and digest.

Puréed diets have been reported to have a safe consistency and providing a food variety that meet the nutritional needs (Pu et al., 2021). Compared to a liquid diet, a puréed diet is more versatile and often can deliver more nutrients, including dietary fibre. Additionally, all forms of texture-modified diets, including a puréed diet, can help prevent complications associated with poor nutrition (Giridhar, 2016) thus, it is safe to stay on it for longer than a liquid diet (Viganó et. al, 2011). Puréed food is often prescribed to individuals with dysphagia, especially in the long-term care setting (Stahlman et al., 2001). The purpose for providing this texture is to facilitate oral consumption, provide adequate nutrient intake, and reduce the risk of choking and aspiration, as a result, prescribing this type of diet could improve older adult's eating (Stahlman et al., 2001). Therefore, the IDDSI has defined that for those individuals who presents dysphagia, all food items must be puréed into a level-4 category consistency to avoid choking hazards (Côté et al., 2020).

The diet consists of foods that are blended, whipped, or mashed until they are a "pudding-like" texture (Brown, 2022). Moreover, puréed food is blended and requires no chewing. As a result, a puréed diet can help people get enough food when they are having difficulty chewing or swallowing. In addition to maintaining sufficient oral intake, it can even reduce choking risk (Brown, 2022). Individuals with missing teeth, pain in their mouth, or those recovering from an oral procedure may benefit from a puréed diet as well as the population with a dysphagia condition.

Dietitians of Canada positions puréed food as a great tool to fight nutritional deficiencies that can compromise the immune system, slow down the body's natural healing process, and increase the risk of infection (Dietitians of Canada, 2015).

People with swallowing problems who require a puréed diet may not meet their recommended intake of fibre. Studies of long-term care residents show fibre intakes are low, ranging from 10 g to 16 g of fibre per day (Lengyel et al., 2008; Volkert & Schrader, 2013). Fibre intakes of those who consume puréed diets are similar to that of the general population (Dahl & Stewart, 2015). Many puréed foods naturally contain dietary fibre. Puréed beans, peas, and lentils are good sources of fibre. For example, a ¼-cup serving of hummus, prepared from

puréed chickpeas, provides 2.5 g of fibre. Puréed fruits and vegetables are also sources of fibre, with ½-cup servings providing, on average, about 2 g of fibre (Dahl, 2013).

Cooking does not change the amount of fibre in foods; cooked and puréed vegetables contain the same amount of fibre as raw vegetables. Animal-sourced foods such as dairy, meats, fish, poultry, and eggs do not naturally contain fibre (Trumbo et al., 2002).

There is no data on the acceptability of the recipes manufactured for people with dysphagia or for the LTC residents. The existing studies either focus on the flavour perception (Ettinger, Keller & Duizer, 2014) or the preference between the commercial shaped entrees and the institutionally prepared entrees (Amunrud, Mitchell & Sun, 1999). In 2010, Rubicon's Simply Puree Proteins started a project with the sponsorship of the National Institute of Food and Agriculture from the United States aiming to develop and produce an appealing, good-tasting, affordable purée protein option to population with dysphagia aiming at flavour and visual characteristics improvement; however, there is no data on the outcome of this project (USDA, 2010).

Purées can be made from most foods. Although some purées may be challenging to prepare, it is possible to quickly prepare puréed foods that are both appealing and nutrient-dense (Dahl, 2019).

Puréed food preparation in long-term care has shown that there are many challenges. For instance, to obtain a puréed consistency, some regular food items (e.g., meats, bread) are processed with liquid to ensure a complete break-down of solid food into a smooth, cohesive consistency (Keller et al., 2012). With the added liquid, there is concern over decreased nutrient density of the product (Keller et al., 2012; Dahl et al., 2013).

A study conducted by Dahl (2013), determined that individuals in long-term care who are consuming a puréed diet may not be getting sufficient protein. Since older adults show a general decline in appetite and food intake, large volumes of food are unlikely to be consumed by residents (Dahl & Stewart, 2015) and therefore nutrient intakes will be low. To avoid risk of inadequacy, there is interest in formulating puréed food products that are nutrient dense. Individuals with dysphagia who receive a puréed diet may also be deficient in essential micro-nutrients, due to challenges in preparation of some puréed foods. For example, many fibre and folate/folic acid rich foods, including grains and stringy green vegetables may be difficult to process into a puréed consistency and are therefore excluded from the diet (Adolphe et al., 2009).

Food that naturally contains more liquid such as fruits or some vegetables, may require the addition of thickeners, to increase the consistency, and to avoid the risk of aspiration,

resulting in a more cohesive bolus for swallowing (Stahlman et al., 2001; Kennewell & Kokkinakos, 2007). Additionally, older adults have shown to have diminished smell and taste, which may impact their appetite and food consumption (Hays & Roberts, 2006). The use of flavour-enhancing ingredients in puréed food may increase the food consumption of seniors with swallowing disorders (Kaufmann, 2005; Best & Appleton, 2011). Given the lack of knowledge about current ingredients being used in long-term care for the preparation of puréed foods and the impact that varying ingredients and preparation methods have on the sensory and nutritional properties of the products, more work is required in this area.

Formulation and stability of puréed foods

Optimal formulations for puréed food need to have ideal sensory parameters, such as having a soft, smooth, and creamy mouthfeel, without being sticky, grainy, or greasy (Hall & Wendin, 2008).

According to the CODEX Alimentarius (1995), there are some requirements that puréed food must meet when developing a product. For instance, this kind of food needs to be made from fruit or vegetables in good condition, properly ripe and fresh, or preserved by physical or chemical procedures. It must have a fine and uniform texture and have a particle size that does not require or encourage chewing. Additionally, it must present a homogeneous appearance with the organoleptic characteristics of the product. Puréed food must be prepared and handled in accordance with the provisions of the CODEX. Vitamins and minerals must be selected in the proper amount to be added to puréed foods. For storage and transportation, it must be in a dry and well-ventilated environment. It must be heat-treated or commercially sterilized, meeting the appropriate times and temperatures in order to eliminate pathogenic microorganisms and those that cause recontamination of the product. This treatment can be before or after being hermetically sealed in a container.

In the puree, the permitted additives must be used and, in the amounts, specified in CODEX. Finally, it must meet the physical and chemical characteristics.

Plant and animal-based ingredients

There are some studies that suggests that the ingredient selection for purées recipes can influence the nutritional and sensory attributes of the puréed food (Philip & Greenwood, 2000; Kennewell & Kokkinakos, 2007). For standardized recipes, the formulations may consider the

potential nutrient deficiencies such as fibre, vitamin D, folate, and vitamin B12 (Dahl et al., 2003; Adolphe et al., 2009). Furthermore, careful consideration is needed when choosing the type and quantity of a thickener and the liquid that are going to be used in puréed recipes (Keller et al., 2012).

Ingredient choices and liquid quantity are important parameters for maximizing nutrient density. Including baby rice cereal in puréed food may improve the micro-nutrient content, cohesion, and texture without discernibly changing the flavour (Kennewell & Kokkinakos, 2007). Vitamin fortification may also be necessary to improve the micro-nutrient status of older adults (Adolphe et al., 2009).

The National Dysphagia Diet (NDD) proposes a guide for the preparation of modified textures. Likewise, NDD describes puréed food as having a homogenous, cohesive, and pudding-like consistency, requiring little to no mastication to swallow safely (Garcia & Chambers, 2010).

Plant-based foods are generally classified into fruits, vegetables, legumes, grains, nuts, and seeds; their derived processed counterparts such as breads, pasta, breakfast cereals, cooked and fermented vegetables and legumes, and fruit purees, juices, and jams as well as derived ingredients such as oleaginous seed–derived oils, sugars, and some herbs and spices. What differentiates them from animal-based foods is that their fibre fraction is made of indigestible compounds, mainly cellulose, hemicellulose, pectin, and/or resistant starch (Fardet, 2017).

Most individuals get adequate protein by consuming a balanced diet. However, for those with swallowing problems, protein becomes even more important. People with dysphagia may consume less food due to difficulty with chewing and swallowing (Keller et al., 2012). Older adults need more protein in their diet because of age-related changes to body composition and physiological functions and this may be particularly important for those with swallowing problems.

Adequate protein helps to preserve lean body mass and immune function, and promotes healing (Kaiser et al., 2010). Animal sources of protein, including meat, fish, poultry, eggs, and dairy, contain adequate levels of all essential amino acids. On the other hand, plant sources of protein, such as legumes and grains, are more nutritious when eaten together, as they complement each other in providing a complete range of essential amino acids. For instance, combining a legume such as beans with a grain, such as rice, makes a protein that is used efficiently by the body. For adults, these combinations do not need to be consumed at the same meal but should be consumed in the same day. In older adults, plant protein may not be as

efficient as animal protein so higher amounts of plant protein may be needed (Landi et al. 2016).

The quinoa and amaranth are Andean grains that are free of gluten, have proteins of high biological value, and are rich in minerals, vitamins, fibre, and antioxidant compounds. Some other protein sources can be used to provide highly nutritious puréed food. During the germination of grains, proteins, lipids, and starches hydrolyzed and, the content of antioxidant compounds improves (Pathan & Siddiqui, 2022). The germinated grains are suitable for the formulation of baby foods due to their greater digestibility. However, the modifications that occur during germination influence the thermal, rheological, textural, and sensory characteristics of the final product (AL-Ansi et al., 2023). The flavour and texture of semi-solids foods can be significantly influenced by the composition of ingredients and the processing conditions employed during preparation (Landi et al. 2016).

It is important to mention that micronutrient fortification has previously been shown to improve vitamin status among elderly people living in the community (Das et al., 2019), but the effect of fortification has not been studied in elderly population that is consuming a puréed diet. The study carried out by Adolphe et al. (2009) has provided the first evidence that vitamin fortification of puréed foods for long-term care residents is an effective method for improving nutritional status in a population at high risk for malnutrition. Besides the positive results, this suggest that further research is needed to develop foods fortified with vitamins, as well as minerals, to improve this population nutritional status for all micronutrients (Adolphe et al., 2009).

In-house and commercial preparation of puréed foods

In long-term care, domestic preparations of puréed food are frequent, and little understanding of baseline preparations for puréed food (Dahl et al., 2007). To develop good quality purées that can meet the nutritional, sensory and textural needs of dysphagia in adults, a significant interpretation of the challenges involved with the production of these foods is needed.

Blending techniques

For in-house preparation of foods for dysphagia diet, any food can be blended into a smooth, pudding-like texture with no lumps that will work for this way of eating.

For preparing puréed foods, the most common blending techniques include a blender, a food processor, or an immersion blender. For preparing a perfect puree at home, the most common suggestions are that it is necessary to cook food until soft, then cut food into small chunks, and place it into a blender or food processor (Wolff, 2016). It is possible that during this process, liquid needs to be added such as juice or broth to get the right thickness. However, IDDSI suggests that water is not used as the liquid. Instead, compatible liquids that offers added nutrition (and more flavor) such as milk, butter, cream, cheese, gravy, cream soup, or sour cream can be used (IDDSI, n.d.).

Sensory characteristics of puréed foods

As mentioned before, elderly people are at greater risk of malnutrition and dehydration, especially those who consume a puréed diet. Therefore, to improve the nutrient status of older adults with dysphagia, puréed products should be prepared with adequate sensory and nutritional properties (Ilhamto,2014). The study carried out by Ilhamto (2014) highlight that poor ingredient formulations and methods in standardized puréed recipes act as barriers that can greatly impact the texture, nutrition, and sensory acceptability of puréed products. Ilhamto (2014) suggests that more research is needed to determine the effect of varying ingredient formulations on the sensory and nutritional properties of puréed products.

There are challenges associated with the consumption of puréed food, including insufficient liquid and nutrient intakes and poor texture and sensory acceptability of foods (Durant, 2008). Since the process of modifying solid foods into a puréed consistency often involves the addition of liquids, nutritional dilution may occur. Usually, it is common to find that in long-term care facilities, seniors have poor appetite and a low-calorie intake (Thomas et al., 2000). Therefore, there is a need to develop acceptable and nutrient dense puréed food products, while maintaining regular portion sizes (Dahl et al., 2007).

Methods for assessing sensory properties of puréed foods

Assessing food texture is a crucial aspect of understanding sensory attributes, and these evaluations are often categorized into two main approaches: objective (instrumental) tests, which employ specialized equipment to measure physical properties, and subjective tests, which are based on human perception to assess textural attributes.

Although the purpose of an instrumental test is to measure texture, correlations between instrumental and sensory measures are necessary (Everard et al., 2006). Instrumental tests should be designed to explain a textural quality experienced by consumers (Bourne, 2002).

Previous research has demonstrated the potential of employing various texture analyzers as a better approach for evaluating important properties of purées, including viscosity, adhesiveness, smoothness, and thickness. Peh et al. (2022) found that the data obtained from the texture analyzer positively correlated with sensory attributes related to adhesiveness, such as the perception of mouth and throat sensations and the ease of swallowing. These findings indicate that utilizing texture analyzers could serve as an advantageous alternative to relying solely on sensory evaluation, especially when involving multiple participants. By doing so, the method could effectively reduce the sensory fatigue experienced by panellists during testing, thus enhancing the overall assessment process and the reliability of results.

The effectiveness of modified texture foods is dependent upon its textural properties (Wendin, 2010). Texture of food, as described by Bourne (2002), can only be accurately perceived, described and quantified by humans. Texture has been previously defined as a group of physical characteristics that derive from the structural elements in food and are sensed by the feeling of touch, related to deformation, disintegration, and flow of the food under a force, and are objectively measured by mass, time, and distance (Bourne, 2002). The ideal puréed food should be "ready to swallow," not requiring any chewing or added saliva. Puréed foods should be moist, cohesive (holds together), and spoon thick. They should not be sticky, lumpy, dry, or runny.

Correlating perceived texture with instrumental rheology measures may be done for many different reasons, such as: 1) to develop a quality control instrument, 2) to predict consumer responses, 3) to understand the sensory response associated with the physical texture measured, or 4) to improve/develop a physical texture measurement that will accurately mimic a sensory attribute (Szczesniak, 1987). If strong correlations have been established between sensory and instrumental measures, physical texture measurements could be utilized as a quick and large-scale quality control mechanism that can replace sensory evaluation (Xiong et al., 2002).

The taste of puréed foods needs to be more intense than for regular texture foods. This is because the act of chewing a food releases flavours in the mouth. Once a food is puréed, it does not require chewing. It can be simply swallowed without much time for the flavour of the

food to be tasted. Increasing the flavour of puréed foods helps with flavour recognition (Lepore & Dahl, 2013).

Sensory profiles of puréed products

Sensory evaluation is the process of using our senses (taste, smell, touch, sight) and applying them to determine the acceptability of foods. In other words, it is a way for assessing the food to make sure that it looks, smells, and tastes delicious (Lepore et al., 2014). The purée should smell, taste, and look appetizing for an older adult who wants to eat and enjoys it. Furthermore, the texture needs to be smooth and cohesive. A puréed food should be uniform in appearance and colour (Dahl, 2021).

Sensory Perception in Senior Adults

Studies have reported for decades that the older adults have less sensitivity to low concentrations of odorants than the younger adults (Murphy & Vertrees, 2017).

It is natural for older people to lose some of their ability to taste. However, most can still identify sweet, sour, bitter, or salty foods, especially when the taste is concentrated. For example, older persons may add large amounts of salt to enhance the flavour and make foods more palatable (Murphy, & Vertrees, 2017). Therefore, foods with stronger flavours may be more inviting. To provide pleasure and satisfaction from eating, foods must taste good. The ability to taste has a huge effect on health because a lack of taste may lead older persons to select a nutritionally inferior food. Additionally, a reduced sense of taste may be a reason why some seniors have a lower food intake. Many factors can alter taste, such as smoking, nasal congestion, dentures, poor oral hygiene, diseases of the mouth, or the deficiencies of vitamin A, niacin, or zinc. Therefore, the criteria for food formulation for seniors should not only include a high nutrient density but also acceptable sensory characteristics to bring comfort, pleasure, and enjoyment.

Puréed food currently available in the market

The use of pulses in food preparations is underutilized and for the purposes of this study, there was no available information about the use of pulses for the development of puréed food designed for people with swallowing disorders. However, there are a number of products currently offered in the market. Table 2.15 shows the most common brands of purées for people with swallowing problems comparing the amount of energy, protein, and fibre in the products.

Table 2.15 Comparison between existing brands[2]

Brand	Country	Purées Options	Kcal	Protein (g)	Fibre (g)
Thick and Easy	Canada	Roasted chicken with carrots,1 tray, 198 g	250	14	1
Hormel	USA	Italian Style Lasagna with meat sauce, 1 tray, 198g	270	14	2
		Homestyle beef with potatoes & corn, 1 tray, 198g	260	13	3
Trepuree Campbells	Canada	Salmon with peas and pasta, 250 g	300	20	4
		Prime purée fish Newburg, 100 g	160	14	1
		Prime minced roast chicken, 100 g	130	17.5	0.4
Rubicon	USA	Purée Rice Mix, 100 g	378	6.31	0.5
		Corn Mix, 100 g	333	5.11	0
The Puree Food Co.	New Zealand	Chicken Veloute, 100 g	NR	25	NR
		Glazed Carrots, 100 g	NR	25	NR
		Minted peas, 100 g	NR	25	NR
Traditional preparation	Homecare Hospitals	Recipes made with blenders		15-20 g per 100 g*	5-13 g per 100 g*

NR: Not reported. Adapted from Hormel Health Labs, Campbells Food Service, Rubicon, The Pure Food Company. *From the College of Dietitians of Ontario, 2019.

Meal replacements

Meal replacement is a term used to describe a formulated food that, by itself, can replace one or more daily meals (CFIA, 2014). Meal replacement usually are drinks, bars, soups, or any intended as a substitute for a solid food, with controlled quantities of calories and nutrients.

Canadian regulations states that meal replacements need to have a minimum of 225 calories per serving and an accurate amount of fibre and protein (CFIA, 2014). Therefore, having appropriate food that can be categorized as a meal replacement can help the existing protocols allowing patients not just being at risk when eating, but improving their daily intake (Tutor, 2017) and take into consideration a texture modification (Raheem et al., 2021).

[2] Hormel Health Labs, Campbells, Rubicon, The Pure Food Company.

Strategies where food can be modified to fulfill this task include developing puréed foods that prevent the risk of becoming malnourished (Philpott et al., 2017).

Pulses

Definition

Pulses are defined by the Food and Agriculture Organization (FAO) (2016) as legumes harvested as a dry grain. Pulses Canada defines them as the edible seeds from the legume family (any plants that grow in pods), but the term "pulse" specifically refers to legumes that are grown and harvested for their dry seed and grown as food (Pulse Canada, 2019). Other foods in the legume family like fresh beans and peas are not considered pulses because some include their leaves, stems, and pods and are usually consumed as vegetables (Nachay, 2017). Soybeans and peanuts are also not considered pulses because they have a much higher fat content, whereas pulses are not a source of fat (Pulse Canada, 2019).

Types of pulses

Canada is one of the largest producers and exporters of pulses in the world (Pulse Canada, 2019). Some of the most common Canadian-grown pulses are chickpeas, lentils, peas, red beans, and faba beans (Pulse Canada, 2019). Pulses come in a variety of shapes, sizes and colours. Table 2.16 shows common pulse varieties. They can be consumed in many forms, including whole or split, or in food products like baked goods or snacks after they are ground into flours or separated into fractions such as protein, fibre, and starch (Dahl, 2019).

Table 2.16 Pulses Varieties

Pulse Name	Variety	Description
Chickpeas (garbanzo beans)	Desi 	Smaller and darker than Kabulis. Desi means 'country' or 'local'.
	Kabuli 	Chickpeas are a round, beige pulse that are popular across the globe.

Lentils	**Green** 	Most popular types of lentils. They hold their shape when cooked, and have a mild, earthy flavour which makes them versatile and suitable additions to many meals.
	Red 	Red lentils are the fastest cooking lentil, but they lose their shape easily and become mushy, making them unsuitable for recipes that call for green or brown lentils. Red lentils are commonly used to thicken dishes.
	Small Brown 	Most common type of lentil, they range in colour from light brown to a very dark brown that is almost black. Mild flavour.
	French Green 	Variation on green lentils and are about 1/3 of the size. They have a peppery flavour and stay very firm when cooked. They require a long cooking time compared to other lentils.
Dry Peas	Split Green 	Small, round and have a more earthy flavour than milder yellow split peas.
	Whole Green 	Small and round. They are most eaten boiled or steamed. They have a sweet flavour and starchy texture and are very similar to yellow peas.

Dry Peas	Split Yellow 	Yellow split peas are commonly used to make soups and purées. Have a more neutral flavour than green split peas.
	Whole Yellow 	Small and round. They have a milder flavour and are less sweet than green peas.
Beans	Black 	Shiny black beans that are commonly used in Latin American cooking. They are also popular as vegetarian-friendly meat substitute because of their dense, meaty texture.
	Kidney (Dark Red) 	Dark red kidney beans were named for their similarities in both shape and colour to a kidney. Firm texture and a bold flavour, making them a great addition to soup and chili.
	Pinto 	Variation on the common bean. Most popular beans in the United States and northwestern Mexico and are also common in Brazilian cooking.
	Fava 	Oval and green in colour. They are popular in Latin America. Often dried and salted and eaten as a snack, or as a deep-fried ball, known as a falafel.

Notes: Adapted from Global Pulse Confederation (n.d.)

The Canadian pulse industry has experienced remarkable growth over the years, driven by increasing global demand for plant-based proteins, healthy foods, and sustainable agricultural products (Pulse Canada, 2019). Pulses are a vital source of protein, fibre, vitamins, and minerals, making them an essential component of a balanced diet (Canadian Nutrient File) As a result, these versatile legumes find their way into various food products, including purées soups, snacks, baked goods, and plant-based alternatives (Pulse Canada, 2019). The government of Canada has been supportive of the pulse industry, investing in research, development, and market promotion. As a result, Canadian pulses have gained recognition and

trust in international markets, opening up trade opportunities and fostering economic growth (Agriculture and Agri-Food Canada, 2022).

Nutritional composition

Pulses provide protein, fibre, vitamins, and minerals such as iron, zinc, magnesium, and folate. These nutrients derived from pulses can enhance a diet quality (Mudryj A., et al., 2014). Another fact about pulses is that they are nitrogen-fixing crops, meaning that they can improve the environmental sustainability of cropping systems (Pulse Canada, 2019). Lastly, is important to mention that pulses are an affordable source of plant-based protein, with about 2-3 times as much protein per serving as cereal grains such as rice, oats, barley, and wheat (Boye et al., 2010). In addition to all, pulses are a rich source of polyphenols delivering antioxidant properties. For example, Faba beans contain a considerable amount of saponins and tannins (Mudryj et al., 2014). Recent studies suggest that consumption of pulses may have potential health benefits, including reduced risk of cardiovascular disease, cancer, diabetes, osteoporosis, hypertension, gastrointestinal disorders, adrenal disease and reduction of LDL cholesterol (Dahl, 2019). Such studies have contributed significantly to a growing awareness of the usefulness of including pulses in the diet and a steady rise in interest in using pulses and ingredients derived from them in the development of novel food products, especially in North America (McCrory et al., 2010).

Table 2.17 Pulses Nutrition Facts per half-cup cooked serving[3]

Pulse	Calories	Total Fat g	Na Mg	Carbs g	Fibre g	Protein g	Fe mg	K mg	Mg mg	Folate mg
Black	110	0.5	<1	20	8	8	1.8	306	60	128
Kidney	110	0	< 2	20	7	8	2.6	357	40	115
Pinto	125	<1	0	24	10	8	2.2	354	48	128
Chickpeas	130	2	5.8	23	6	7	2	239	39	141
Lentils										
Green	115	<0.5	<2	20	8	9	3.3	366	36	179
Red	170	0	0	28	5	12	4	277	25	98
Small Brown	110	0	0	20	8	9	3	365	36	179
Dry Peas Split green, yellow	115	<0.5	<2	21	8	8	1.3	355	35	64

Adapted from Canadian Nutrient File data set, 2005.

[3] Canadian Nutrient File Data Set, 2005.

Lentils

Lentils are a nutritious food, rich in protein (24g per 100g raw) and dietary fibre, high in carbohydrate and low in fat.

Table 2.18 Nutrition composition of raw and boiled lentils[4]

Nutrient	Per 100 g Raw	Per 1 cup Boiled
Energy (kcal)	352	243
Carbohydrate (g)	63.35	42.1
Protein (g)	24.63	18.9
Total Fat (g)	1.06	0.8
Fibre, total dietary (g)	10.7	8.9

Chickpeas

Chickpeas are a nutrient-dense food, providing rich content protein (20g per 100g raw), dietary fibre high in carbs and low in fat.

Table 2.19 Nutrition composition of raw, boiled, canned chickpeas[5]

Nutrient	Per 100 g Raw	Per 1 cup Boiled	Per 1 can Drained, rinse
Energy (kcal)	378	138	210
Carbohydrate (g)	62.95	22.87	34.76
Protein (g)	20.47	7.04	10.70
Total Fat (g)	6.04	2.47	3.75
Fibre, total dietary (g)	10	6.3	9.6

Peas

Peas contains protein (5g per 100g), fibre and carbohydrates and is low in fat.

Table 2.20 Nutrition composition of raw, boiled, canned peas[6]

Nutrient	Per 100 g	Per 1 cup	Per 1 can

[4] CNF, 2005. Lentils food code 3392
[5] CNF, 2005. Chickpeas food code 3379
[6] CNF, 2005. Peas food code 2149

	Raw	Boiled	Drained, rinse
Energy (kcal)	81	138	58
Carbohydrate (g)	14.45	15.63	10.60
Protein (g)	5.42	5.36	3.01
Total Fat (g)	0.40	0.22	3.75
Fibre, total dietary (g)	5.1	6.6	3.3

Red Beans

Red beans are rich in protein (22.5g per 100g) and dietary fibre (14.7g per 100g), high in carbohydrate and low in fat.

Table 2.21 Nutrition composition of raw, boiled, canned red beans[7]

Nutrient	Per 100 g raw	Per 1 cup boiled	Per 1 can Drained, rinse
Energy (kcal)	337	127	81
Carbohydrate (g)	61.29	22.80	14.83
Protein (g)	22.53	8.67	5.22
Total Fat (g)	1.06	0.5	0.36
Fibre, total dietary (g)	14.7	6.6	4.3

Puréed food with pulses

Purées with pulses contribute to dietary diversity, particularly for plant-based protein sources (Boye et al., 2010). They can be used in a wide range of recipes, such as soups, stews, dips, spreads, sauces, and purées (Manitoba Pulse & Soybean Growers, 2010). Additionally, using pulses is a suitable option for individuals with food allergies or sensitivities (Dahl, 2019). Some common options in the market include canned or jarred lentil puree, hummus (chickpea puree), bean dips/spreads, and pea puree (McCrory et al., 2010).

The use of pulses for puréed food formulations provides different advantages that are important to be considered. First, the nutritional profile will add essential nutrients like protein and fibre to an individual's diet (Mudryj et al., 2014). Additionally, pureeing pulses can help retain these nutrients making the food more nutritious, especially for individuals who have difficulty consuming whole foods due to dental or swallowing issues (Mudryj et al., 2014).

[7] CNF, 2005. Red beans food code 3365

Second, puréed pulses are easier for the digestive system to process compared to whole pulses, which can be beneficial for people with digestive problems or those recovering from surgery or illness (Boye et al., 2010). Moreover, pureeing pulses can create a smooth and creamy texture, making them more palatable for those who may have difficulty chewing or prefer softer foods. It also allows for easy blending of flavours and seasonings, enhancing the taste of the dish (Nachay, 2017). Pulses also contribute to the dietary diversity that individuals need, as they are an excellent source of plan-base protein. Canada's Food Guide 2007 edition recommended eating beans, lentils, and peas often as an alternative to meat. The same Guide from 2007 defined one serving of pulses as ¾ cup (175 mL), which is about the size of a tennis ball; however, the most recent Canada's Food Guide (2019 edition) does not have food categories and serving amounts anymore (Manitoba Pulse & Soybean Growers, 2010; Health Canada, 2019). Pulses are naturally free of common allergens like gluten, dairy, and nuts, making them a safe option for individuals with food allergies or sensitivities (FAO, 2016). Finally, pulses are a cost-effective alternative for formulations because they are generally more affordable than many other protein sources providing essential nutrients to those with specific dietary needs (Boye et al., 2010).

Overall, incorporating puréed pulses into the diet can be an excellent choice to enhance nutritional intake, support digestion, and meet the dietary needs of certain individuals, particularly those with difficulty chewing or swallowing (Mudryj et al., 2014). It can also be a delicious and nutritious way to add variety to the menu and experiment with new flavours and culinary experiences.

Storing pulses

Pulses can be easily found in several types of stores appealing to diverse tastes and preferences. From local grocery stores to organic food outlets and bulk food stores, there are a wide range of options. According to Manitoba Pulse & Soybean Growers cooking recommendations (2010), when searching for pulses, is important to explore the ethnic, bulk, or canned food sections, as well as the baking ingredients aisle, where these legumes can often be spotted. Another consideration includes when selecting dry pulses, keeping an eye out for vibrant and evenly sized seeds with smooth skins, free from chips or shrivelled coats (Manitoba Pulse & Soybean Growers, 2010). Pulse organization's most recent update suggests properly storing pulses in tightly covered containers, in a cool, dark, and dry environment. Dry pulses

can retain their quality for years, though it's recommended to use them within a year to prevent them from becoming excessively dry, which can prolong their cooking time (Pulse Canada, 2019). On the other hand, canned pulses offer unparalleled convenience, as they come ready to use (Manitoba Pulse & Soybean Growers, 2010). It is important to remember to rinse and drain canned pulses before incorporating them into preparations. Stored in cool, dry places, canned pulses can maintain their quality for up to one year (Pulse Canada, 2019).

Soaking and cooking pulses

Pulses require cooking to become suitable for consumption, which involves time-consuming and meticulous processes (Agarwal, 2016). Nevertheless, processing is essential to enhance their taste, digestibility, and nutrient availability, which directly impacts their acceptance among consumers, overall health benefits, and marketability (Nakkito et al., 2015). Soaking is a crucial initial step in cooking or germinating pulses, and it significantly improves their cooking quality, and nutrient availability, and reduces the presence of antinutritional factors (ANF) inherent in them (Agarwal, 2016). Through the years, soaking pulses in plain water, sometimes with additives like sodium bicarbonate, has been a common practice in households and commercial settings to reduce cooking time and enhance the appearance and texture of cooked beans (Agarwal, 2016). The duration of soaking, water hardness, and soaking water temperature all play a role in determining the outcome of the soaking process. While soaking can lead to a reduction in water-soluble vitamins, such as vitamin B1 or thiamine, especially in an alkaline medium, it significantly improves *in vitro* protein digestibility, starch digestibility, and the availability of essential minerals like zinc, iron (Luo & Xie, 2014). These components may vary among different pulse seed genotypes. Additionally, soaking during germination promotes the synthesis of vitamin C and helps to neutralize antinutritional factors like trypsin inhibitors (Vasishtha & Srivastav, 2013).

For optimal digestion and to minimize the likelihood of gas formation, it is essential according to Badiei (2015) to discard the soaking water when preparing pulses and rinse them thoroughly under running water. Doing this is an essential step that effectively washes away the fermentable oligosaccharides that can lead to gas and discomfort when consumed (Zamindar et al., 2013). Ingesting substantial quantities of beans is notorious for inducing flatulence, bloating, and gas passage in humans, mainly due to the presence of these oligosaccharides (Niittynen et al., 2007). The lack of the necessary enzymes in the small

intestine to efficiently break down these compounds, results in undigested oligosaccharides being fermented by natural gut bacteria in the large intestine (Barret & Gibson, 2012). By discarding the soaking water, it is possible to help alleviate the severity of flatulence after consuming pulses, therefore, soaking them before cooking has long been recognized as an effective technique that can allow individuals to enjoy the nutritional benefits of pulses without encountering any unwanted digestive issues.

Soaking considerations

Soaking pulses offers a range of valuable benefits that enhance their nutritional profile and overall cooking preparation. Firstly, soaking reduces the presence of phytic acids, a compound that can hinder the absorption of crucial nutrients and minerals like protein, iron, zinc, and calcium. As a result, the body can better utilize these essential elements for improved health (Albarracín et al., 2013). Secondly, tannins and polyphenols, which may contribute to bitterness and reduce nutrient absorption, are diminished through soaking. This not only enhances the taste but also facilitates better nutrient assimilation (Claudine et al., 2004). Thirdly, soaking helps to neutralize anti-nutritional enzyme inhibitors, promoting better digestion and nutrient availability. Moreover, the process of soaking effectively removes gas-causing compounds, alleviating potential digestive discomfort associated with pulses (Vasishtha & Srivastava, 2013). Lastly, soaking improves the texture of the pulses and decreases cooking time, making them more tender and convenient to prepare in various culinary creations (Zamindar et al., 2013). Tables 2.22 describes soaking recommendations for pulses[8].

Table 2.22 Soaking methods for dry pulses

Soaking method for dry pulses	Instructions
Long, cold soak or overnight	Let stand 12 hours or overnight in the refrigerator
Quick soak	- Bring pulses and water to boil in a saucepan. - Boil gently for 2 minutes. - Remove from heat, cover, and let stand for 1 hour.
Microwave soak	- Combine pulses and water in a microwavable dish. - Cover and microwave on high for 10-15 minutes - Let stand for 1 hour.

[8] Adapted from Manitoba Pulse & Soybean Gowers, 2010 cooking guide, 2010

Cooking considerations

Pulse purées are a versatile and convenient addition to different dishes, especially for dips and certain baked goods (Manitoba Pulse & Soybean Growers, 2010). Creating a purée is a straightforward process that can be easily accomplished with a food processor. It begins by placing either cooked pulses or rinsed and drained canned pulses into the food processor. For every 1 cup (250 mL) of cooked pulses, is needed to add ¼ cup (50 mL) of water to achieve the desired consistency by blending the mixture until a smooth purée similar in a texture to canned pumpkin is obtained (Manitoba Pulse & Soybean Growers, 2010). Manitoba Pulse & Soybean Growers (2010) recommends freezing the purée in plastic bags, and it can be kept in the freezer for several months, ready to be utilized. However, there is still the need to investigate if sensory attributes changed after defrosting the purées. Table 2.23 describes some cooking recommendations for dry pulses[9]

Table 2.23 Cooking methods and times for dry pulses

Instruction	**Beans**	**Whole Peas**	**Split Peas**	**Whole Lentils**	**Splits Lentils**	**Whole Chickpeas**	**Split Chickpeas**
Rinse	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soak	Yes	Yes	No	No	No	Yes	No
Amount of water per 1 cup (250 ml) of dry pulses	2½-3 cups (625 to 750 ml)	2½-3 cups (625 to 750 ml)	2 cups (500 ml)	2½-3 cups (625 to 750 ml)	2 cups (500 ml)	2½-3 cups (625 to 750 ml)	2 cups (500 ml)
Cooking time	1-1½ hrs.	1½-2 hrs.	45 min.	10-30 min.	5-15 min.	1½-2 hrs.	½-1 hrs.
Pressure cook time	8-12 min.	5-7 min.	No	No	No	12-15 min.	5-7 min.
Yield from 1 cup (250 ml) of dry pulses	2½ cups (625 ml)	2½ cups (625 ml)	2 cups (500 ml)	2½ cups (625 ml)	2 cups (500 ml)	2½ cups (625 ml)	2 cups (500 ml)

The products designed and tested in this study may improve the quality of life for individuals facing challenges in food intake, decreased motivation to eat, and low appetite, leading to prolonged mealtimes. Puréed foods are often used to address these issues, but their lack of appetizing flavours may result in a loss of interest and willingness to eat. Current

[9] Adapted from Manitoba Pulse & Soybean Growers, cooking guide, 2010

guidelines primarily focus on nutritional content rather than the gastronomic value of meals. To address this, the study proposes developing pulse-based puréed recipes that provide flavours, sensations, and protein-nutrient-enriched meals to enhance the eating experience. The research will explore how children, adults and senior adults perceive purees containing main pulses such as beans, lentils, chickpeas, and yellow peas. Pulses offer numerous nutritional benefits, including protein, fibre, vitamins, and minerals, making them an ideal option for nutritious puréed formulations. The smooth and creamy texture of pulse purées enhances their palatability, while their cost-effectiveness and allergen-free nature make them suitable for various individuals, including those with dietary restrictions.

Overall, incorporating pulse purées in formulations not only improves nutritional intake but also promotes dietary diversity, addressing specific dietary needs and supporting overall health and well-being.

3. Rationale, hypothesis, and objectives

Rationale

The difficulty and discomfort in swallowing food that is not appealing usually results in different malnutrition problems. As a result, people with swallowing disorders experience poor quality of life living away from an active social life, especially seniors.

"Any disruption in the swallowing process may be defined as dysphagia" (Crary & Groher, 2003). Dysphagia has become a highly prevalent syndrome of increasing frequency among the senior population. It affects morbidity, mortality, the length of the hospital stays, and the population's quality of life (Sura et al., 2012). Usually, in people that are younger than 60 years, dysphagia is mostly associated with oncologic and neurologic pathologies, whereas in seniors, it is related to aging itself or to stroke and neurodegenerative diseases (Baijens et al., 2016). However, it is of great importance that adequate food can be developed for anyone who is currently facing this health condition no matter what led them to have a swallowing disorder.

For many people, the experience that food offers radically changes when they are diagnosed with dysphagia. The pleasant experience suddenly becomes a daily concern focusing only on eating in a nutritionally adequate way rather than enjoying their meals.

Currently, the evidence of unappetizing purées served at different long-term care facilities leads to people gradually losing interest in food and willing to eat. Appropriately designed foods for the swallowing disorders population have been overlooked in existing studies. Consequently, previous studies are focused only on addressing the nutritional area while sensory components such as flavor, texture, or pleasantness are left aside.

There are not enough studies that evaluate and determine the impact of puréed food on adults and seniors. The existing data reveals that there are not enough strategies to improve the protein caloric intake in meals and prevent losing weight at the same time. As a result, there is an important gap that needs to be filled with a sustainable and long-term solution. Furthermore, a research gap exists regarding purées formulated with pulses. Even though in the current market, there are some available options of purées for swallowing disorder conditions, there is not yet one that uses pulses as a protein base for the formulations and development of purées. Furthermore, the perception of puréed food with pulses is not yet determined.

Developing a tasteful nutritional meal replacement that has the potential to impact people's lives through a pleasant and tasteful experience can be led by a purée that has all the

necessary characteristics that can address the nutritional but also the gastronomic components that a good food should have. Therefore, it is necessary to investigate the sensory acceptability of purées formulated with pulses to restore nutritional well-being. Including pulses in the formulations can improve the nutritional value. In addition, incorporating different plant and animal ingredients can improve the gastronomic value of puréed food. Consequently, the current study would result in a better understanding of the development of adequate and tasteful puréed products that can have an impact on the quality of life.

Hypothesis

1) Adding pulses to puréed foods will increase their protein and fibre content.
2) The combination of animal and plant ingredients to puréed foods with pulses will improve their sensory characteristics.

Study Objectives

1) To develop puréed food using pulses (beans, lentils, peas, and chickpeas) in combination with other plant and animal ingredients
2) To evaluate the sensory characteristics of puréed foods formulated with pulses in adults and children.

4. Methods

Study design:

The study was designed as an open label randomized controlled trial. The study was conducted at the Appetite lab at Mount Saint Vincent University (MSVU) and at the Dartmouth Senior Centre. The current study was approved by the MSVU University Research Ethics Board (Ethics file # 2022-097) (Appendix 1). Written informed consent was obtained from all the participants after explaining the procedures of the study.

Instrumentation and software:

1) The appliances in the Appetite Lab to develop the samples.
2) Hanna HI2020 Edge Multiparameter pH Meter (Hanna Instruments, Woonsocket, Rhode Island, USA)
3) Digital Glass Body pH Electrode for Semi-Solids and Emulsions - HI10530. (Hanna Instruments, Woonsocket, Rhode Island, USA)
4) Partica LA-950V2. Laser scattering particle size distribution analyzer (HORIBA Scientific Ltd. Kyoto, Japan).
5) Ninja BL770 Mega Kitchen System, 1500W, 64-oz. (Shark Ninja Operating LLC, Needham, Massachusetts, USA)
6) ESHA Genesis (ESHA Research, Inc. Salem, Oregon, USA).
7) GraphPad Prism version 9.4.0 (GraphPad Software, San Diego, CA, USA).
8) Compusense (Compusense Inc. Guelph, Ontario, Canada).

Participants and recruitment

Sample size. 65 participants consisting of 35 adults aged 19 to 65 years old (18 females and 17 males) and 30 senior adults aged 65 years and older, (16 females and 14 males) were recruited to evaluate the sensory characteristics of the pulse purée samples. This sample size considered the possible interaction of sex and age on sensory evaluation. In accordance with the guidelines set by the Institute of Food Technologists (IFT, 1981), a sensory panel consisting of 50-100 participants is considered acceptable for affective sensory testing (IFT, 1981) .

Another 20 children (9-15 y) were recruited to test the recipes using 100 mm VAS and 9-point Peryam &Kroll hedonic scale (Kroll, 1990). However, the data for adults and children were analyzed separately due to the differences in hedonic scales for adults and children.

The participants for the study were recruited from MSVU, Dartmouth Senior Centre (DSSC) and surrounding communities using posters (Appendix 2), and by word of mouth. The posters were distributed around the MSVU campus and the facilities of the DSSC. For this study, the recruitment consisted of healthy participants that have not been diagnosed with dysphagia or any symptom related to this swallowing condition, not have known food allergies and not having lactose intolerance either.

All participants were screened over the phone for the initial eligibility check and invited to an information session for the final enrollment. Individuals who were taking medications known to influence sensory perception, were smokers, or had any learning difficulties that would affect their ability to participate in the study, were excluded from the study. Eligible participants were scheduled for a testing session.

Study protocol

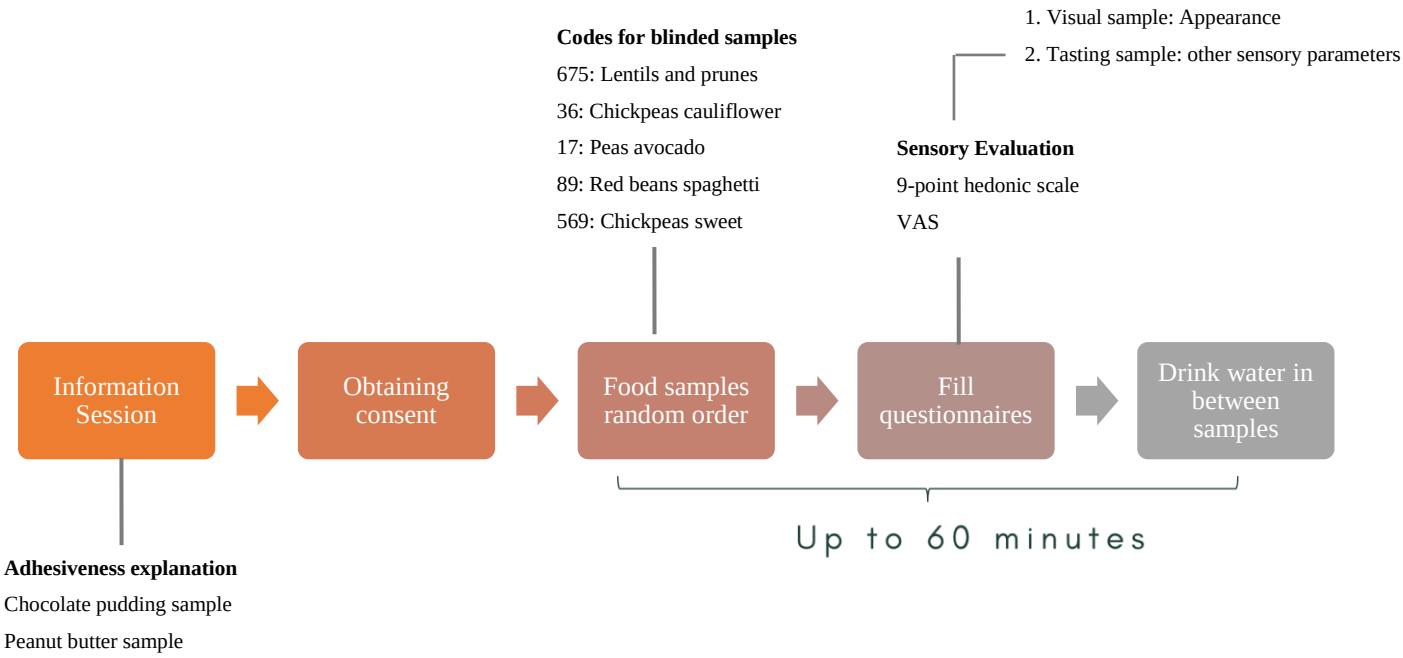


Figure 4.1 Experimental protocol

Participants arrived at the laboratory at the time they had chosen for the session. Each participant had an information sheet and a definition of sensory parameters sheet (Table 10). Participants had some time to read through the information given and the opportunity to ask the questions. After that 5-minute time, the researcher showed and explained the sensory forms, and explained about a specific sensory term "*adhesiveness";* for doing this, participants were given two samples to compare: chocolate pudding and peanut butter to explain the difference between them. In addition, it was explained to the participants how to use the hedonic and visual analog scales for sensory evaluation. After this introduction, participants were asked to sign the consent form.

Upon completion of the consent form, participants were taken to the individual feeding cubicles and were given the samples in a random order. Blind codes were assigned to each of the samples to prevent the participants from being biased. The participants assessed the appearance of the sample first (100 mm Visual Analogue Scale (VAS) and 9-point hedonic scale) after viewing the sample.

Once the participant answered the first two questions, they were asked to taste the sample and complete the questionnaire evaluating different sensory characteristics. The sensory characteristics that were assessed for acceptance included pleasantness, taste, texture, flavor, saltiness, sweetness, bitterness, sourness, smoothness, swallowness, adhesiveness, mouthfeel, aftertaste, using a 9-point hedonic scale ranging from 1 “dislike extremely” to 9 “like extremely” (Peryam et al., 1960). As for the sensory attributes assed for intensity it included appearance, pleasantness, saltiness, sweetness, bitterness, sourness, adhesiveness and swallowness, using a 100 mm VAS (Hill et al., 1984). Additionally, the assessment of prospective purchasing of food samples using a 100mm VAS was performed as well. The participants were instructed to have water between each new sample. The sensory session lasted for approximately 60 minutes. All participants were free to withdraw at any time during the study.

The same protocol was applied for the panel of senior adults. Some of the participants (seniors) recruited did the testing sessions at the Dartmouth Senior Service Centre (DSSC). The samples were transported to the DSSC by following the requirements for safe food transportation and food quality standards aimed at preventing food contamination. As for the sensory evaluation with children, the same protocol was used with the difference of using 9-point hedonic scales for children ranging from 1 “super bad” to 9 “super good” (Peryam &Kroll Peryam et al., 1960) for the assessment of appearance and pleasantness of the samples. Children were also using 100 mm VAS (Hill et al., 1984) and a food sensory Three-Elemental Screener for appearance and pleasantness (McDowell et al., 2021).

Table 4.1 Sensory Attributes Definitions

Term	Definition
Appearance	Characteristics that incorporate all visually perceptible sensory ideas of food. Examples include shape, exterior, structure, color, shine, clarity.
Pleasantness	The overall enjoyment of the food; how palatable or pleasant this food is
Taste	The sensation in the mouth that is produced by the combination of sour, sweet, savory, salty, and bitter components of the food tested.
Texture	Texture refers to those qualities of a food that can be felt with the fingers, tongue, palate, or teeth (i.e., crispy, crunchy, soft, hard, tender, chewy, creamy)
Flavor	The complex sensation perceived from the combination of the taste and smell (aroma) produced by the food or drink.
Saltiness	The taste produced by salt.

Sweetness	The taste produced by sugar and other sweets that varies from non-sweet (e.g., water) to very sweet (e.g., maple syrup or honey)
Bitterness	A basic taste produced by many foods, that varies from non-bitter (water) to very bitter (black coffee without sugar).
Sourness	The taste produced by many foods that vary from non-sour (e.g., water) to very sour (e.g., lemon)
Smoothness	The velvety feeling of the food in the mouth that varies from low rough (e.g., water) to high smooth (e.g. potato puree)
Swallowness	How easy is it for you to swallow the food or drink that is in your mouth
Adhesiveness	The force required to remove the food that sticks to the mouth (palate and teeth) that varies from low (e.g., pudding) to high (peanut butter)
Mouthfeel	The sensation in the mouth that is created by food when touching the tongue, gums, and teeth.
Aftertaste	A taste in your mouth that occurs after the swallowing of the food, and which differs from the taste perceived whilst the food was in your mouth.

Adapted from Sensory analysis vocabulary, ISO 5492:2008

Food product development

The process for the development of the purée samples included three main stages: ideation, formulation, and processing, which led to the generation of the final recipes used for the study.

- *Ideation*

This part of the process was inspired by different recipes originated in several places, recipes, and cookbooks (Pulse Canada recipe blog from Global Pulse Confederation (n.d.), Food Guide for people affected with amyotrophic lateral sclerosis and recipes for people with swallowing difficulties from Fundación Francisco Luzón (2017), and the Puréed Food Company (n.d.).

- *Formulation and processing*

The treatments consisted of five different puréed samples formulated with pulses prepared using a blender. The formulation process of the purées followed different considerations. First, when considering puréed food preparation, it was essential to ensure that the methods used can be replicated in both institutional and household settings, without the need for specific and expensive equipment. Keeping the minimum required tools simple and accessible ensures that anyone can create delicious pulse purée regardless of their cooking environment. Moreover, using commercially available ingredients found in regular groceries eliminated the necessity for any specialized items. It was important to select a variety of

ingredients, both from plant and animal sources, to provide a delightful taste, rich flavors, and a well-balanced combination of nutrients and energy adapting to the diverse dietary needs and preferences. By adhering to these considerations, we could create culinary experiences that are both practical and enjoyable for everyone involved.

Both dry and canned forms of pulses were used for the recipe preparations. The dry pulses were red beans and lentils and for the canned pulses, chickpeas and peas were used. The dry pulses were soaked to achieve the appropriate texture, while the canned ones did not require soaking. Additionally, the use of minced beef and chicken as sources of animal proteins were used in the formulations along with different types of vegetables and natural spices to obtain the final purée used as treatments for the sensory evaluation.

Every recipe adhered to a set of considerations to ensure flavour and the nutritional component. Each purée was designed to incorporate a different variety of pulses, guaranteeing a harmonious blend of textures and tastes. To meet the nutritional requirements, a minimum of 200 g of cooked pulses was included in every recipe. Additionally, each recipe was balanced by incorporating one animal protein source and a selection of plant-based ingredients, infusing each purée recipe with vibrant flavours. The use of natural spices further elevated the taste profile, creating a delightful and aromatic profile for the senses. Moreover, great care to limit the amount of salt was taken care of, prioritizing health without compromising on taste. Depending on the type of pulse employed, specific soaking considerations were considered during the recipe's development. Red beans followed soaking considerations before the recipe preparation, on the other hand, lentils, green lentils, and chickpeas required no soaking. In the end, after considering these factors, it was possible to ensure that each recipe embodied both nutrition and flavour in the five purée recipes.

The blending of the purées was done by using a Ninja BL770 Mega Kitchen System, 1500W, 64-oz professional blender. Finally, the ESHA Genesis Software was used for the recipe labels of the nutrient profile and also for the nutritional analysis of each recipe.

Puréed treatments

A total of twenty recipes were developed; however, five recipes were selected for the sensory evaluation (Figure 4.3). Each of five recipes contained one type of pulses, including lentil, chickpea, green peas, and red beans. Detailed information about the ingredients used for the treatments are described in section 5.

Figure 4.2 Puréed treatments using five different pulses

Nutrient analysis

Energy and macro- and micronutrient analysis was completed for each of the recipes after the formulationusing ESHA Food Processor (Version 10.14.1) and the Canadian Nutrient File (Health Canada, 2005).

The recipe's protein quality was assessed in adherence to the Canadian Food and Drug Regulations (FDR), which currently mandate the utilization of the protein efficiency ratio (PER) as a method for evaluating the protein quality of foods in Canada. Health Canada acknowledges two accepted methods for accurately measuring protein quality: the protein efficiency ratio (PER) and the protein digestibility-corrected amino acid score (PDCAAS) (Health Canada, 2019).

IDDSI testing methods

The IDDSI framework consists of 8 levels (0 - 7), where drinks are measured from Levels 0 – 4, while foods are measured from Levels 3 – 7 (*IDDSI - IDDSI Framework*, n.d.) The IDDSI Framework has the goal to provide a common terminology to describe food textures and drink thickness. IDDSI Testing Methods are intended to confirm the flow or textural

characteristics of a particular product at the time of testing (Côté et al., 2020). The testing methods that were used for this study included forks and spoons. The spoon tilt test was used to determine which level the purées will fit into the framework.

Spoon Tilt Test: The spoon tilt test is used to determine the stickiness of the sample (adhesiveness) and the ability of the sample to hold together (cohesiveness). The Spoon Tilt Test is described in the current IDDSI framework. The Spoon Tilt Test is used predominantly for measures of samples in levels 4 and 5 (Côté et al., 2020).

To be suitable for a IDDSI Level 4 the sample needed to have specific characteristics to be considered a safe texture for people with swallowing disorders. These characteristics includes to hold shape on spoon, not firm, not sticky, and little food left on the spoon.

Physicochemical analyses

pH measurement

In relation to food and cooking, pH is known as a measure to ensure food safety (Ilhamto et al., 2014). While food safety is a crucial consideration, understanding the pH of an ingredient can also help to achieve a balance of flavors (Fuller, 2011.) Acidity, or sourness, is an important factor as much as salt or seasoning in achieving the balance of flavor. The measurements of pH of the puréed samples were conducted with Hanna HI2020 Edge Multiparameter pH Meter with a digital glass body pH electrode HI10530 for semi-solids and emulsions. Foods with an equilibrium pH $\leq$ 3.7 will not support the growth of bacterial microorganisms Public Health Ontario. However, if the pH of the food (jarred/canned products) is $\leq$ 4.6, microorganisms are inhibited provided the water activity is $\leq$ 0.85. According to Public Health Ontario's Home Canning Literature Review, June 2014, a hermetically sealed acidic canned or jarred food with an equilibrium pH $\leq$ 4.6 that has gone through sufficient heat treatment to eliminate vegetative forms of microorganisms (Public Health Ontario, 2014) is considered safe. This process ensures the preservation of the food's quality and prevents the growth of harmful bacteria, making it suitable for consumption over an extended period.

The pH of the samples was measured with a fresh batch of samples. Approximately 36 g of samples were tested twice in a period of 24 hours. However, it is essential to clarify that these measurements do not represent the samples' shelf life.

Particle Size

The particle size distribution of samples was obtained using a laser diffraction analyser (Partica LA-950V2, Laser scattering. Horiba Scientific Ltd.). The particle size analysis was done at Dr. Jeff Dahn's Physics Laboratory of Dalhousie University, Department of Physics and Atmospheric. The samples were dispersed in distilled water (refractive index: 1.55; 1.33 water). The refractive index was estimated based on a previous study (Luo et al., 2021) where the refractive index and absorptivity of the puréed samples were set to 1.54 and 0.001, respectively. These purées, similarly, like in this study, contained various ingredients: 27% pork loin, 10% pumpkin, 5% potato, 50% water, 2% oat, 3.7% skimmed milk powder, and 2.3% corn starch (Luo et al., 2021).

Data analysis

Statistical analyses and graph plotting were performed using GraphPad Prism version 9.4.0 (GraphPad Software, San Diego, CA, USA).

Normality and lognormality tests were used to test for the normality of data distribution. The effects of a treatment, sex and age on sensory perception were evaluated using a three-way ANOVA. When a significant effect of sex or age, or their interaction with a treatment was found, the differences between males and females, or adults and seniors was determined using a two-way ANOVA. If the data was normally distributed, the effect of a treatment was assessed using one-way ANOVA, and the differences between the treatments were determined using Tukey-Kramer post-hoc test. If the data was not normally distributed, the effect of a treatment was assessed using Friedman test, and the differences between the treatments were determined with Dunn's multiple comparison test.

Values are expressed as mean ± standard deviation. Differences between samples were considered significant at $P \leq 0.05$.

5. Results

Food product development

Recipes

Recipes were formulated and prepared in the Medavie Community Kitchen at the Center of Applied Research, (Appetite Lab) Mount Saint Vincent University using fresh ingredients. Recipes included dry and canned pulses (lentils, chickpeas, peas, and red beans), sources of animal protein (chicken and minced beef), fruits and vegetables and different condiments and spices. All the ingredients used for the formulations were purchased from local grocery stores (Atlantic Super Store/Giant Tiger Store). The ingredients and amounts of ingredients used in the formulation of puréed treatments are shown in Table 5.1 to 5.10, respectively. All purées were stored in the lab in a refrigerator at 4°C until needed for testing for a period no longer than 8 hours. During sensory testing, approximately 30 g of each purée was served to panelists. The products were held at room temperature prior to testing.

For the testing sessions for senior adults, the same procedure was carried out, however the samples were transported to the DSSC, meeting the requirements for safe food transportation, food quality standards and kept a scheduled timeline to prevent food contamination.

Figure 5.1 *Lentils, chicken, and prunes* recipe

Figure 5.2 *Chickpea cauliflower soup* recipe

Figure 5.3 *Peas avocado salad* recipe

Figure 5.4 *Red bean spaghetti* bolognes recipe

Figure 5.5 *Chickpea sweet potato dessert* recipe

Lentils, chicken, and prunes

Table 5.1 List of ingredients

	List of Ingredients *Number of Servings: 4.65 (250 g per 1 cup)*		
Ingredient	Quantity	CNF Food Code	Percent Weight
Lentils raw	230 g	3392	30.98
Chicken breast	70g	841	19.79
Onions	70g	2401	13.78
Fresh tomatoes	100g	2460	8.61
Chicken broth	360 g	7450	6.88
Water	160g		6.02
Garlic	12g	2394	6.02
Dried bay leaf	2	172	4.65
Rosemary	1 tsp	204	1.72
Dried prunes	80 g	7491	1.03
Toasted almonds	16g	2539	0.26
Dried parsley	1 tsp	197	0.1
Olive oil	4 tbsp	422	0.05
Salt	1 tsp	214	0.05
Pepper	¼ tsp	198	0.04

Directions

1. Put the chicken, onions, tomato, garlic, rosemary, dried bay leaf, dried parsley, prunes, oil, salt, pepper, and almonds to boil with the chicken broth.
2. When the chicken is cooked, add the lentils, and cook until lightly soft.
3. Wait until it is cools down.
4. Blend everything until smooth (IDDSI level 4).

Nutrition Facts
Valeur nutritive
Per (250 g)
pour (250 g)

Calories 400	% Daily Value* / % valeur quotidienne*
Fat / Lipides 15 g	20 %
Saturated / saturés 2 g + Trans / trans 0 g	10 %
Carbohydrate / Glucides 48 g	
Fibre / Fibres 8 g	29 %
Sugars / Sucres 8 g	8 %
Protein / Protéines 18 g	
Cholesterol / Cholestérol 10 mg	
Sodium 280 mg	12 %
Potassium 500 mg	11 %
Calcium 50 mg	4 %
Iron / Fer 4.5 mg	25 %

*5% or less is **a little**, 15% or more is **a lot**
*5% ou moins c'est **peu**, 15% ou plus c'est **beaucoup**

Ingredients: unsalted chicken broth chicken, dry lentils red, water, tomatoes, prunes, chicken, onion, olive oil, toasted almonds, garlic cloves, table salt, dry rosemary, dry bay leaf, black pepper, dried parsley.

Figure 5.6 Nutrition Facts Table: *Lentils, chicken, and prunes* recipe

Chickpeas cauliflower soup

Table 5.2 List of ingredients

	List of Ingredients *Number of Servings: 5.03 (250 g per 1 cup)*		
Ingredient	Quantity	CNF Food Code	Percent Weight
Canned Chickpeas	280 g	3279	22.3
Quinoa	180 g	4495	16
Chicken breast	80 g	841	15
Onions	100g	2401	14.3
Cauliflower	200g	2385	13
Chicken broth	360 ml	7450	8
Water	160 ml		6.4
Whole milk 2%	170 ml	61	4.3
Garlic	12g	2394	0.96
Cumin	1 tsp	182	0.24
Salt	1 tsp	214	0.06
Pepper	¼ tsp	198	0.05
			0.03

Directions

1. Put the chicken, chickpeas, onions, garlic, cumin, salt, pepper, to boil with the chicken broth.
2. Steam the cauliflower.
3. Rinse the quinoa with cold water, cook until it is ready (see grain open) and rinse it again. Leave aside.
4. Once the chicken is cooked wait until it cools down.
5. Mix all the cooked ingredients and blend everything adding the milk slowly until smooth (IDDSI level 4).

Nutrition Facts
Valeur nutritive
Per (250 g)
pour (250 g)

Calories 360	% Daily Value* / % valeur quotidienne*
Fat / Lipides 16 g	21 %
Saturated / saturés 2.5 g + Trans / trans 0 g	13 %
Carbohydrate / Glucides 41 g	
Fibre / Fibres 8 g	29 %
Sugars / Sucres 8 g	8 %
Protein / Protéines 14 g	
Cholesterol / Cholestérol 15 mg	
Sodium 440 mg	19 %
Potassium 250 mg	5 %
Calcium 75 mg	6 %
Iron / Fer 0.4 mg	2 %

*5% or less is **a little**, 15% or more is **a lot**
*5% ou moins c'est **peu**, 15% ou plus c'est **beaucoup**

Ingredients: chickpeas, cauliflower, whole milk, dry quinoa, water, onion, chicken, olive oil, garlic cloves, table salt, ground cumin, black pepper, unsalted chicken broth chicken.

Figure 5.7 Nutrition Facts Table: *Cauliflower soup* recipe

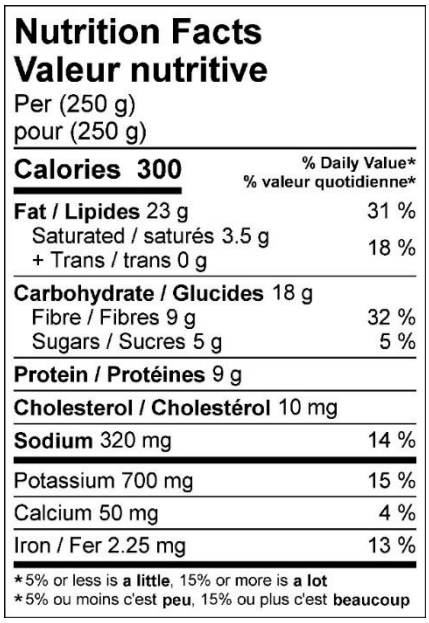
Peas avocado salad

Table 5.3 List of ingredients

	List of Ingredients *Number of Servings: 4 .01 (250 g per 1 Cup)*		
Ingredient	Quantity	CNF Food Code	Percent Weight
Dry Peas	250 g	2149	26.91
Chicken	80 g	841	24.02
Onions	70 g	2401	19.22
Avocado	280 g	1511	7.69
Cilantro	20 g	2067	6.73
Spinach	80 g	2213	5.19
Olive Oil	4 tbsp	422	5
Chicken broth	200 ml	7450	1.97
Green onion	10 g	2144	1.92
Lime Juice	4 tsp	1595	0.96
Salt	1 tsp	214	0.29
Pepper	½ tsp	198	0.11

Directions

1. Put the chicken, onions, salt, pepper, to boil with the chicken broth.
2. Once the chicken is cooked, remove from heat.
3. Add the peas, cilantro and spinach and wait until it cools with the lid on.
4. In the blender start blending the cooked ingredients, once they are mixed add the avocado, slowly add the olive oil. Check texture. (IDDSI level 4). Finally add the lime juice and blend one more time to incorporate everything.



Nutrition Facts
Valeur nutritive
Per (250 g)
pour (250 g)

Calories 300	% Daily Value* / % valeur quotidienne*
Fat / Lipides 23 g	31 %
Saturated / saturés 3.5 g + Trans / trans 0 g	18 %
Carbohydrate / Glucides 18 g	
Fibre / Fibres 9 g	32 %
Sugars / Sucres 5 g	5 %
Protein / Protéines 9 g	
Cholesterol / Cholestérol 10 mg	
Sodium 320 mg	14 %
Potassium 700 mg	15 %
Calcium 50 mg	4 %
Iron / Fer 2.25 mg	13 %

*5% or less is **a little**, 15% or more is **a lot**
*5% ou moins c'est **peu**, 15% ou plus c'est **beaucoup**

Ingredients: Green peas, avocado, unsalted chicken broth chicken, spinach, onion, olive oil, chicken, juice lime, cilantro leaves, green onion, table salt, black pepper.

Figure 5.8 Nutrition facts table: *Peas avocado salad* recipe

Red bean spaghetti bolognes

Table 5.4 List of ingredients

	List of Ingredients *Number of Servings: 4.91 (250 g per 1 Cup)*		
Ingredient	Quantity	CNF Food Code	Percent Weight
Beans, kidney, dark red	230 g	3265	21.02
Onions	100 g	2401	19.97
Carrots	60 g	2380	14.67
Tomatoes	50 g	2460	11.41
Crushed tomatoes peppers	100 g		8.15
Tomato Sauce	40 g		8.15
Minced Beef	180 g	2683	8.15
Pasta	140 g		4.89
Whole Milk 2%	250 ml	61	2.2
Water	140 ml		0.98
Olive Oil	2 tablespoons	422	0.24
Bay Leaf	2	172	0.09
Garlic	12 g	2394	0.05
Salt	1 tsp	214	
Pepper	½ tsp	198	

Directions

1. Soak the beans for 24 hours with enough water to cover the beans.
2. Cook the beans with 2 cups of water for each cup of beans. When the are soft, remove from fire and let them cool.
3. In a pot add the minced beef, onions, garlic, tomatoes, carrots, crushed tomatoes with green peppers salt, pepper, and bay leaf for boil.
4. Once the minced beef is cooked, add the cooked red beans. Let it cool before blending.
5. Cook the pasta. Let it cool.
6. In the blender start blending the cooked ingredients. Check the texture. (IDDSI level 4).
7. Finally blend the pasta with the milk. Check texture. (IDDSI level 4).
8. Serve separately.

Nutrition Facts
Valeur nutritive
Per (250 g)
pour (250 g)

Calories 420	% Daily Value* / % valeur quotidienne*
Fat / Lipides 15 g	20 %
Saturated / saturés 2 g + Trans / trans 0 g	10 %
Carbohydrate / Glucides 48 g	
Fibre / Fibres 12 g	43 %
Sugars / Sucres 7 g	7 %
Protein / Protéines 23 g	
Cholesterol / Cholestérol 5 mg	
Sodium 350 mg	15 %
Potassium 350 mg	7 %
Calcium 150 mg	12 %
Iron / Fer 5 mg	28 %

*5% or less is **a little**, 15% or more is **a lot**
*5% ou moins c'est **peu**, 15% ou plus c'est **beaucoup**

Ingredients: whole milk, red beans, minced beef, spaghetti pasta enriched, onion, tomatoes, tomatoes, crushed, carrots, olive oil, garlic cloves, table salt, black pepper, dry bay leaf.

Figure 5.9 Nutrition facts table: *spaghetti bolognes* recipe

Chickpeas sweet potato dessert

Table 5.5 List of ingredients

	List of Ingredients *Number of Servings: 4.43 (250 g per 1 Cup)*		
Ingredient	Quantity	CNF Food Code	Percent Weight
Topping			
Canned Chickpeas	180 g	3279	24
Sweet Potatoes	100 g	2240	11
Carrots	50 g	2380	5
Peaches	120 g		12.2
Brown Sugar	25 g	4317	6.3
Vanilla Extract	½ tsp	216	1.3
Water	100 ml		
Cinnamon	1/8 tsp	178	0.05
Ginger	1/8 tsp	189	0.04
Salt	2 pinches	214	0.07
Vanilla Cake			
Flour all purpose	120 g	4501	11
Eggs	4	125	16
Vanilla Extract	3 tsp	216	
Baking powder	2 tbsp	4003	0.91
Whole Milk	25 ml	61	12

Directions

1. Put the chickpeas, peaches, carrots, cinnamon, vanilla extract, and half of the brown sugar to boil until the chickpeas are softer.
2. Prepare a sponge cake. Preheat the oven to 250 °C.
3. Separate the eggs (yolks, and whites)
4. Beat the eggs until stiff.
5. Cream the eggs with the rest of the brown sugar. Add the flour and the baking powder.
6. Bake for 25 minutes. Take out of the oven. Let it cool.
7. In the blender start blending the ingredients for the topping. Check the texture. (IDDSI level 4). Finally, blend the cake with the milk. Serve separately.

Nutrition Facts
Valeur nutritive
Per (250 g)
pour (250 g)

Calories 380	% Daily Value* / % valeur quotidienne*
Fat / Lipides 7 g	9 %
Saturated / saturés 1.5 g + Trans / trans 0 g	8 %
Carbohydrate / Glucides 68 g	
Fibre / Fibres 8 g	29 %
Sugars / Sucres 31 g	31 %
Protein / Protéines 15 g	
Cholesterol / Cholestérol 140 mg	
Sodium 270 mg	12 %
Potassium 550 mg	12 %
Calcium 175 mg	13 %
Iron / Fer 2 mg	11 %

*5% or less is **a little**, 15% or more is **a lot**
*5% ou moins c'est **peu**, 15% ou plus c'est **beaucoup**

Ingredients: chickpeas, eggs, peaches, whole milk, sweet potatoes, whole-wheat flour, brown sugar, carrots, vanilla extract, baking powder, table salt, ground cinnamon, ground ginger.

Figure 5.10 Nutrition facts table: *Chickpeas sweet potato dessert* recipe

Participants characteristics

Sixty-five participants completed the study (Figure 6.1), thirty-five adults (n=35) and 30 seniors (n=30) of which thirty-four were females (n=34) and thirty-one were males (n=31). Twenty-one children (n=21) completed the study separately. Participants characteristics are shown in Table 5.11, 5.12.

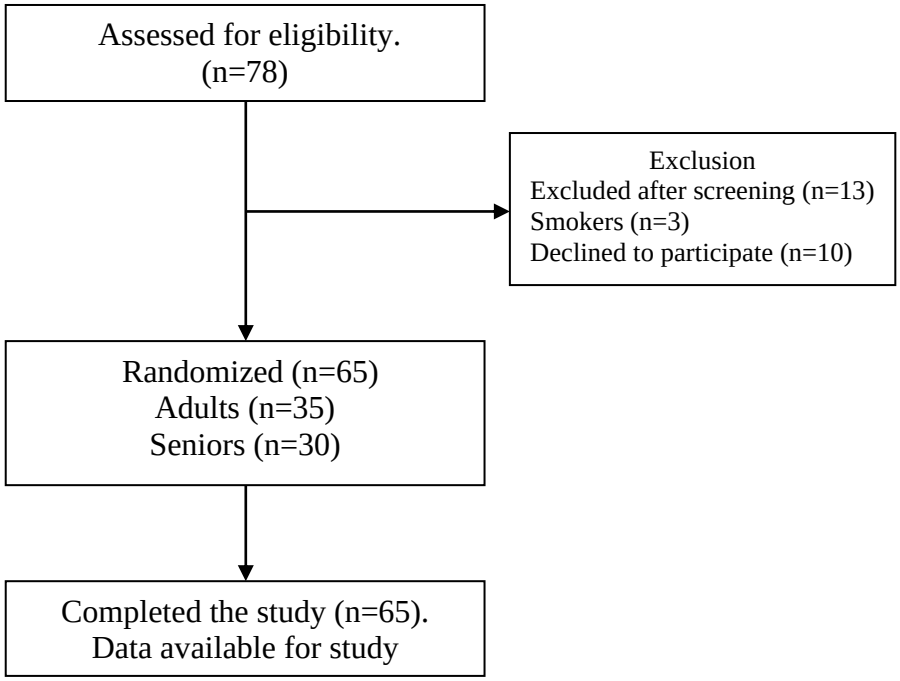


Figure 5.11 CONSORT participant flow diagram

Table 5.6 Participant baseline characteristics

	Adults (19-64y)	**Seniors (≥65y)**	**Children (9-17y)**
Age (years)	39±12.1	73.3±6.8	11.4±2.0
Total of participants	35	30	21

Table 5.7 Participant baseline characteristics – Adults all ages

	Female	**Male**
Age (years)	37.4±13.4	40.5±9.8
Total	18	17

Sensory evaluation

There was an effect of a treatment on appearance, pleasantness, taste, texture, flavor, and sweetness Table 5.1.

Although there was an effect of a treatment on hedonic perception of saltiness and sourness ($P<0.05$), the post-hoc analysis did not detect any differences between the treatments.

There was no effect of a treatment on hedonic perception of bitterness. On the other hand, the analysis indicated a significant effect of a treatment on smoothness, swallowness, mouthfeel, and aftertaste. The sensory attributes of the purée treatments are illustrated below in Figures 5.12-5.18.

The *peas avocado salad* and the *chickpeas sweet potato dessert* were found to be more appetizing than the other samples, with appearance playing a significant role in influencing this perception. However, among children, only the *chickpea sweet potato dessert* showed a notable effect, being perceived as more appetizing than the other options. The pleasantness of the *chickpeas sweet potato dessert* was higher compared to all the samples ($P<0.0001$). Additionally, the chickpea sweet potato dessert sample exhibited a significant effect across all sensory attributes in comparison to the other samples.

Table 5.8 Sensory Evaluation of the five treatments (Adults and Seniors)

Sensory Characteristics	Treatments					P-value (treatment)
	Lentils, chicken & prunes	Chickpeas cauliflower soup	Peas avocado salad	Red beans spaghetti	Chickpeas sweet potato dessert	
Appearance (VAS, mm)	39.4±26.4^{a}	45.4±27.1^{ab}	59.4±30.1^{bc}	45.3±28.8^{a}	66.1±25.0^{c}	P<0.0001
Appearance (9-pt HS)	4.7±1.7^{a}	5.3±1.7^{a}	6.4±1.9^{b}	5.2±1.8^{a}	6.5±1.7^{b}	P<0.0001
Pleasantness (VAS, mm)	54.8±30.2^{ac}	53.4±30.5^{ac}	62.2±29.7^{a}	48.2±29.4^{c}	78.6±22.5^{b}	P<0.0001
Pleasantness (9-pt HS)	5.9±2.1^{ac}	5.4±2.2^{ac}	6.1±2.1^{a}	5.1±1.9^{c}	7.4±1.5^{b}	P<0.0001
Taste (9-pt HS)	6.1±2.1^{a}	5.6±2.2^{ab}	6.2±2.2^{ac}	5.2±2,1^{b}	7.4±1.7^{c}	P<0.0001
Texture (9-pt HS)	5.9±2.0^{ab}	5.6±2.0^{a}	6.7±1.7^{b}	5.4±1.8^{a}	7.2±1.6^{b}	P<0.0001
Flavour (9-pt HS)	6.1±2.3^{ac}	5.9±2.0^{ac}	6.3±2.2^{ab}	5.4±2.2^{c}	7.4±1.6^{b}	P<0.0001
Saltiness (VAS, mm)	45.9±26.8^{a}	43.8±24.8^{a}	37.7±23.9^{a}	37.5±23.7^{a}	10.1±13.6^{b}	P<0.0001
Saltiness (9-pt HS)	6.2±1.8^{a}	6.2±1.7^{a}	6.2±1.6^{a}	5.6±1.6^{a}	6.1±1.6^{a}	P=0.0406
Sweetness (VAS, mm)	25.4±24.3^{a}	13.2±17.4^{a}	20.4±21.7^{a}	15.1±18.8^{a}	68.2±24.2^{b}	P<0.0001
Sweetness (9-pt HS)	5.9±1.7^{a}	5.6±1.7^{a}	5.9±1.6^{a}	5.3±1.6^{a}	7.4±1.6^{b}	P<0.0001
Bitterness (VAS, mm)	19.0±23.0^{a}	14.8±22.2^{ab}	18.6±25.3^{a}	14.6±20.7^{a}	8.9±16.0^{b}	P<0.0001
Bitterness (9-pt HS)	5.8±1.8^{a}	5.9±1.5^{a}	6.0±1.8^{a}	5.8±1.7^{a}	6.2±1.7^{a}	P=0.1455
Sourness (VAS, mm)	13.3±19.5^{ab}	9.1±14.9^{a}	19.5±22.5^{b}	9.2±15.5^{a}	7.2±9.8^{a}	P<0.0001
Sourness (9-pt HS)	6.0±1.6^{a}	6.1±1.4^{a}	5.9±1.7^{a}	5.7±1.6^{a}	6.4±1.8^{a}	P=0.0173
Smoothness (VAS, mm)	63.8±28.9^{ac}	65.0±28.8^{ac}	75.3±24.4^{ab}	59.2±29.9^{c}	79.1±20.6^{b}	P<0.0001
Smoothness (9-pt HS)	6.5±1.8^{ab}	6.2±1.9^{a}	6.9±1.6^{b}	6.0±1.8^{a}	7.2±1.4^{b}	P<0.0001
Swallowness (VAS, mm)	83.3±20.1^{ab}	81.9±22.1^{ab}	86.3±20.1^{a}	76.0±25.7^{b}	87.9±16.9^{a}	P=0.0008
Swallowness (9-pt HS)	6.8±1.7^{ab}	6.8±1.6^{ab}	7.1±1.8^{a}	6.2±1.9^{b}	7.3±1.5^{a}	P<0.0001
Adhesiveness (VAS, mm)	36.6±27.0^{ab}	31.5±26.4^{ab}	30.6±26.2^{a}	41.1±26.8^{b}	38.4±29.4^{ab}	P=0.0076
Adhesiveness (9-pt HS)	6.1±1.7^{ab}	6.1±1.6^{ab}	6.4±1.8^{a}	5.8±1.7^{b}	6.6±1.5^{a}	P=0.0023
Mouthfeel (9-pt HS)	5.8±2.1^{ac}	5.6±2.0^{ac}	6.2±1.8^{ab}	5.3±1.7^{c}	7.1±1.5^{b}	P<0.0001
Aftertaste (9-pt HS)	5.8±2.1^{ac}	5.7±1.9^{ac}	6.0±1.9^{ab}	5.3±1.9^{c}	7.0±1.6^{b}	P<0.0001
Prospective Purchasing (VAS, mm)	45.4±33.7^{ac}	42.9±36.2^{a}	55.8±36.0^{bc}	35.9±32.0^{a}	69.0±31.4^{b}	P<0.0001

Means ± SD, n=65. 9-point hedonic scale: 9: Like extremely, 8: Like very much, 7: Like moderately, 6: Like slightly, 5: Neither like nor dislike, 4: Dislike slightly, 3: Dislike moderately, 2: Dislike very much, 1: Dislike extremely. One-way ANOVA with Tukey-Kramer post-hoc test: The difference between the values with different superscript letters is statistically significant ($P \leq 0.05$).

Table 5.9 Sensory Evaluation of the five treatments (Children)

Sensory Characteristics	**Treatments**					**P-value (treatment)**
	Lentils, chicken & prunes	Chickpeas cauliflower soup	Peas avocado salad	Red beans spaghetti	Chickpeas sweet potato dessert	
Appearance (VAS, mm)	35.0±27.1[a]	44.7±25.4[abc]	41.3±24.9[ab]	50.4±25.1[bc]	63.6±20.8[c]	P<0.0001
Appearance (9-pt HS)	4.4±2.1[a]	4.8±2.1[a]	5.0±1.9[a]	5.4±1.8[ab]	6.5±1.4[b]	P=0.0002
Pleasantness (VAS, mm)	34.3±17.4[a]	41.5±26.7[a]	52.4±24.9[ab]	62.3±25.2[b]	69.7±23.4[b]	P<0.0001
Pleasantness (9-pt HS)	4.1±1.6[a]	4.6±2.0[a]	5.2±2.0[ab]	6.2±1.9[bc]	7b.1±1.7[c]	P<0.0001

Means ± SD, n=21. 9-point hedonic scale: 9: Super good, 5: Maybe good or maybe bad, 1: Super bad. For VAS appearance: 100mm Like a lot, 0mm – dislike a lot. For VAS pleasantness 100mm: Very pleasant, 0mm – Not pleasant at all. One-way ANOVA with Tukey-Kramer post-hoc test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Appearance

The results indicated that there was an effect of a treatment on the subjective perception of the appearance ($P<0.0001$) of the food samples by 65 participants who completed the study. Specifically, the treatments with *chickpeas sweet potato dessert* and *peas avocado salad* resulted in a higher visual appeal compared to the treatments with *lentils, chicken and prunes, chickpeas cauliflower soup* and *red beans spaghetti bolognes*. The observed differences in visual appeal can possibly be attributed to the fresh green and saturated orange colours of the *peas avocado salad* and *chickpeas sweet potato dessert* treatments, respectively, which were perceived as more attractive than the colours of the other treatments. The other treatments did not have such attractive colours. Vibrant and natural colours can give the impression of freshness in puréed foods. A bright green or rich orange colour can evoke feelings of fresh ingredients, even if the food is puréed and lacks texture (Spence, 2015).

The findings for children revealed a significant effect of the treatment on the subjective perception of the appearance ($P<0.0001$). Specifically, the treatments with *chickpeas sweet potato dessert* resulted in a higher visual appeal compared to the other treatments.

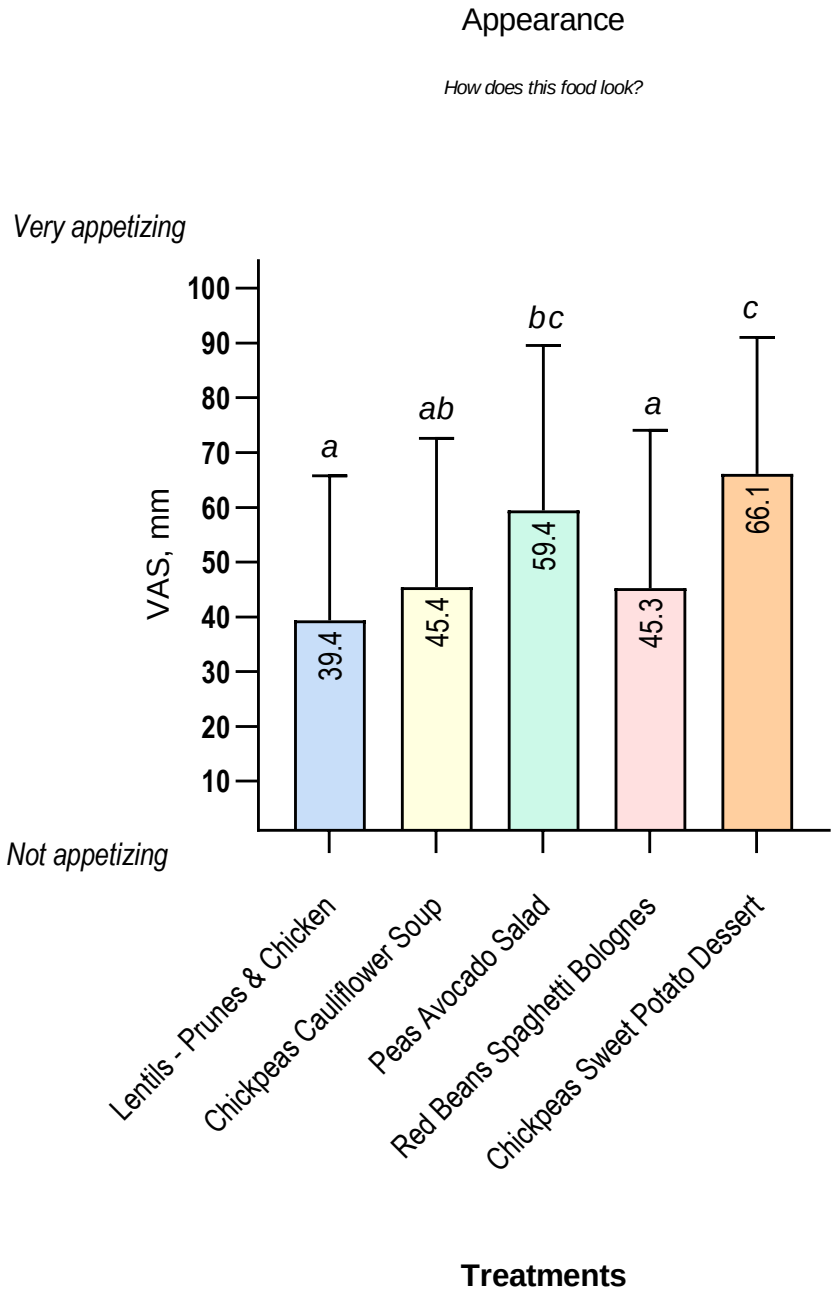


Figure 5.12 Perceived appearance (VAS) in adults (≥19 y).
Mean ± SD; n=65. Friedman test. Treatment P<0.0001. Post-hoc Dunn's multiple comparison test: values with different superscript letters are different (P≤0.05).

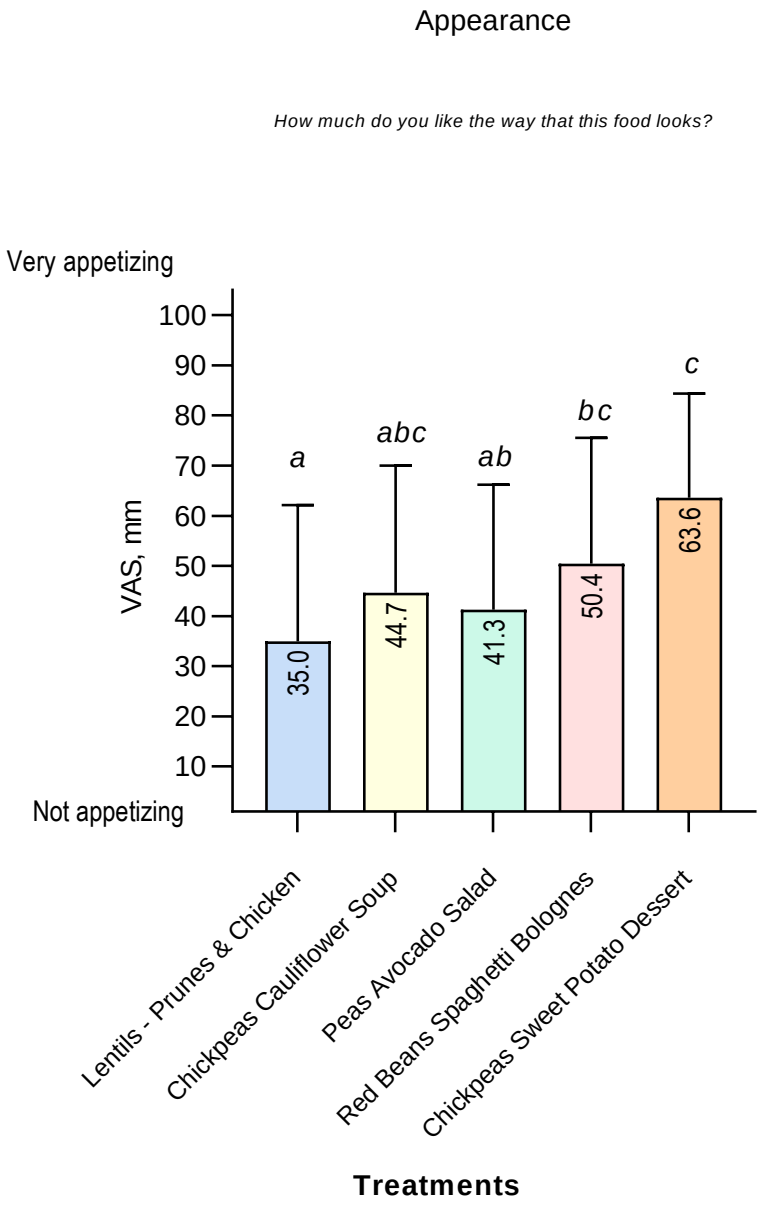


Figure 5.13 Perceived appearance (VAS) in children (9-15 y).
Values are Mean ± SD; n=21. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: values with different superscript letters are statistically significant(P≤0.05).

Since the sample of participants contained two age and sex groups, a 3-way ANOVA was conducted, and there was an effect of treatment (P<0.0001), age (P=0.04), and treatments by age interaction (P=0.05) found.

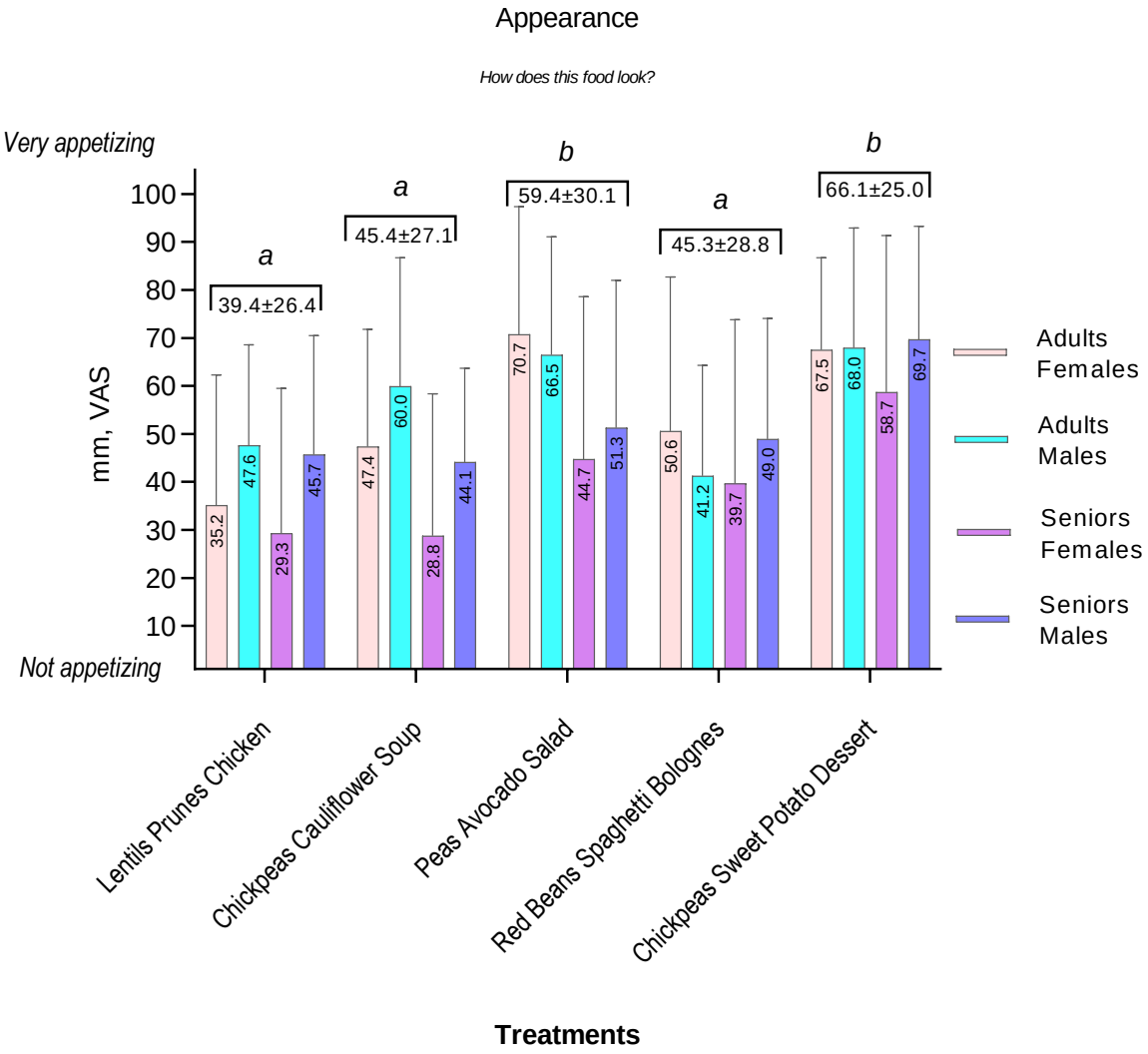


Figure 5.14 Perceived appearance (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Three-way ANOVA with Tukey-Kramer post-hoc test. Treatment (P<0.0001), age (P=0.04), sex (P=0.11), treatment × age (P=0.05), treatment × sex (P=0.2). The difference between the treatments is significant with different superscripts (P≤0.05).

As shown in the graph (Figure 5.15), adults exhibited a notably higher average subjective perception of appearance compared to seniors as it could be explained by the effect of age (P=0.04) and a treatment by age interaction (P=0.05). Interestingly, this difference was particularly pronounced in the case of *pea avocado salad* or *chickpea cauliflower soup*, as opposed to the other samples, which may explain the observed treatment by age interaction.

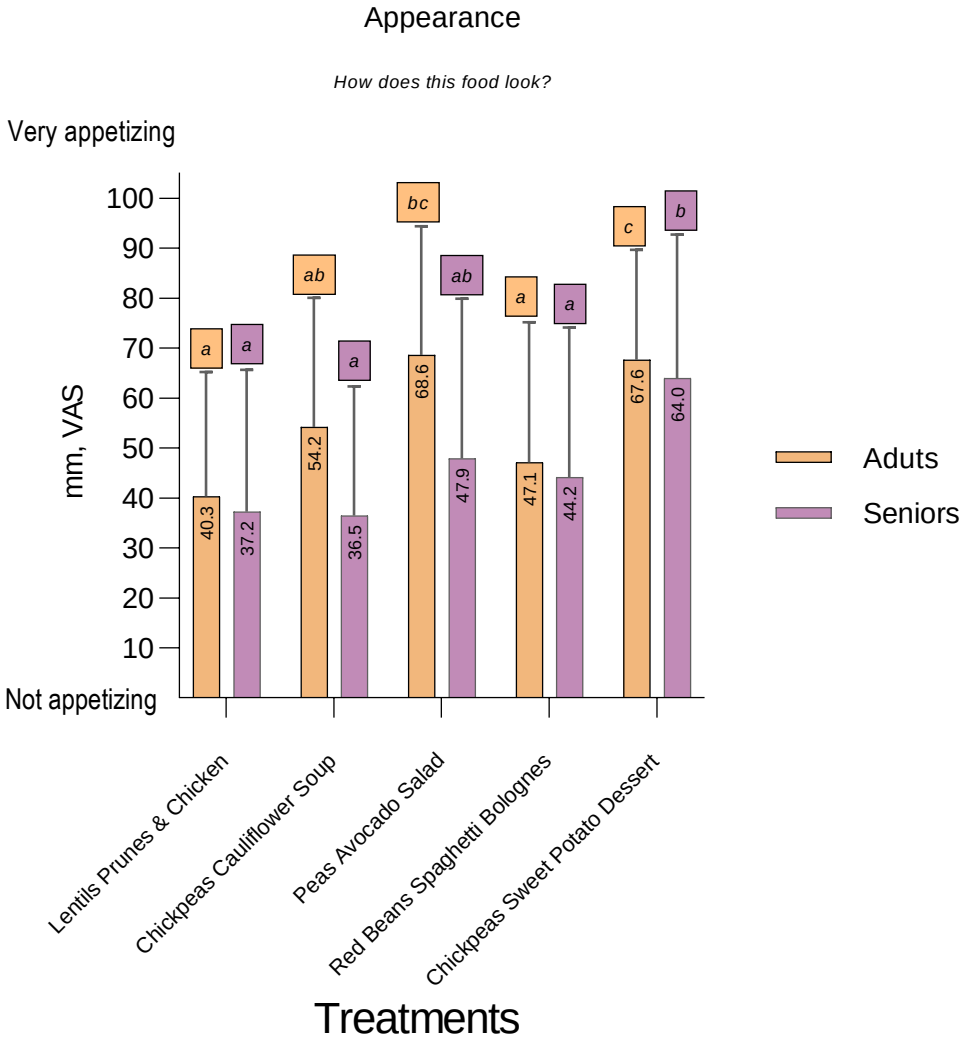


Figure 5.15 Perceived appearance (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Treatment P<0.0001. Values are Mean ± SD; n=65. Two-way ANOVA Tukey-Kramer. Treatment (P<0.0001), age (P=0.04), treatment × age (P=0.05). The difference between the values with different superscript letters is statistically significant (P≤0.05).

The figure 5.16 presents the results on perceived appearance, measured using a 9-point hedonic scale, which ranged from 1 (dislike extremely) to 9 (like extremely). The participants

were asked to rate how much they enjoyed the pleasantness of the sample. The data collected from all 65 participants indicate a significant effect of the treatment on perceived appearance ($P<0.0001$). Once again, the *chickpea sweet potato dessert* and the peas avocado salad received the highest appearance ratings suggesting that they were particularly appealing to the participants. On the other hand, the lowest appearance ratings were observed for *lentils, chicken, and prunes* recipe. It is worth mentioning that the treatments with *chickpea cauliflower soup* and *red beans spaghetti bolognes* resulted in a neutral perception (around 5 points) on the 9-pt hedonic scale, indicating that participants neither strongly liked nor disliked their visual appearance.

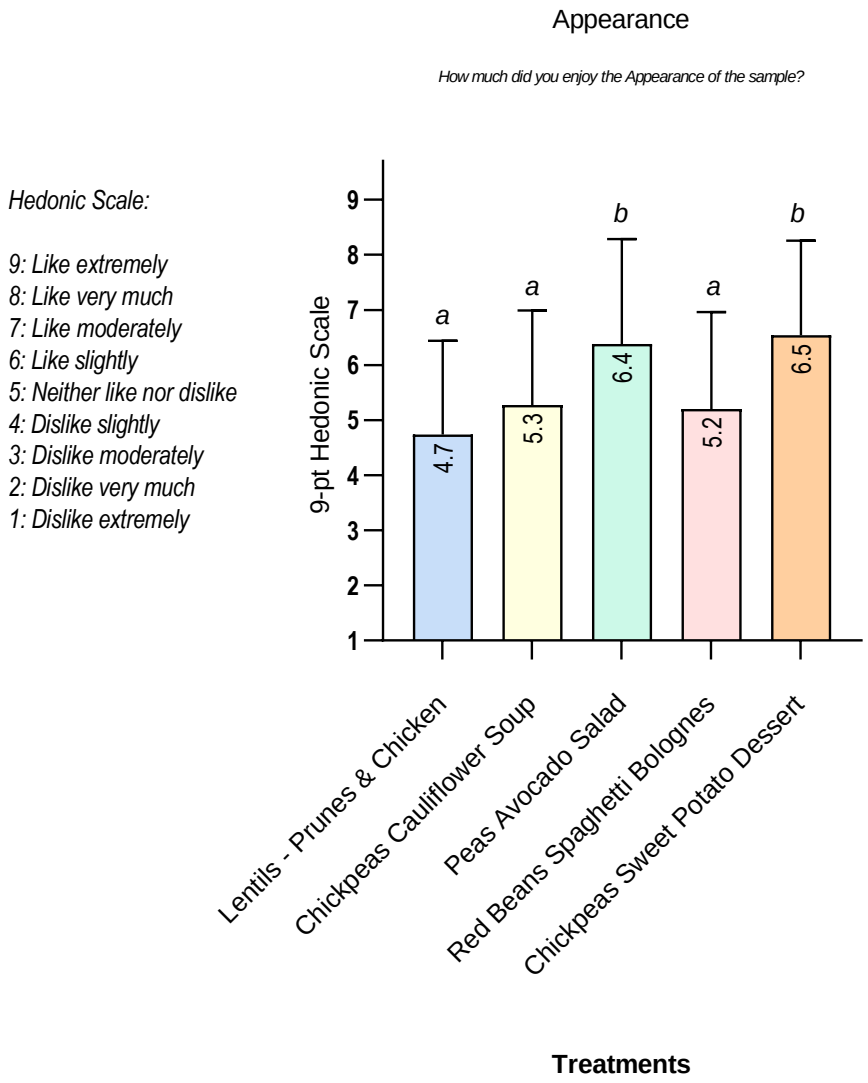


Figure 5.16 Perceived appearance (9-point hedonic scale) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment P<0.0001. Post-hoc Dunn's multiple comparison test: values with different superscript letters are statistically significant(P≤0.05).

Pleasantness

The results on perceived pleasantness were measured with a 9-point hedonic scale that ranged from 1 (dislike extremely) to 9 (like extremely). The participants had to answer the question: how much did they enjoy the pleasantness of the sample? The data for all 65 participants indicate the significant effect of a treatment on perceived pleasantness ($P<0.0001$). The highest pleasantness was detected for the *chickpea sweet potato dessert*, and the lowest one was detected for *red beans spaghetti bolognes*. However, it is worth mentioning that all treatments resulted either in neutral perception (around 5 points) or positive perception (6 points and above) on 9-point hedonic scale.

The findings for children revealed a significant effect of the treatment on perceived pleasantness ($P<0.0001$). The highest pleasantness was detected for the *chickpea sweet potato dessert*, and the lowest one was detected for *lentils, chicken, and prunes* recipe. It is worth noting that when comparing children and adults on perceived pleasantness for the *red beans spaghetti bolognes* recipe, children tend to enjoy this sample more.

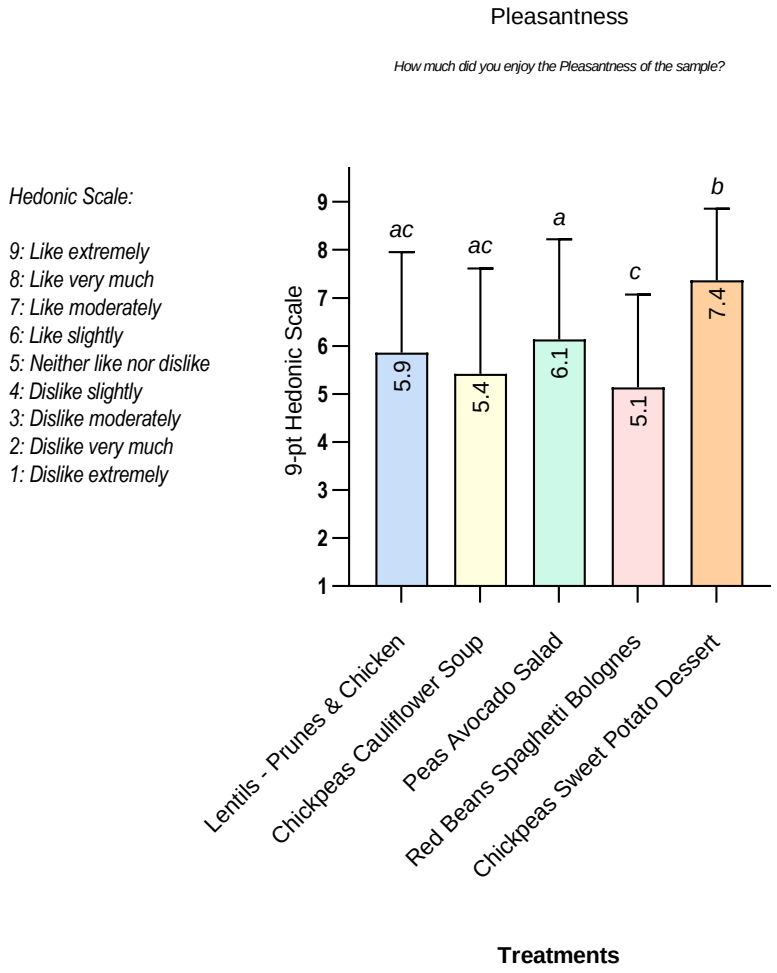


Figure 5.17 Perceived pleasantness (9-point hedonic scale) in adults (≥19 y). Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

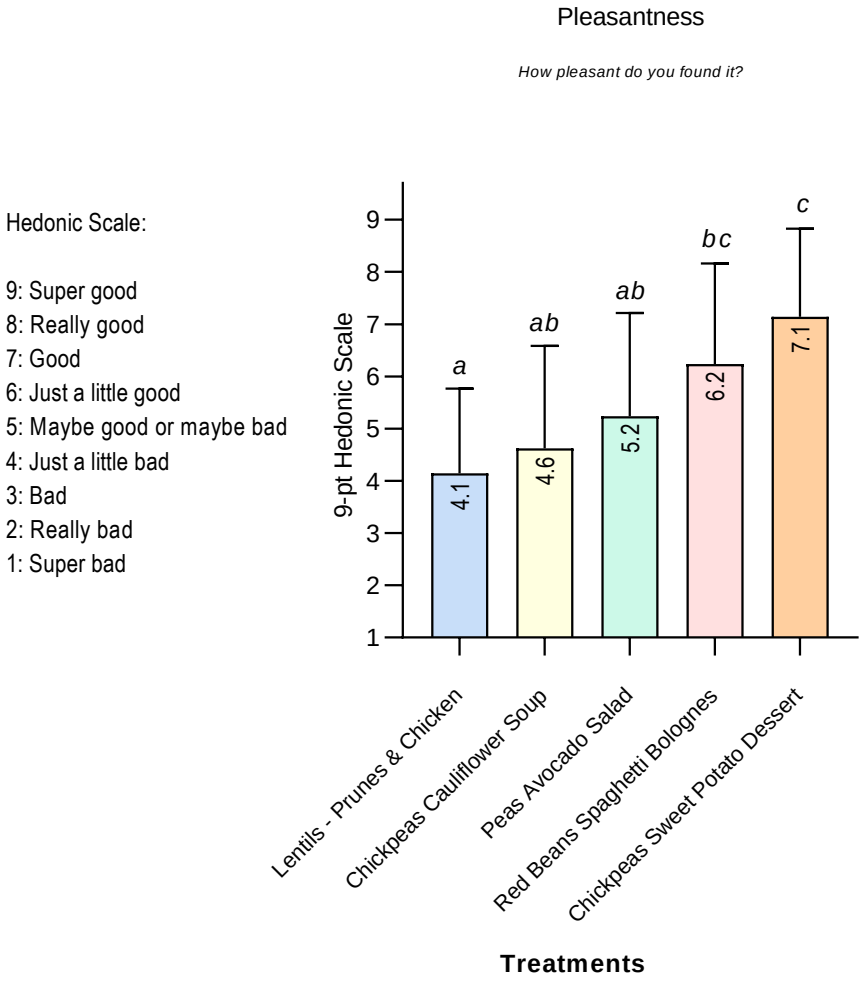


Figure 5.18 Perceived pleasantness (9-point hedonic scale) in children (9-15 y). Mean ± SD; n=65. Friedman test. Treatment: $P<0.0001$. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant ($P\leq0.05$).

The analysis for the effects of sex and age revealed that there was only an effect of age on perceived pleasantness (P=0.03). The perceived pleasantness of the treatments was lower in senior adults compared to adults.

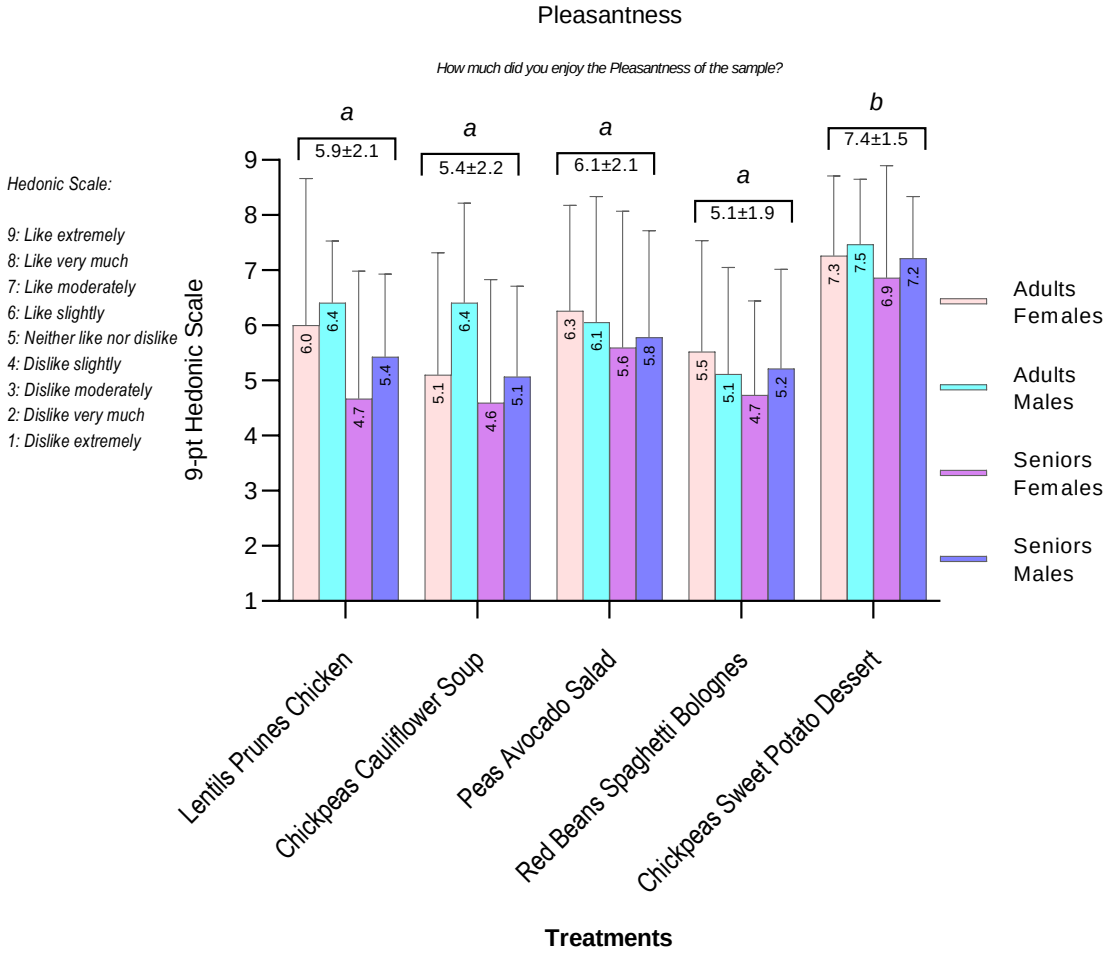


Figure 5.19 Perceived pleasantness (9-point hedonic scale) in adults (≥19 y). Values are Mean ± SD; n=65. Three-way ANOVA with Tukey-Kramer post-hoc test. Treatment (P<0.0001), age (P=0.03), sex (P=0.22), treatments × age (P=0.56), treatment × sex (P=0.5). The difference between the treatments is significant with different superscripts (P<0.05).

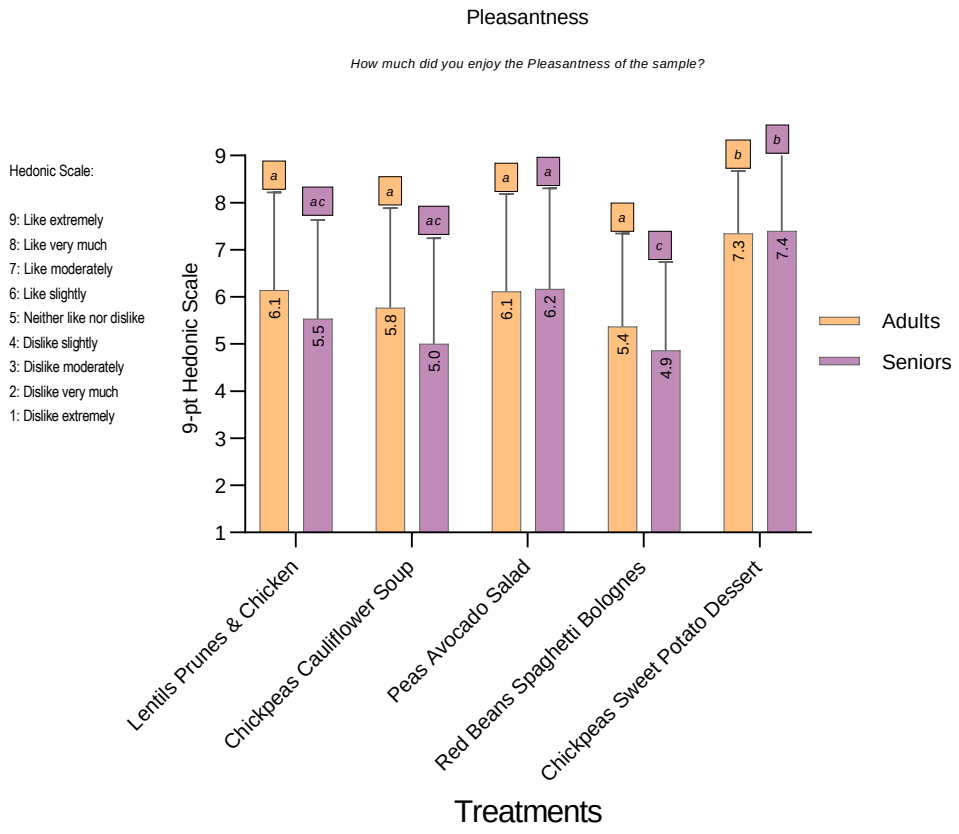


Figure 5.20 Perceived pleasantness (9-point hedonic scale) in adults (≥19 y). Values are Mean ± SD; n=65. Treatment P<0.0001. Two-way ANOVA Tukey-Kramer. Treatment (P<0.0001), age (P=0.05), treatment × age (P=0.3). The difference between the values with different superscript letters is statistically significant (P≤0.05).

Taste

The perceived taste were measured with a 9-point hedonic scale that ranged from 1 (dislike extremely) to 9 (like extremely). The participants had to answer the question: how much did they enjoy the taste of the sample? The data for all 65 adult participants indicate the effect of treatment on perceived taste (P<0.0001). The highest taste perception was detected for the *chickpea sweet potato dessert*, and the lowest one for *red beans spaghetti bolognes*. However, it is worth mentioning that all treatments resulted either in neutral perception (around 5 points) or positive perception (6 points and above) on 9-pt hedonic scale.

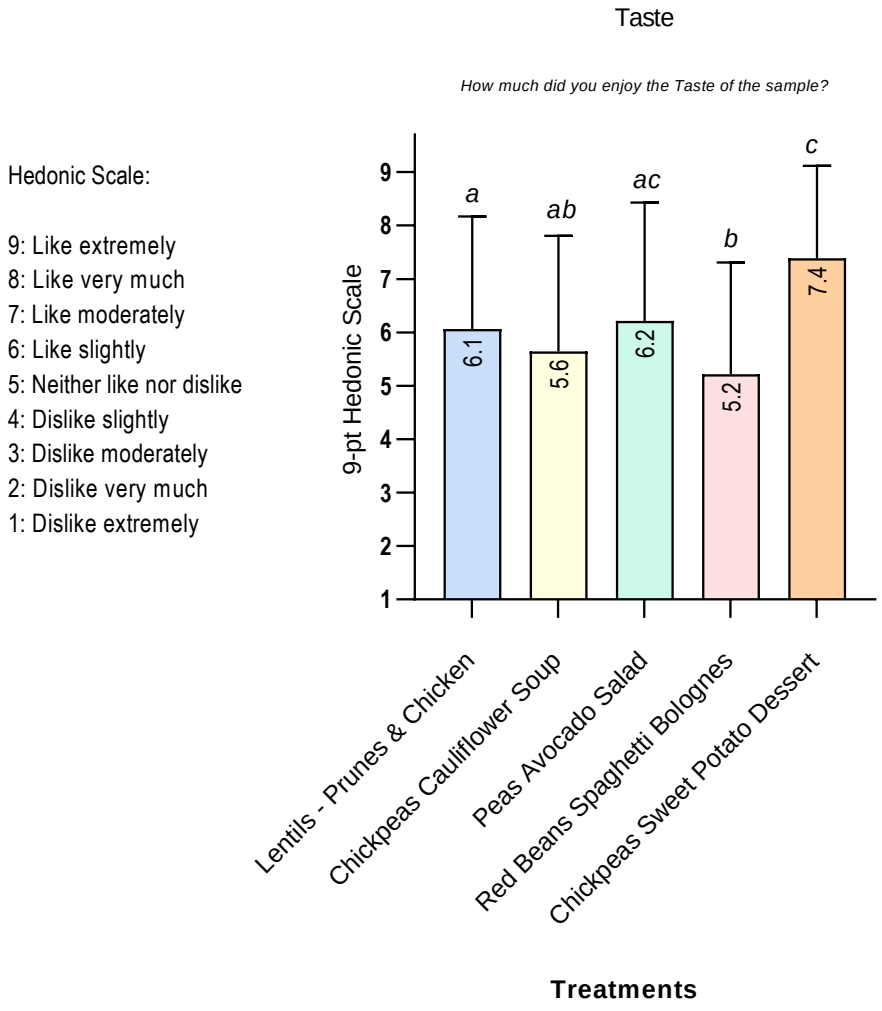


Figure 5.21 Perceived taste (9-point hedonic scale) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: values with different superscript letters are statistically significant (P≤0.05).

Texture

The results on perceived texture were measured with a 9-point hedonic scale that ranged from 1 (dislike extremely) to 9 (like extremely). The participants had to answer the question: how much did they enjoy the texture of the sample? The data for all 65 participants indicated the effect of treatment on perceived taste (P<0.0001). The highest hedonic perception of texture was detected for the *chickpea sweet potato dessert* and the lowest one for *red beans spaghetti bolognes*. However, it is worth mentioning that all treatments resulted either in neutral perception (around 5 points) or positive perception (6 points and above) on 9-pt hedonic scale.

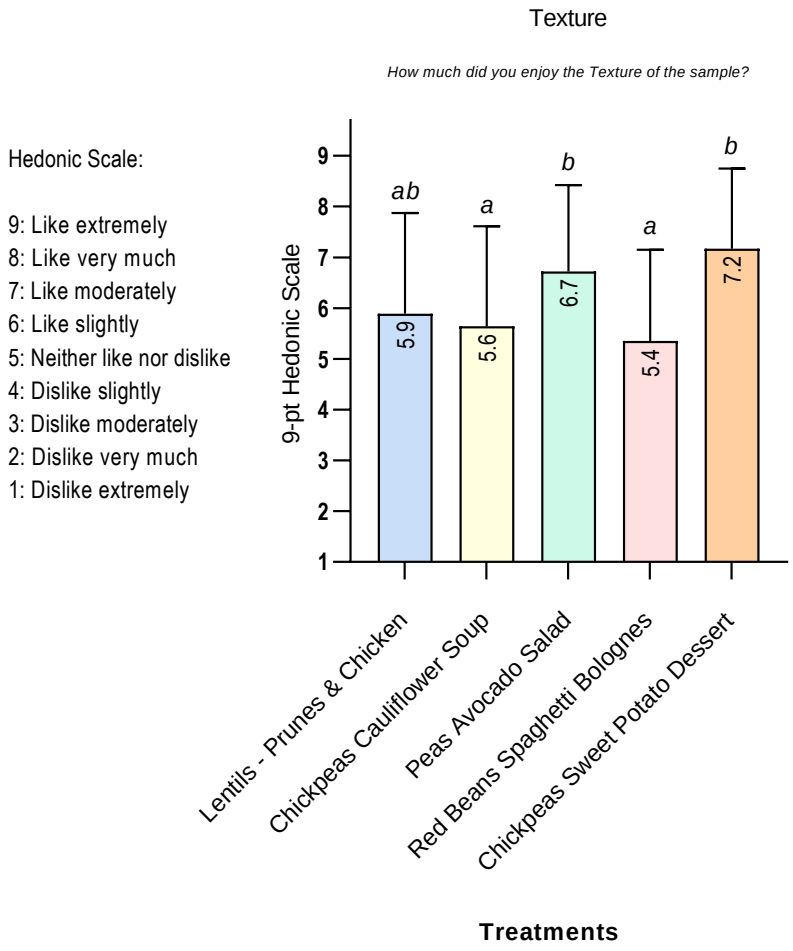


Figure 5.22 Perceived texture (9-point hedonic scale) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Flavour

The results on perceived flavour were measured with a 9-point hedonic scale that ranged from 1 (dislike extremely) to 9 (like extremely). The participants had to answer the question: how much did they enjoy the flavour of the sample? The data for all 65 participants indicate the effect of treatment on perceived taste (P<0.0001). The highest perception of flavour was detected for the *chickpea sweet potato dessert* and the lowest one for *red beans spaghetti bolognes*. However, it is worth mentioning that all treatments resulted in neutral perception (around 5 pt) or positive perception (around and above 6 pt) on 9-pt hedonic scale.

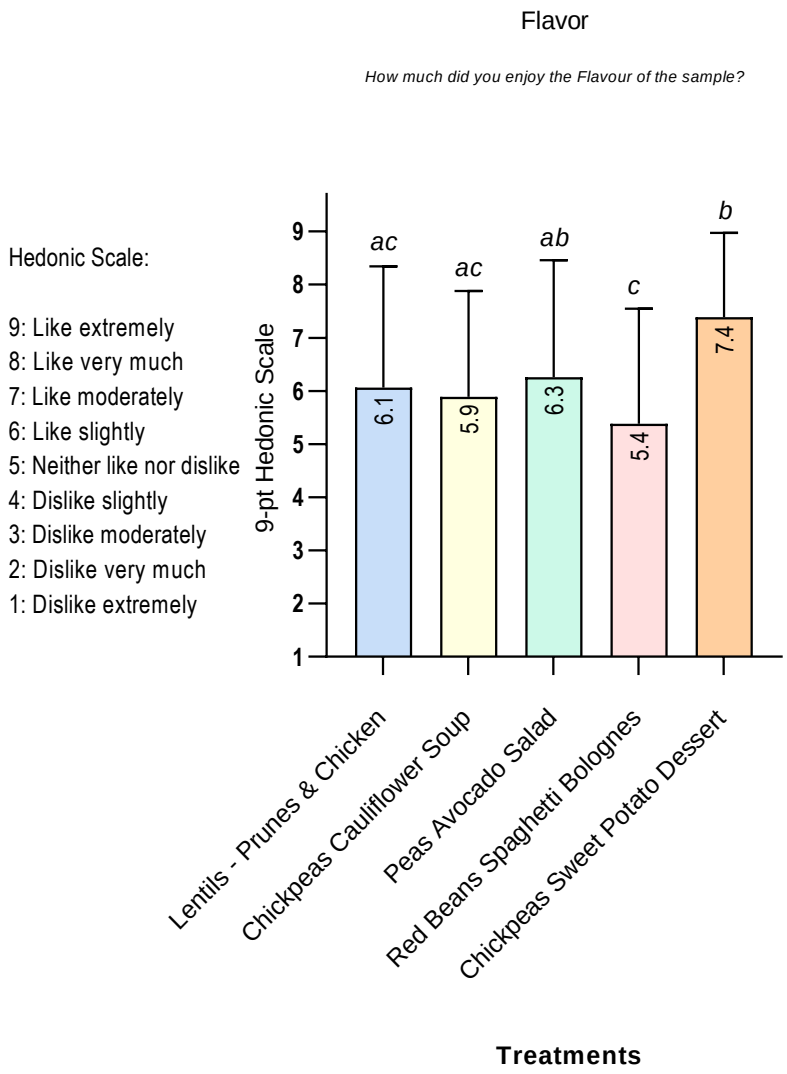


Figure 5.23 Perceived flavor (9-point hedonic scale) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Saltiness

The data analysis revealed a significant effect of a treatment on the subjective perception of saltiness of the food samples ($P<0.0001$). The treatment with *chickpeas sweet potato* resulted in a lower perceived intensity of saltiness compared to the other treatments.

The results may have implications for dietary preferences and health considerations, as individuals' sensitivity to saltiness can influence their food choices and overall sodium intake.

Understanding how specific treatments impact saltiness perception can facilitate the formulation of more palatable food options, adapted to meet consumer preferences and dietary requirements. Moreover, this knowledge contributes to the broader context of taste perception research and how it relates to the sensory experience of various food treatments.

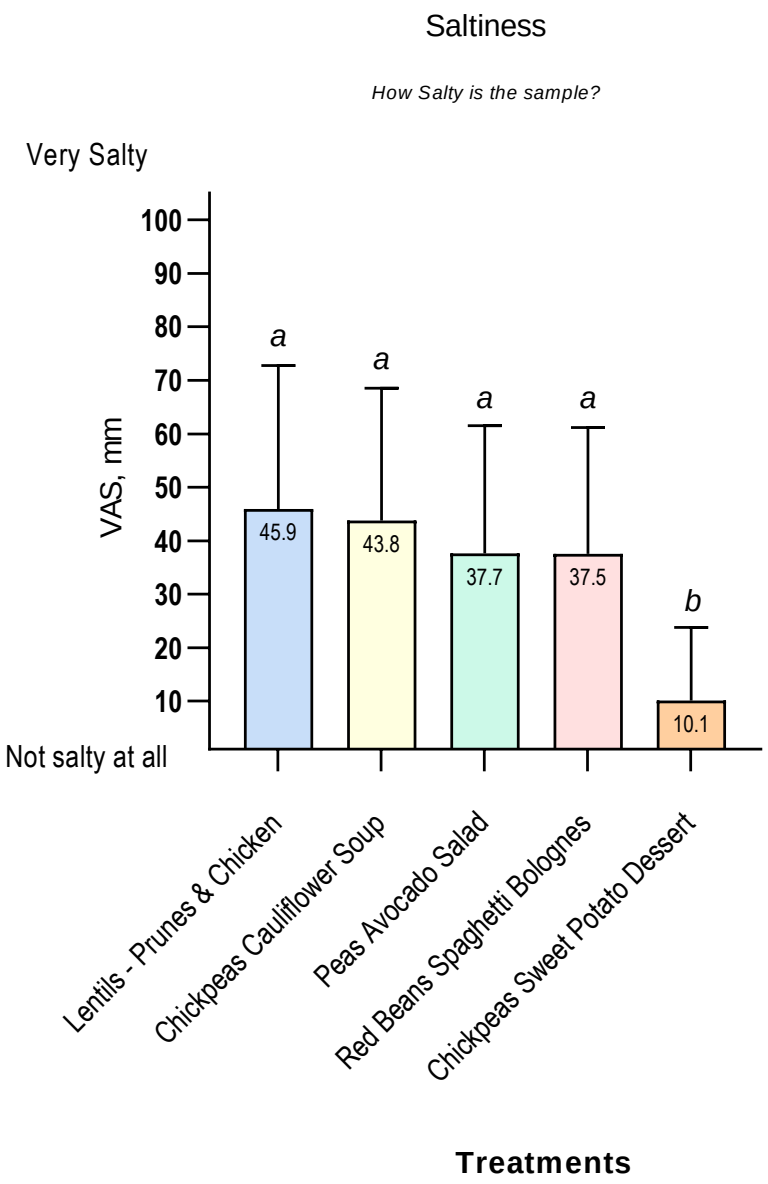


Figure 5.24 Perceived saltiness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Three-way ANOVA detected an effect of age (P=0.03), and a treatment by age interaction (P=0.01) but no effect of sex on perceived saltiness (Figure 5.24).

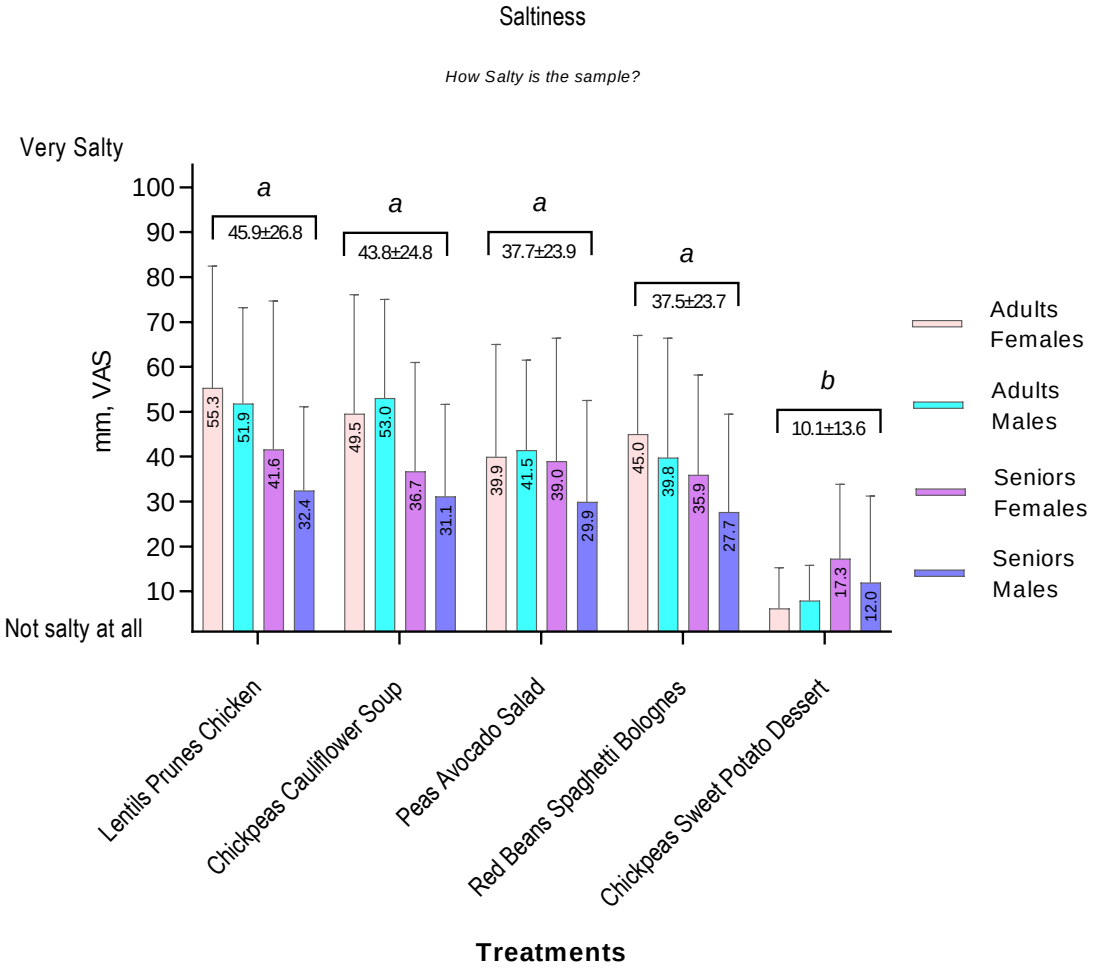


Figure 5.25 Perceived saltiness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Three-way ANOVA with Tukey-Kramer post-hoc test. Treatment (P<0.0001), age (P=0.03), sex (P=0.3), treatment × age (P=0.01), treatment × sex (P=0.9). The difference between the treatments is significant with different superscripts (P≤0.05).

When the data was analyzed with two-way ANOVA, there was an effect of age (P=0.03) and a treatment by age interaction (P=0.01) resulting in a higher perception of saltiness in adults than in seniors (Figure 5.25).

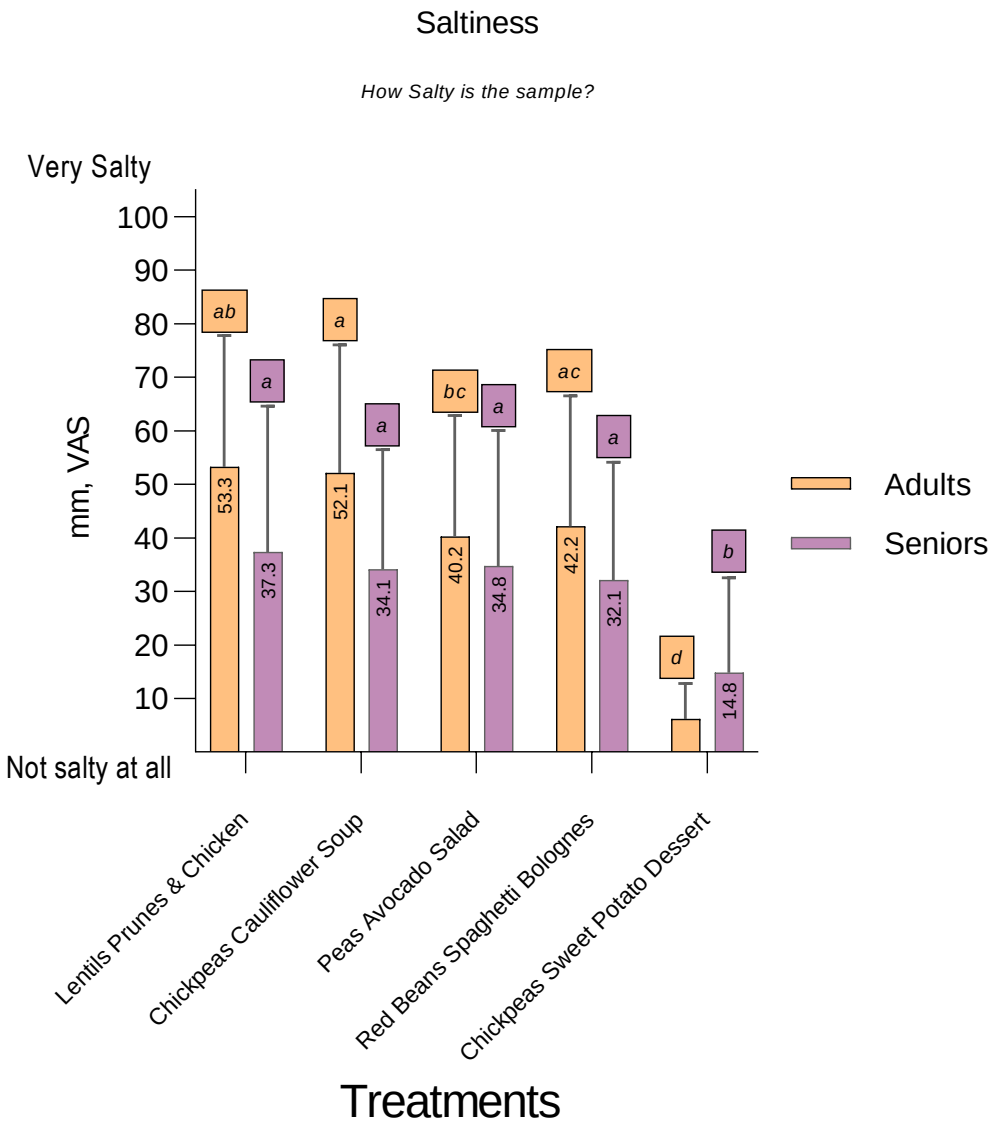


Figure 5.26 Perceived saltiness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Two-way ANOVA Tukey-Kramer. Treatment (P<0.0001), age (P=0.04), treatment × age (P=0.01). Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Smoothness

There was an effect of a treatment on subjective perception of smoothness (P<0.0001) of the food samples by 65 participants who completed the study. The treatments with *chickpeas sweet potato dessert* and *peas avocado salad* resulted in higher smoothness compared to the treatments with *lentils, chicken, and prunes, chickpeas cauliflower soup* and *red beans spaghetti bolognes* (Figure 5.26).

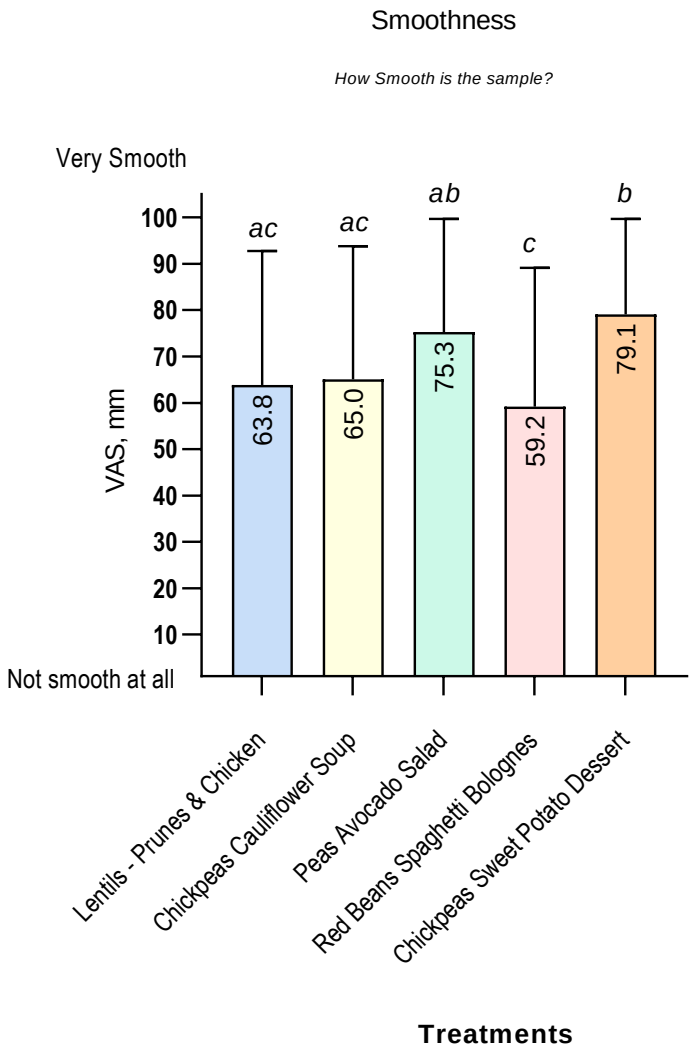


Figure 5.27 Perceived smoothness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

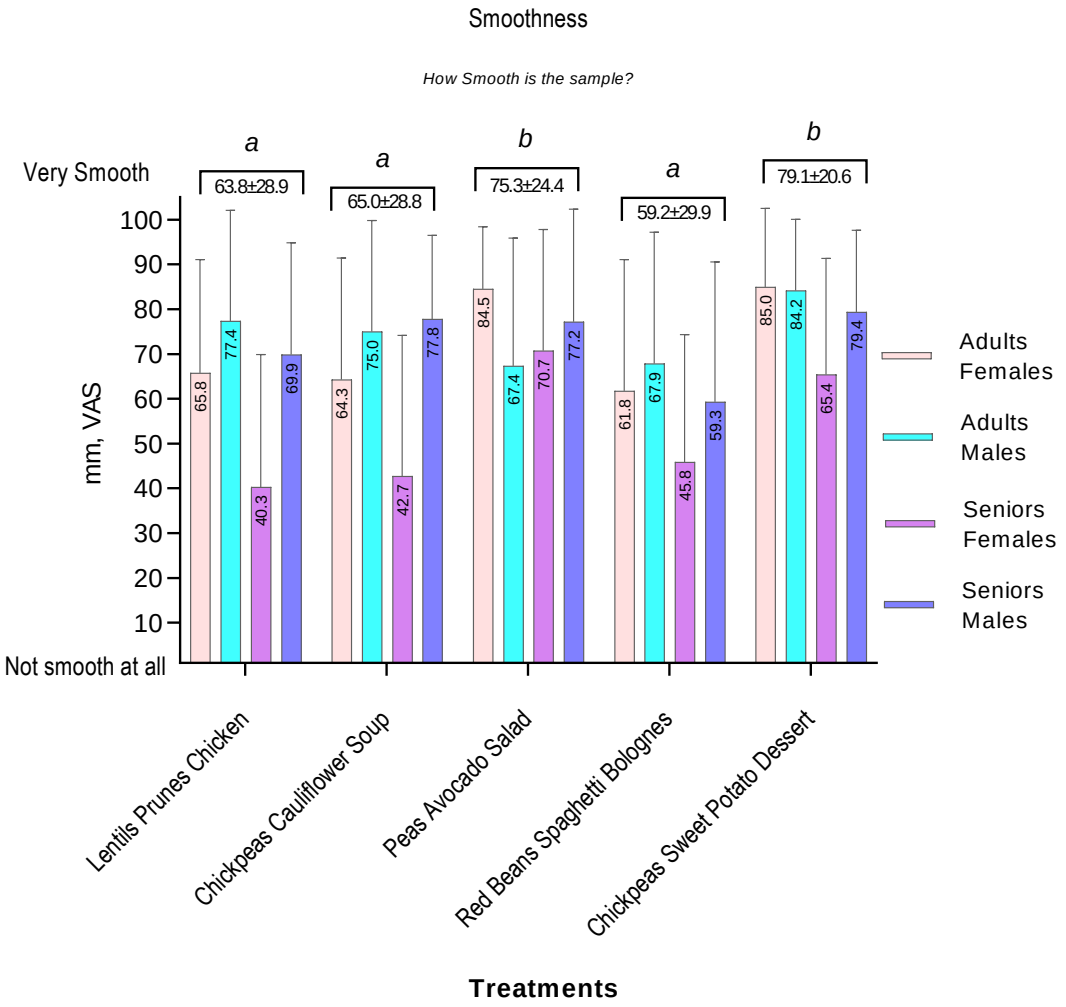


Figure 5.28 Perceived smoothness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Three-way ANOVA with Tukey-Kramer post-hoc test. Treatment (P<0.0001), age (P=0.02), sex (P=0.02), treatment × age (P=0.31), treatment × sex (P=0.01). The difference between the treatments is significant with different superscripts (P≤0.05).

The detected effect of sex (P=0.04) and treatment by sex interaction (P=0.01) for smoothness was driven by a higher perception of smoothness in males than their female counterparts (Figures 5.27 and 5.28). A similar trend was observed for the effect of age (P=0.02), resulting in a higher perception of smoothness in adults compared to senior adults (Figures 5.27 and 5.29).

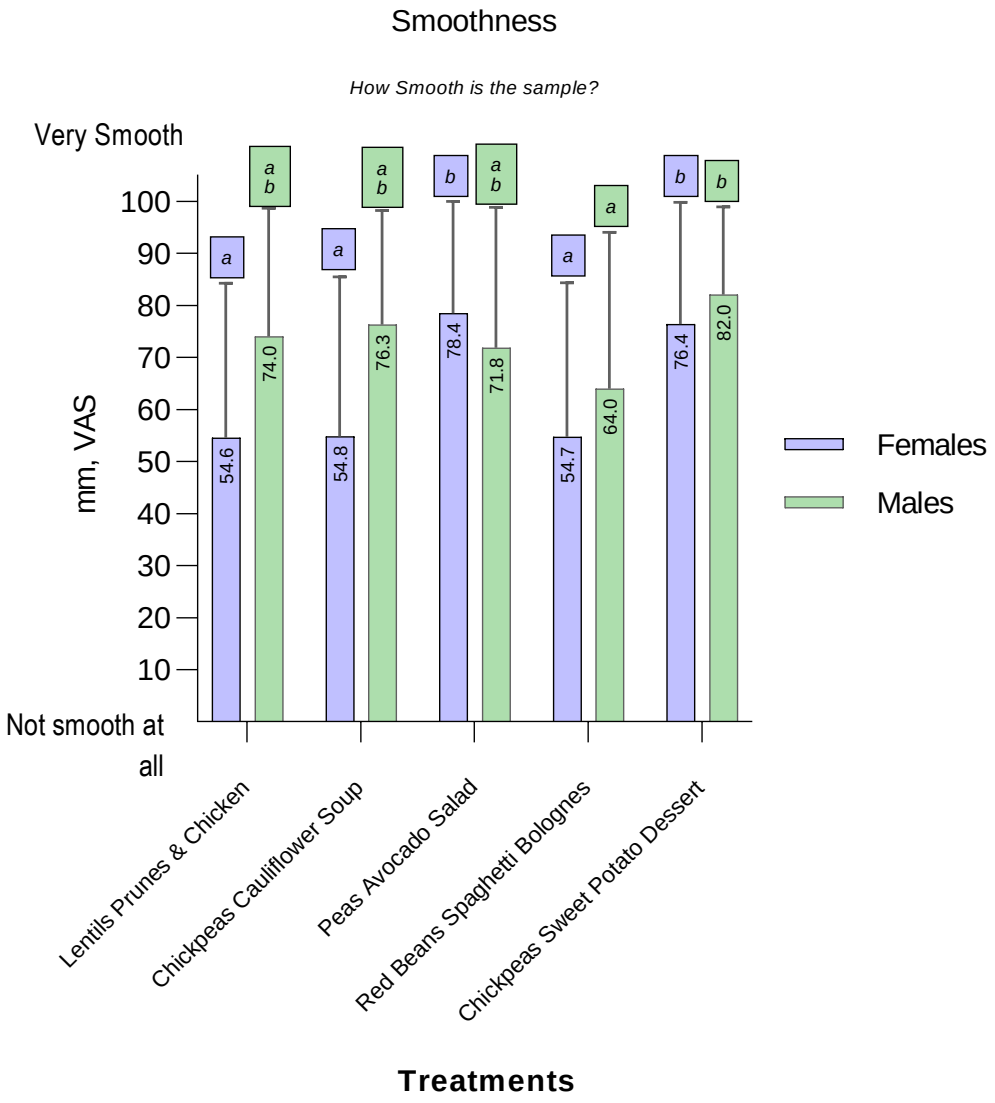


Figure 5.29 Perceived Smoothness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Two-way ANOVA with Tukey-Kramer post-hoc test. Treatment ($P<0.0001$), sex ($P=0.04$), treatment × sex ($P=0.01$). The difference between the treatments is significant with different superscripts ($P<0.05$).

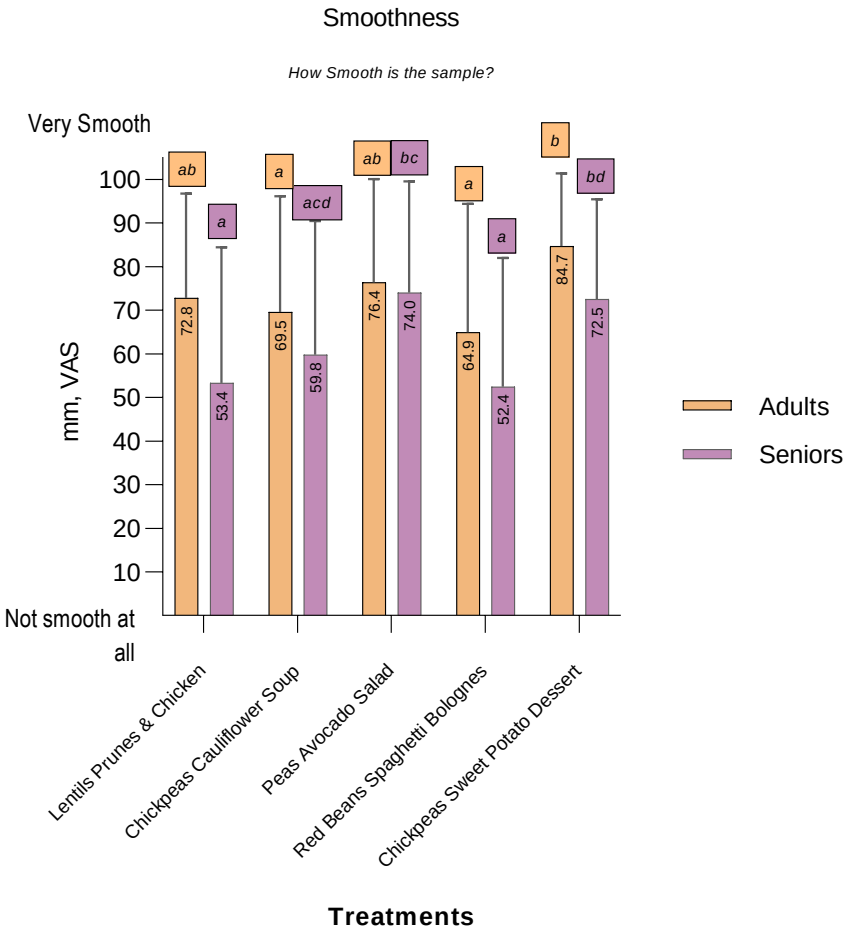


Figure 5.30 Perceived smoothness (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Treatment P<0.0001. Two-way ANOVA Tukey-Kramer. Treatment (P<0.0001), age (P=0.04), treatment × age (P=0.01). Post-hoc Dunn's multiple comparison tests: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Adhesiveness

There was an effect of a treatment on perceived adhesiveness (P<0.002) (Figure 5.30).

The *chickpea sweet potato dessert* scored the highest for adhesiveness, suggesting that it was perceived as the stickiest among all the food samples. On the other hand, the *red beans spaghetti bolognese* received the lowest adhesiveness rating, indicating that it was perceived as the least adhesive among the treatments.

It is essential to emphasize that despite variations in adhesiveness levels, all the treatments received positive perceptions, with ratings of 6 points and above on 9-point hedonic scale. This indicates that the participants generally found the food samples pleasant to consume, even though some were perceived as stickier than others. Such implications and insights into the adhesiveness of the food samples offer valuable information for understanding consumer preferences and sensory experiences related to the studied treatments.

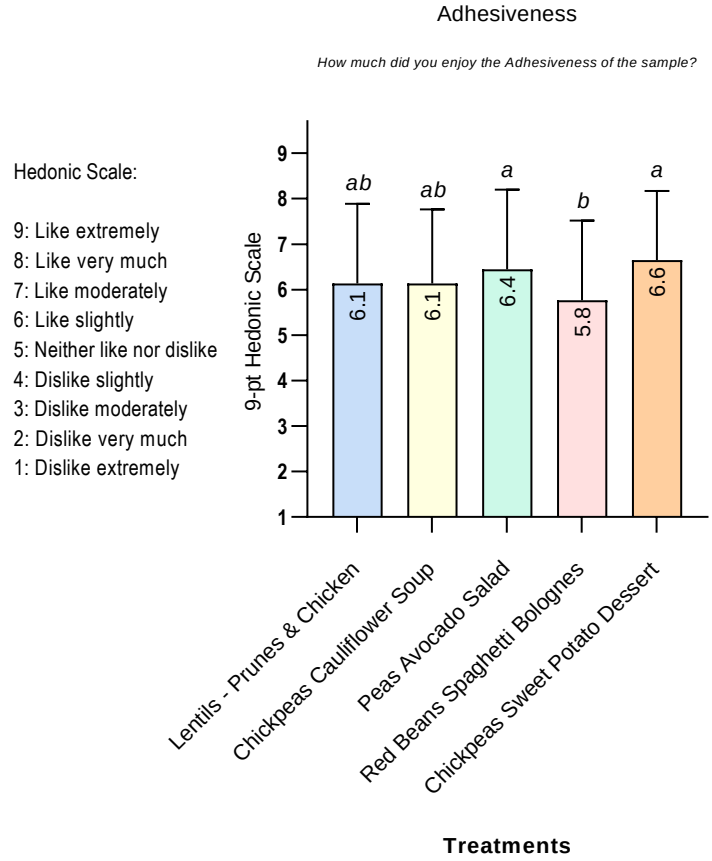


Figure 5.31 Perceived adhesiveness (9-point hedonic scale) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P=0.002. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

Three-way ANOVA detected the effect of age (P=0.05) but not a sex or age by treatment or sex by treatment interactions on perceived adhesiveness (Figure 5.31).

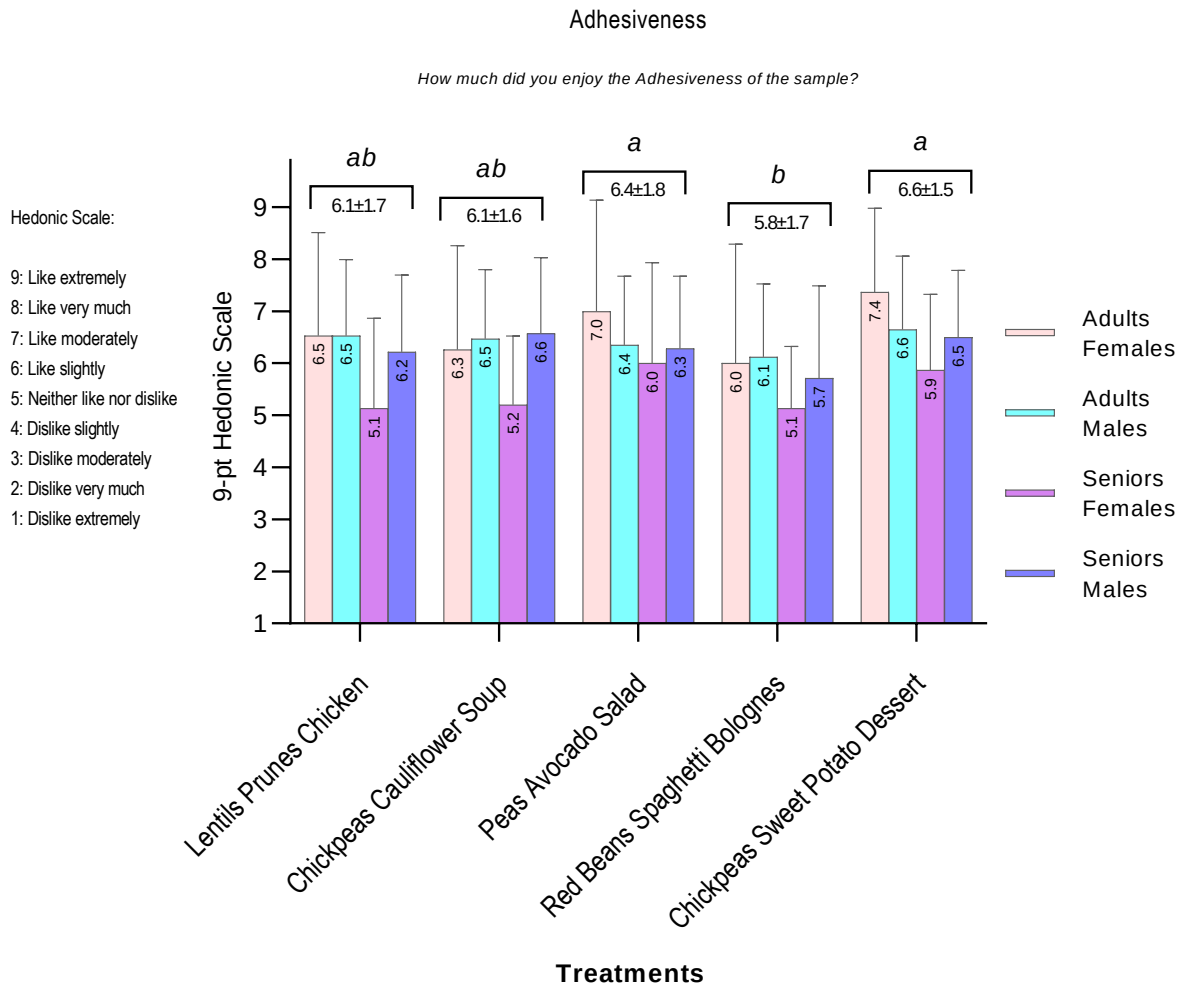


Figure 5.32 Perceived Adhesiveness (9-point hedonic scale) in adults (≥19 y). Values are Mean ± SD; n=65. Three-way ANOVA with Tukey-Kramer post-hoc test. Treatment (P=0.0004), age (P=0.05), sex (P=0.37), treatments × age (P=0.84), treatments × sex (P=0.09). The difference between the treatments is significant with different superscripts (P<0.05).

The analysis with two-way ANOVA revealed that the adults perceived the adhesiveness of the food samples to be higher than seniors did (Figure 5.32). This difference in perceived adhesiveness between the two age groups offers valuable insights into the potential influence of age on the sensory experience of stickiness in the food samples. The higher adhesiveness perception among adults may be indicative of various factors such as differences in taste preferences, oral processing abilities, or overall sensory sensitivity related to adhesiveness.

Understanding these age-related differences in subjective perception can contribute to designing food products that cater to the preferences and needs of specific age demographics. Additionally, it highlights the importance of considering age-related factors when evaluating and developing food items to enhance overall consumer satisfaction.

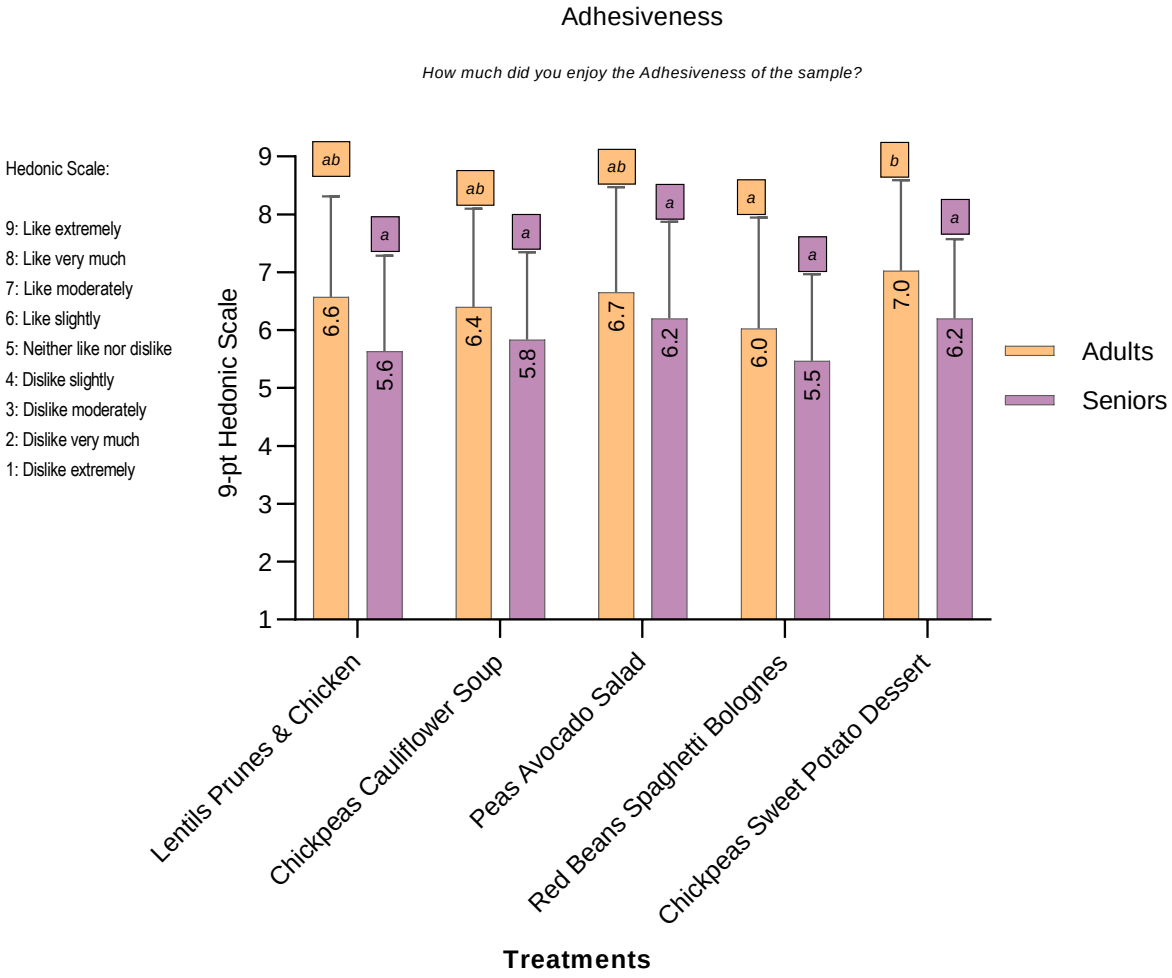


Figure 5.33 Perceived adhesiveness (9-point hedonic scale) in adults (≥19 y). Values are Mean ± SD; n=65. Treatment P<0.0001. Two-way ANOVA with Tukey-Kramer post-hoc test. Treatment (P<0.0001), age (P=0.04), treatment × age (P=0.01). The difference between the values with different superscript letters is statistically significant (P≤0.05).

Prospective purchasing

There was an effect of treatment on the subjective perception of purchasing ($P<0.0001$). Specifically, the treatments with *chickpeas sweet potato dessert* and *peas avocado salad* resulted in a highest prospective purchasing. Participants indicated a greater inclination to consider purchasing these items, suggesting that these recipes were more appealing to potential buyers. On the other hand, the treatments with *lentils, chicken, and prunes*, as well as *chickpeas cauliflower soup*, exhibited a somewhat lower prospective purchasing. Participants were less inclined to consider purchasing these food items, implying that they might not be as attractive to potential buyers. The least favoured recipe was the *red beans spaghetti bolognese* (Figure 5.33). Participants expressed a clear lack of interest in purchasing this particular item, suggesting that it was perceived as the least appealing or desirable option among the studied treatments. Three-way ANOVA detected a trend for the effect of sex on prospective purchasing ($P=0.06$) but not age ($P=0.3$). The comparison of prospective purchasing between males and females using two tailed unequal variance student test showed a higher intention for prospective purchasing for males compared to females ($P=0.02$).

These findings offer valuable insights into how different treatments can influence consumers' purchase perspectives regarding puréed foods. Understanding the factors that contribute to positive or negative purchase perceptions can help in product development and marketing strategies, enabling food manufacturers to better provide to consumer preferences and enhance the overall appeal of puréed products in the market.

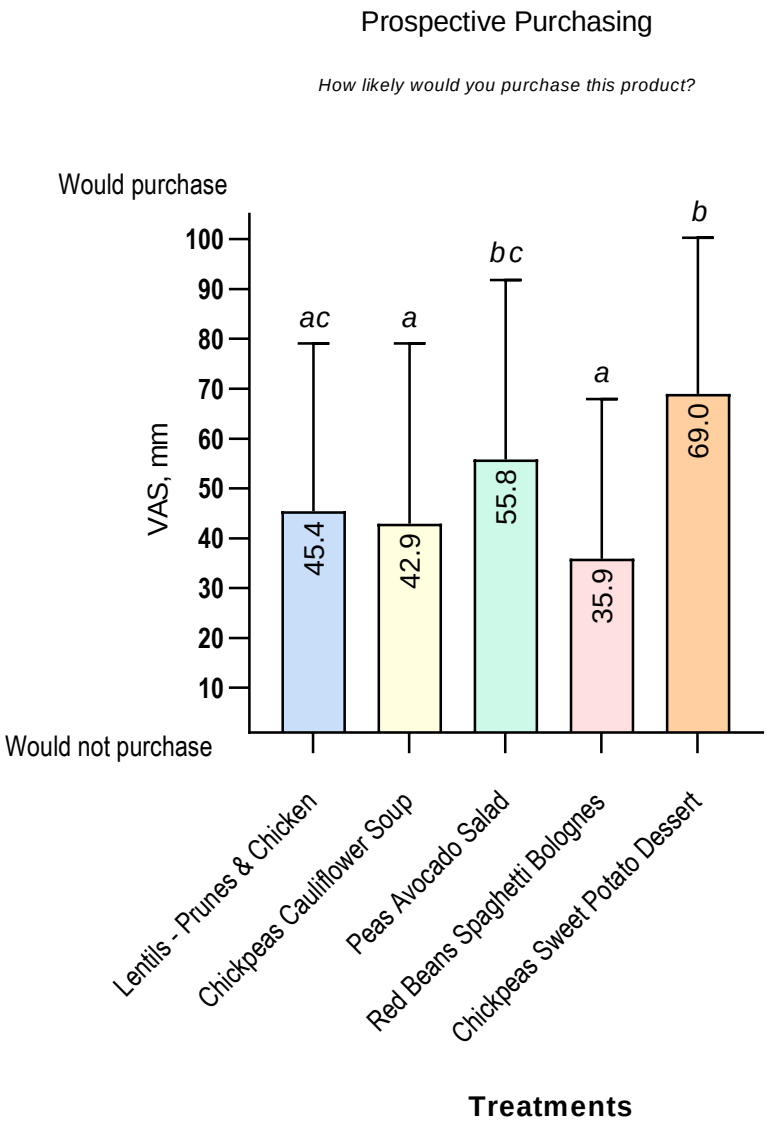


Figure 5.34 Perceived prospecting purchasing (VAS) in adults (≥19 y).
Values are Mean ± SD; n=65. Friedman test. Treatment: P<0.0001. Post-hoc Dunn's multiple comparison test: The difference between the values with different superscript letters is statistically significant (P≤0.05).

pH Assessment

Table 5.14 shows the values for the pH measurements of the samples. Most of the samples have an acidic pH, however the chickpeas sweet potato dessert sample (topping) resulted in a lowest pH value of 4.67.

Table 5.10. pH analysis of food samples

SAMPLE		WEIGHT (g)	pH	
			DAY 1	DAY 2
Lentils, chicken & prunes		36.5	5.56±0.04	5.66±0.04
Chickpeas cauliflower soup		36.5	6.10±0.01	6.10±0.01
Peas avocado salad		36.5	5.36±0.00	5.36±0.00
Red beans spaghetti	Mixed	36.5	5.79±0.13	6.13±0.05
	Spaghetti	36.5	6.53±0.00	6.54±0.00
	Bolognese	36.5	5.63±0.01	5.64±0.01
Chickpeas sweet potato dessert (mixed)	Mixed	36.5	5.78±0.08	6.27±0.07
	Cake	36.5	6.72±0.01	6.72±0.01
	Sweet potato	36.5	4.67±0.01	4.67±0.01

Values are mean ± SD.

Particle size

The results for particle size analysis are shown in Table 5.15. The volume/surface area mean particle size diameter for the *lentils, chicken and prunes* samples is d_{vs}= 566.730 micron (Figure 5.96), for the *chickpeas cauliflower soup* is d_{vs}= 1290.178 micron (Figure 5.97), for the *peas avocado salad* is d_{vs}=534.691 micron (Figure 5.98), for the *red beans spaghetti bolgnes*; spaghetti d_{vs}=487.325 micron (Figure 5.99); red beans d_{vs}=878.202 micron (Figure 5.100), for the *chickpeas sweet potato - sweet potato topping* d_{vs}=867.902 micron (Figure 5.101) and for the *cake* d_{vs}=1212.804 micron (Figure 5.102).

Table 5.11 Particle size distribution

Sample		Range		d_{vs}
Lentils, chicken, and prunes		0.011	1000.000	566.73
Chickpeas cauliflower soup		0.034	3000.000	1290.178
Peas, avocado salad		0.011	1000.000	534.691
Red beans spaghetti	Pasta	0.011	3000.000	487.325
	Bolognes	0.011	3000.000	878.202
Chickpeas sweet potato dessert	Cake	0.011	3000.000	867.902
	Topping	0.011	3000.000	1212.804

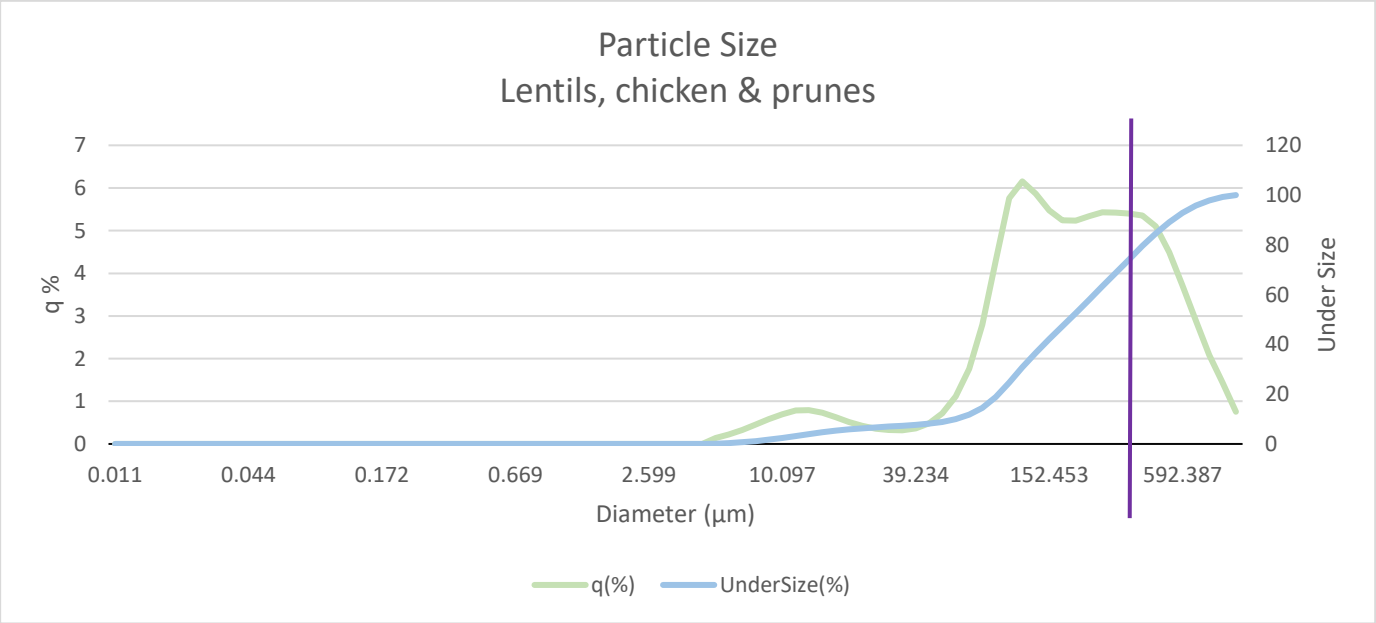


Figure 5.35 Particle size distribution for *lentils, chicken, and prunes* recipe
The values are in the range of 0.011-1000.000. Dvs=566.73

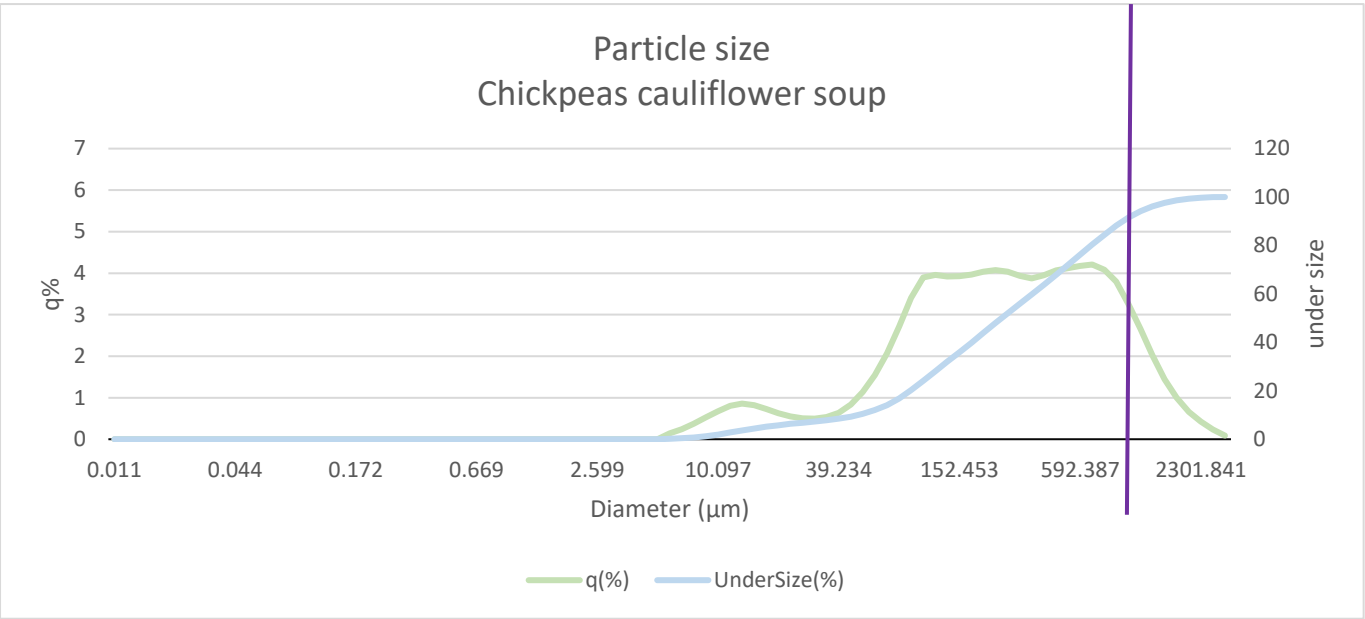


Figure 5.36 Particle size distribution for *chickpeas cauliflower soup* recipe
The values are in the range of 0.034-3000.000. Dvs=1290.178

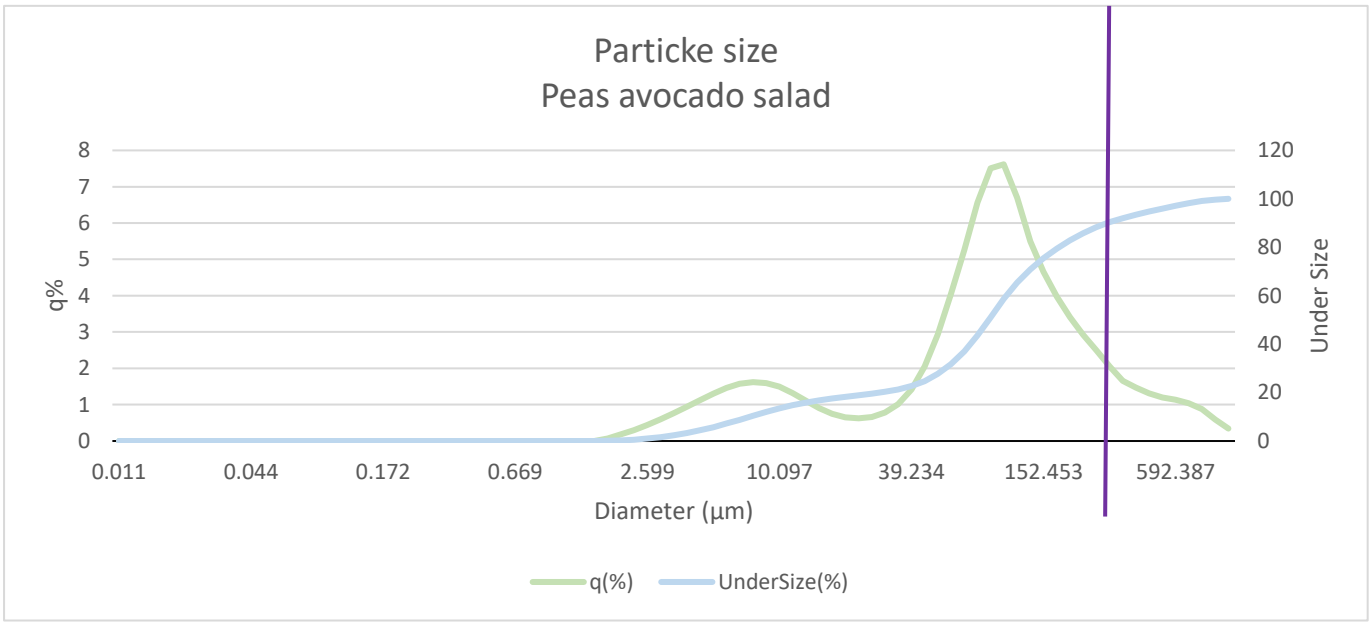


Figure 5.37 Particle size distribution for *peas avocado salad* recipe
The values are in the range of 0.011-1000.000. Dvs = 534.691

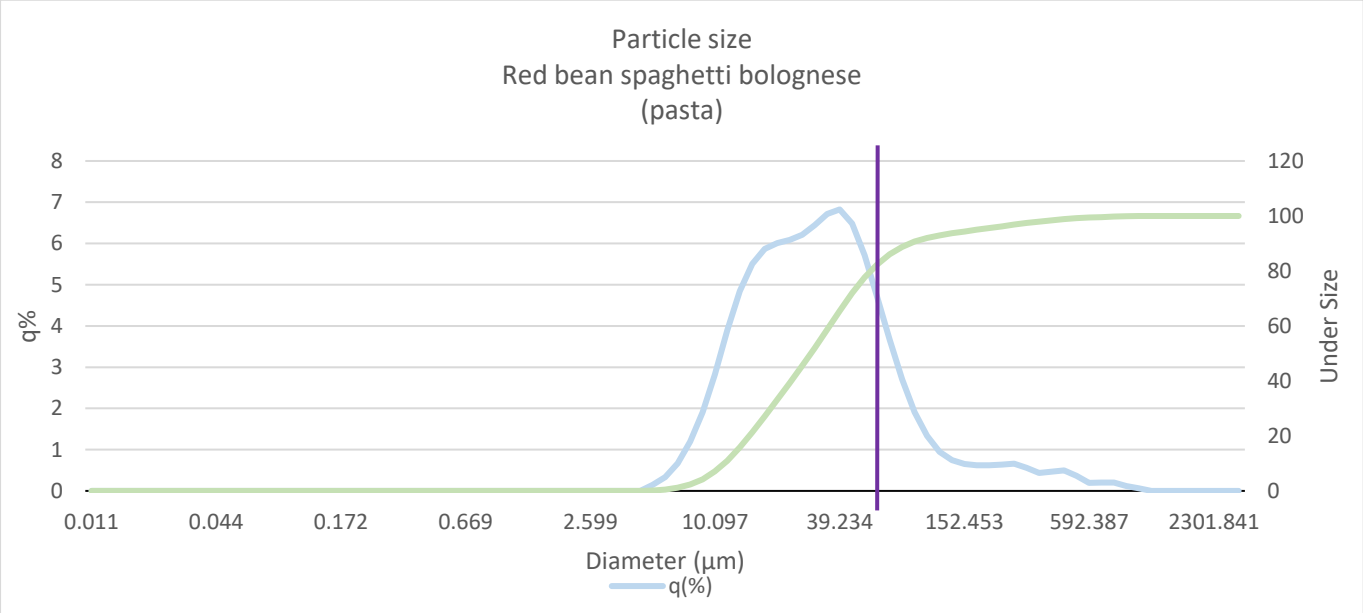


Figure 5.38 Particle size distribution for pasta in *red beans spaghetti bolognes*
The values are in the range of 0.011-3000.000. Dvs = 487.325

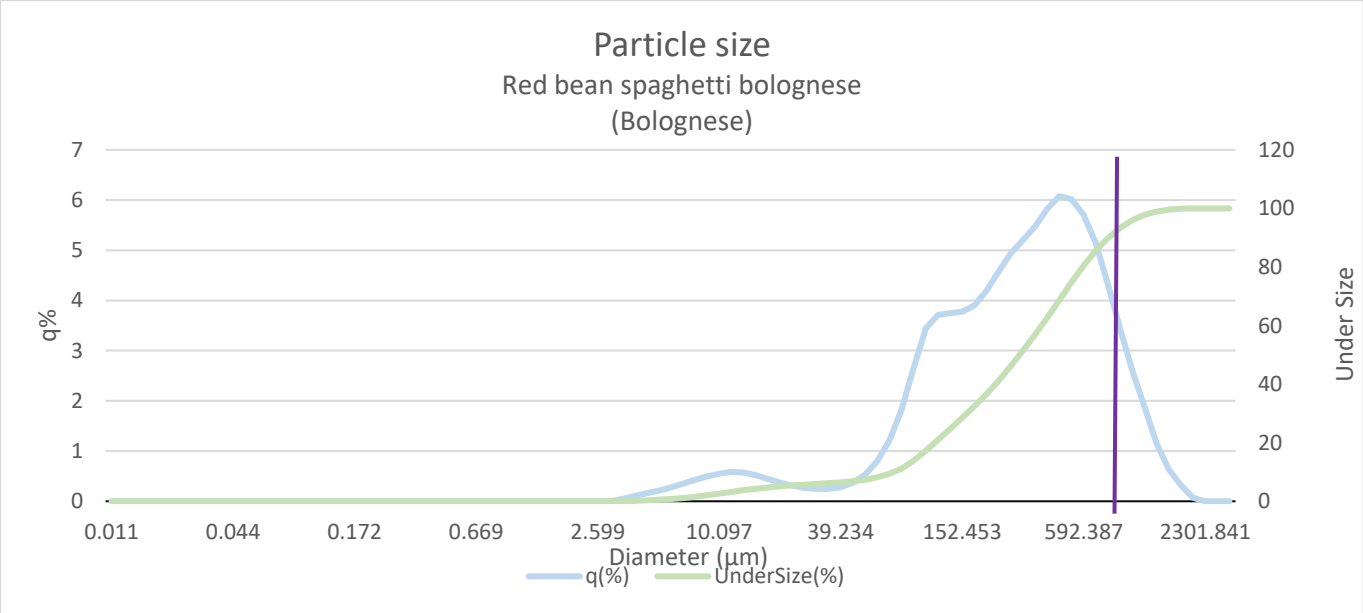


Figure 5.39 Particle size distribution for bolognes in *red bean spaghetti* recipe
The values are in the range of 0.011-3000.000. Dvs = 878.202

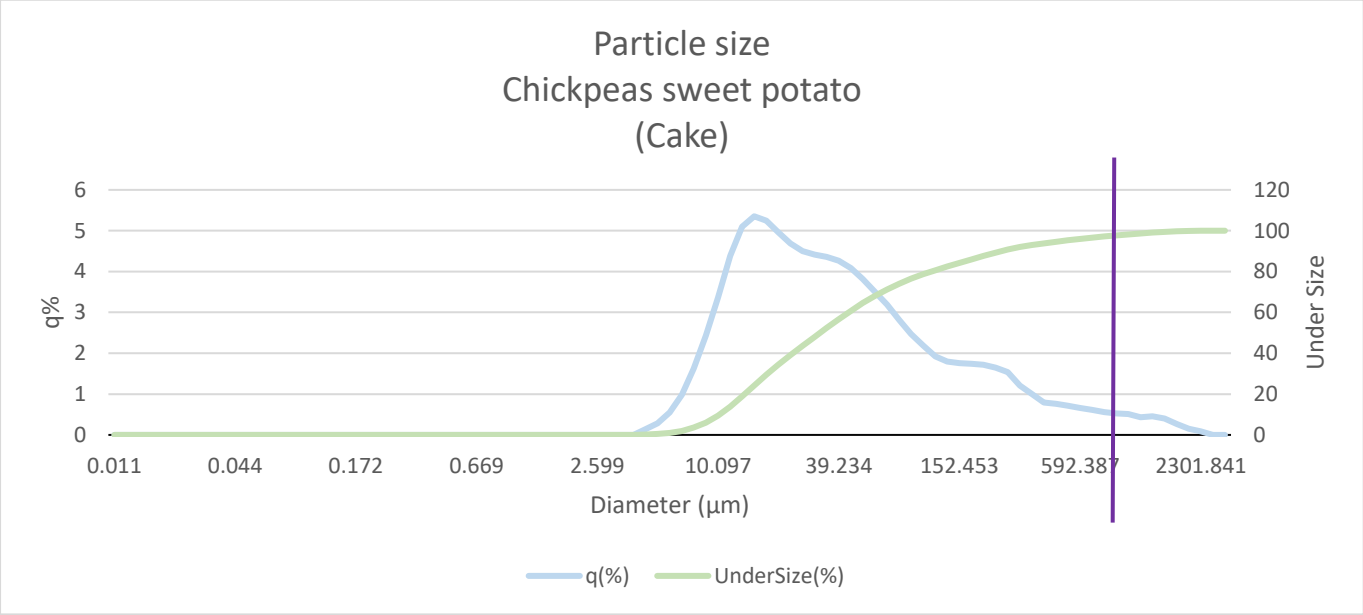


Figure 5.40 Particle size distribution *chickpeas sweet potato dessert* recipe
The values are in the range of 0.011-3000.000. Dvs = 867.902

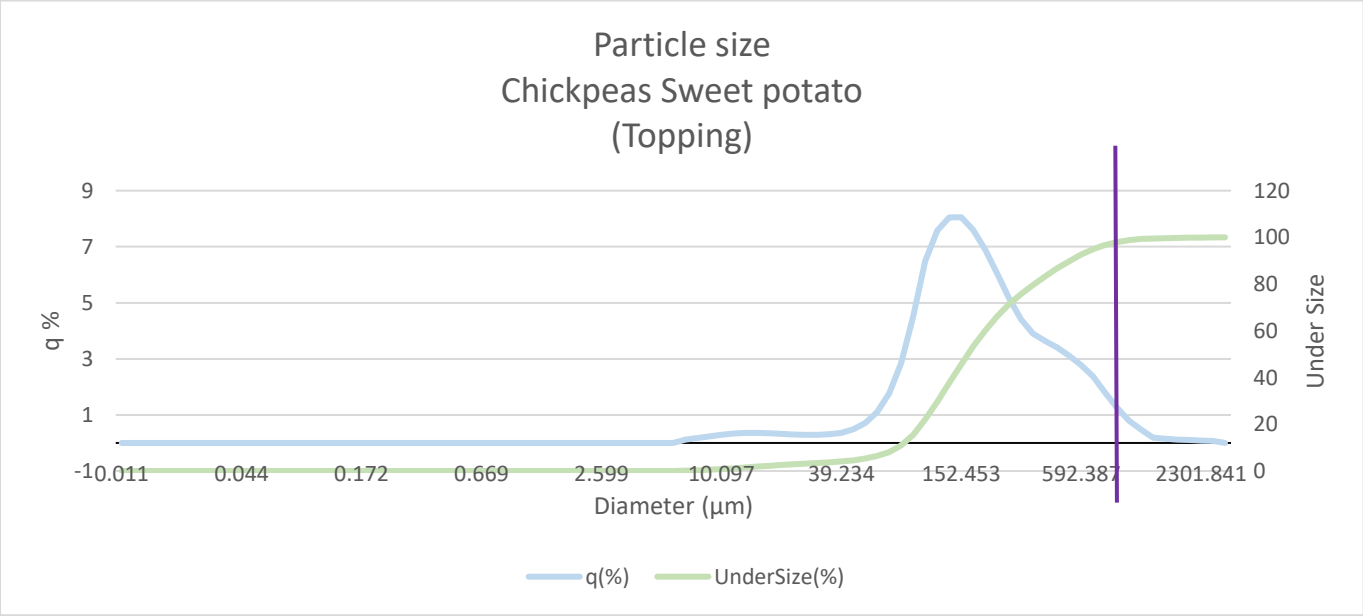


Figure 5.41 Particle size distribution *chickpeas sweet potato dessert* recipe
The values are in the range of 0.011-3000.000. Dvs = 1212.804

Nutrient profile analysis

The data for nutrient analysis is shown in Table 5.16.

Table 5.12 Nutrient profile analysis

Sample	Serving Size (g)	Energy kcal	Carb (g)	%DV	Protein (g)	%DV	PDCAAS	%DV*	Fat (g)	%DV	Fibre (g)	%DV
Lentils, prunes	250	400	48	17%	18	36%	0.86	30%	15	20%	8	29%
Chickpeas cauliflower	250	360	41	15%	14	28%	0.81	23%	16	21%	8	29%
Peas avocado	250	300	18	7%	9	18%	0.78	14%	23	31%	9	32%
Red beans spaghetti	250	420	48	17%	23	46%	0.85	39%	15	20%	12	43%
Chickpeas sweet potato	250	380	68	25%	15	30%	0.88	24%	7	9%	8	29%

* Corrected %DV for protein after PDCAAS.

IDDSI assessment

The result of the IDDSI assessment showed that the samples fall into the Puréed Level 4 (Figure 5.1) category. Figures 6.1 to 6.5 shows the assessment of puréed samples using the Spoon Tilt Test. All the samples are safe for swallowing (holds shape on spoon; not firm and sticky; little food left on spoon). To be suitable for a IDDSI Level 4, the sample needed to have specific characteristics to be considered a safe texture for people with swallowing disorders. These characteristics includes to hold shape on spoon, not firm, no sticky, little food left on spoon.

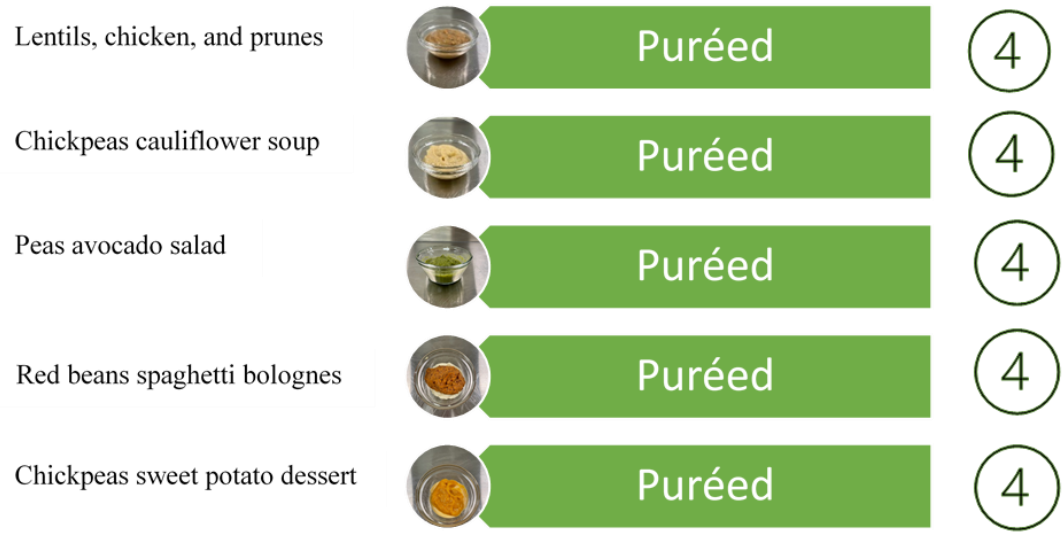


Figure 5.42 IDDSI assessment of the recipes.

Spoon Test Tilt results

Figure 5.43 Spoon Tilt Test IDSSI Level 4. *Lentils, chicken and prunes* recipe.
SAFE: Holds shape on spoon; not firm and sticky; little food left on spoon.

Figure 5.44 Spoon Tilt Test IDSSI Level 4. *Chickpea cauliflower soup* recipe.
SAFE: Holds shape on spoon; not firm and sticky; little food left on spoon.

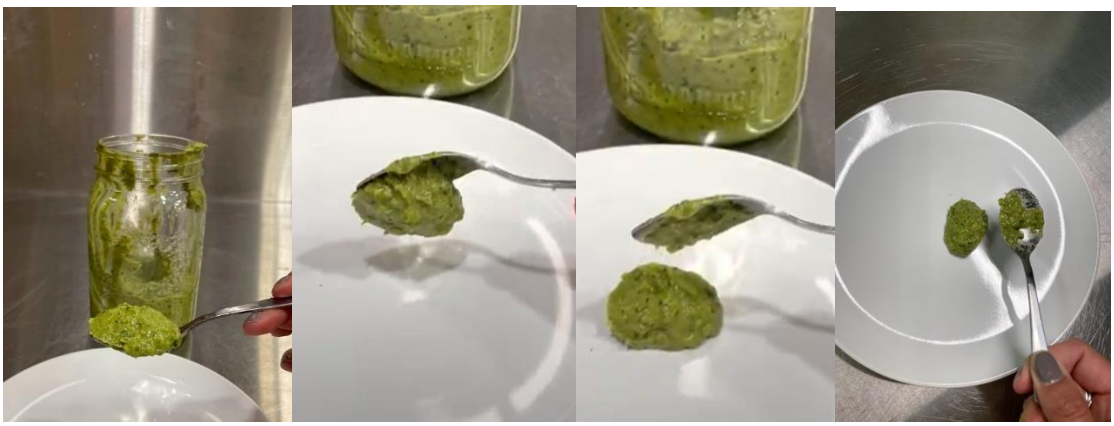


Figure 5.45 Spoon Tilt Test IDSSI Level 4. *Peas avocado salad* recipe.
SAFE: Holds shape on spoon; not firm and sticky; little food left on spoon.

Spoon Test Tilt results (continued)

Figure 5.46 Spoon Tilt Test IDSSI Level 4. *Red beans spag*hetti bolognes recipe. SAFE: Holds shape on spoon; not firm and sticky; little food left on spoon.

Spoon Test Tilt results (continued)

Figure 5.47 Spoon Tilt Test IDSSI Level 4. *Chickpeas sweet potato dessert* recipe
SAFE: Holds shape on spoon; not firm and sticky; little food left on spoon.

6. Discussion

The present study contributes to the area of food development, nutrition, and sensory evaluation, introducing innovative puréed formulations designed for consumers with swallowing disorders. Existing options on the market lacking the puréed products formulated with pulses as their base for formulations, prompting the need for new solutions. In contrast to previous research on food perception, which has focused on a limited set of characteristics (Garcia & Chambers, 2010), we considered a wide variety of ingredients. The common rejection of puréed foods, mainly due to the lack of flavour, colour and appearance is one of the biggest challenges that needs to be taken care of (Ettinger et al., 2014).

This research also aimed to bridge this gap by presenting five distinct recipes that align with a regular solid diet, involving a diverse range of courses, including soup, main course, salad, and dessert. Remarkably, these purees also meet the labelling requirements given by the Canadian Food Inspection Agency (2019), which positions them as viable meal replacement alternatives.

Swallowing disorders, or dysphagia, affect a significant portion of the population, impeding their ability to consume regular solid diets. The limited availability of suitable food products that accommodate pulses as their base has led to a considerable challenge for individuals with such conditions. Consequently, there appears to be an urgent need for the development of innovative puréed formulations that can provide specific requirements.

To address the need for viable puréed food options for individuals with swallowing disorders, an extensive research and development process was undertaken. The development of puréed recipes that potentially may be used as meals in different settings. Five distinct recipes were selected to provide a comprehensive spectrum of tastes and textures, ensuring a holistic eating experience.

The guidelines set by the Institute of Food Technologists (IFT, 1981), establishes that the sample size considered for a sensory study needs between 50-100 participants, which made possible a interaction of sex and age on sensory evaluation. To meet these guidelines, we conducted a study with a sample size of 65 participants, including 34 females and 31 males.

The creation of purées was based on the goal to make them visually appealing and delicious. To infuse these purée creations with captivating flavours and textures, we employed a diverse range of animal and plant-based ingredients, cleverly combining them to provide enjoyable tastes, essential nutrients, and a healthy dose of energy in each carefully crafted purée.

The five chosen recipes embrace a wide variety of meals:

Soup: Rich and creamy, the puréed soup offers a comforting blend of flavours, including wholesome vegetables and spices. The puréed consistency guarantees ease of consumption while maintaining the nutritional integrity of the ingredients.

Main Course: The main course purée embodies the essence of a hearty, well-balanced meal, combining proteins, carbohydrates, and essential nutrients. The meticulous preparation ensures that the puréed form retains the delightful taste of the original dish. However, even when these factors could be integrated the appearance of this recipe did not have a positive result.

Salad: Contrary to common perception, a puréed salad offers a refreshing burst of textures and flavours. By incorporating an assortment of fresh produce, the salad puree provides a nutritious and delectable alternative to traditional salads. When assessing the appearance of this recipe the results showed a positive reaction of the participants, possibly by the bright green colour that this recipe provides. Based on the research findings, it appears that the colours of food have an influence on individuals' eating behaviour, particularly when they tend to consume smaller portions.

Aligning with previous research by Konig et al., (2021), which suggests that colour is often taken for granted, colour needs more studies to create more appealing foods using colour as an attribute as a tool.

Dessert: The dessert purée promises a delightful treat for those with a sweet preference. While achieving a smooth consistency, it does not compromise on taste or visual appeal, delivering a satisfying and nutritious meal.

Is important to mention that these purées also have a potential of being a meal replacement. Beyond serving as a specialized diet for individuals with swallowing disorders, these puréed formulations possess the attributes necessary to be considered as meal replacement options. Meeting the labelling requirements established by the Canadian Food Inspection Agency it may ensure their validity as nutritious and balanced meals, fully capable of use as meal replacements.

Results also have shown that despite a similar perception of some sensory attributes, the relevance of specific attributes such as smoothness and adhesiveness was not the same for adults and seniors. The effect the age was other finding of the study that is worth mentioning. Because of anatomical changes in all the senses involved in human food perception, seniors perceive a lower flavour intensity than adults (Doets & Kremer, 2016). Literature shows that seniors are less sensitive to changes in the flavour profile of foods and show a decreased ability

to discriminate between different intensity levels of flavour and/or taste attributes (Raats, 2016). However, despite these differences in their sensory perception of foods, adults and seniors seem to differ less in their perception of saltiness and sweetness appraisal of food products. Seniors perceived saltiness and sweetness different from adults.

The particle size of food plays a crucial role in chewing and swallowing of foods as well as in the digestibility and bioavailability of nutrients released from the food. The average particle size of chewed solids foods for adults before swallowing is 2-4mm (Jalabert-Malbos et al., 2007). However, particle size recommendation for fine purees is to have a range between 0.5 mm to 1 mm in size (IDDSI - IDDSI Framework, n.d.), this makes them have a suitable texture for individuals with dysphagia or for people who requires a completely smooth texture for fine purees. For regular purees which can slightly have a larger particle size, the ranging is from 1 to 2mm in size to still be considered as a suitable texture for individuals with swallowing difficulties or those transitioning to a regular diet after dysphagia improvement (IDDSI - IDDSI Framework, n.d.). It is important to note that these ranges are approximate and can vary depending on the individual and diet requirements. The average particle size of the recipes developed and tested in this study are in the recommend range of the IDSSI framework guidelines: 566 – 1290 microns that is in line with the recommended particle size of puréed food between 1 mm to 2 mm. Therefore, the recipes evaluated in the present work have a suitable texture for individuals with swallowing difficulties or those transitioning to a regular diet after dysphagia improvement as set by the IDDSI Framework. The other important aspects related to food particle size are their effects on sensory attributes. Thus, the palatability, taste perception and sensory appeal in a puréed food with a consistent, fine particle size are more visually appealing and may be better accepted by consumers, including those who are averse to certain textures. The other research confirms that the particle size of puréed food plays a crucial role in determining its sensory attributes, such as texture, smoothness and swallowness (Mihnea et al., 2022). Smaller particle sizes generally lead to smoother textures, easier swallowing, and improved palatability, making them more suitable for individuals with swallowing difficulties or sensory challenges. Proper consideration and adjustment of particle size can contribute to the overall enjoyment and safety of puréed foods for a wide range of consumers. Therefore, optimizing particle size in food processing can lead to improved digestibility and increased bioavailability of nutrients and bioactive compounds, supporting overall nutrition and health. However, the specific impact of particle size on digestibility and bioavailability can vary depending on the food matrix and individual physiological factors

(Espinosa et al.,2011). Therefore, it's essential to consider the specific context when designing food products to maximize their nutritional benefits.

This study did a pilot evaluation of the recipes with children. This study reveals that despite adults did not like the *red beans spaghetti bolognes*, children liked it. The preference of children for *spaghetti bolognese purée* compared to adults can be attributed to several factors. Firstly, children often have distinct taste preferences, favouring milder and sweeter flavours that the dish offers (Liem & Mennella, 2002). Additionally, the familiarity of the classic pasta and tomato sauce combination, often served to children, creates a positive association with the puréed version. The soft and smooth texture of the purée aligns with children's preference for a gentler mouthfeel. Furthermore, convenience and ease of eating play a role, making puréed foods more manageable for children developing their motor skills (Harris, 2008). Conversely, some adults may have textural sensitivities to puréed foods, impacting their preference for this version. Overall, individual tastes and preferences play a significant role in determining the appeal of *spaghetti bolognese purée* to different age groups. Ultimately, the purees achieved a Level 4 consistency according to the IDDSI spoon test. Finally, the purées resulted in Level 4 Puree for the IDDSI spoon test, indicating that these purées may be a safe option for individuals that struggle with swallowing.

The nutritional analysis of purées made with pulses has granted outstanding findings, with each recipe containing more than 15 g of protein and over 8 g of fibre. This nutrient-dense profile holds significant implications for individuals with dysphagia. Protein is an essential nutrient that plays a vital role in maintaining and repairing body tissues, supporting muscle function, and bolstering the immune system (Butt & Lam, 2005). For dysphagia individuals, who often struggle to consume adequate amounts of food due to swallowing difficulties, puréed meals with high protein content offer an efficient and convenient way to meet their nutritional needs (College of Dietitians of Ontario, 2019). Moreover, the substantial fibre content in these purees provides benefits for digestive health and regular bowel movements, which can be particularly crucial for individuals with dysphagia, who may be at a higher risk of gastrointestinal issues. The combination of sufficient protein and fibre in these purées not only supports overall nutrition but also may enhance satiety, promoting a sense of fullness and satisfaction after meals. As a result, the individuals dysphagia can experience improved nutrition, reduced risk of malnutrition, and enhanced overall well-being by incorporating these nutrient-rich pulse-based purees into their diets.

To finalize, this study contributes for the advance of food development for consumers with swallowing disorders. The new puréed formulations developed in this thesis project offer

a diverse range of meals, covering essential courses, including soup, main dish, salad, and dessert. Moreover, their compliance with the labelling standards set by the Canadian Food Inspection Agency position them as viable meal replacements.

Strengths and limitations

The study developed tasty recipes using pulses as a base for the formulation leading to a puréed products with a rich nutritional profile and a potential to be marketed as meal replacement. The assessment of the recipes using IDDSI tests ensure the safety of these recipes for dysphagia patients and their general applicability to be used in different facilities, including LTC. The sensory evaluation of the samples allowed to have preliminary results on different characteristics, including appearance, taste, smoothness, and texture. The sensory evaluation identified the areas for potential improvement of the recipes. Thus, the future work on the appearance by changing the colours may result in better acceptance of some of the recipes. The nutritional analysis of the samples allowed us to measure protein content and quality; however, the future work can be focused on further improvement of PDCAAS scores of the recipes using some other sources of protein.

One of the study limitations is a sample size. A larger panel is needed to have more reliable data allowing us to have a better understanding of the differences in the perception of certain sensory attributes by consumers from different age and gender groups. Another limitation is the use of healthy people for the evaluation of the sensory attributes of the purées. Healthy individuals cannot be used as a surrogate population for the acceptance sensory testing of puréed food by replacing a dysphagic population. Although the sensory vocabulary was explained to the participants, another limitation of this study is the comprehension of the sensory terminology.

Recommendations for future research

There are many types and varieties of pulses; formulating recipes using more than one type of pulses in a recipe also can help to enhance the protein level as well as the sensory profile. During the study, some participants showed facial expressions before and after testing the purée. A slight rejection of the sample was observed, probably due to its appearance, however their expression changed completely when they tasted the sample, accepting it and having a better attitude for eating the purée. Therefore, a study that can investigate the liking of the purée with their facial expression while viewing the sample before tasting would provide insightful and valuable information for food product development. Training the panel before

the testing sessions can lead to a better performance of the participants, avoiding confusion of terms but getting more accurate responses. Additionally, a pause after a period can be incorporated to the protocol to prevent sensory fatigue. Considering the positive results obtained with children, expanding the sample size within this demographic would be very important. Future research could also focus on developing optimal purée options tailored specifically for children with swallowing disorders. Finally, a deeper analysis of the protein quality scores is needed to compare and understand the added value of pulse proteins and other sources of protein in the formulations of puréed food.

7. Conclusion

The development of the food recipes using blended pulses, in combination with other plant and animal ingredients, resulted in puréed products with acceptable sensory characteristics as evaluated by adult, senior adult and children participants. The texture assessment and particle size analysis demonstrated that the developed recipes meet the criteria set by the International Dysphagia Diet Standardisation Initiative for purées. Future work is needed to reformulate the recipes to meet the regulations set for canned foods, and further improve the protein quality.

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9. Appendix

Appendix 1. Study Poster

Appendix 2. Ethics Approval

University Research Ethics Board (UREB)

Certificate of Research Ethics Clearance

☒ Clearance	☐ Secondary Data Clearance	☐ Renewal	☐ Modification	☒ Change to Study Personnel

Effective Date	December 19, 2022	Expiry Date	December 18, 2023

File #:	2022-097
Title of project:	The development and sensory evaluation of pureed foods
Researcher(s):	Bohdan Luhovyy
Supervisor (if applicable):	n/a
Co-Investigators:	Priya Kathirvel
Version :	1

COVID-19 - Researchers are reminded that they and their research team must abide by all **Public Health** directives and **MSVU** requirements (Resumption of Human Research (msvu.ca)) regarding in-person contact with participants. In-person research requires additional clearance and may not proceed until the second level clearance is obtained.

The University Research Ethics Board (UREB) has reviewed the above-named research proposal and confirms that it respects the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* and Mount Saint Vincent University's policies, procedures and guidelines regarding the ethics of research involving human participants. This certificate of research ethics clearance is valid for a period of one year from the date of issue.

Researchers are reminded of the following requirements:	
Modification to Protocol	Any changes to approved protocol must be reviewed and approved by the UREB prior to their implementation. Form: REB.FORM.002 Info: REB.SOP.404 Policy: REB.POL.003
Changes to Research Personnel	Any changes to approved persons with access to research data must be reported to the UREB immediately. Form: REB.FORM.002 Info: REB.SOP.404 Policy: REB.POL.003
Annual Renewal	Annual renewals are contingent upon an annual report submitted to the UREB prior to the expiry date as listed above. You may renew up to four times, at which point the file must be closed and a new application submitted for review. Form: REB.FORM.003 Info: REB.SOP.405 Policy: REB.POL.003
Final Report	A final report is due on or before the expiry date. Form: REB.FORM.004 Info: REB.SOP.406 Policy: REB.POL.003
Privacy Breach	Researchers must inform the UREB immediately and submit the Privacy Breach form. The breach will be investigated by the REB and the FOIPOP Officer. Form: REB.FORM.015
Unanticipated Research Event	Researchers must inform the UREB immediately and submit a report to the UREB within seven (7) working days of the event. Form: REB.FORM.008 Info: REB.SOP.404 Policy: REB.POL.003
Adverse Research Event	Researchers must inform the UREB immediately and submit a report to the UREB within two (2) working days of the event. Form: REB.FORM.007 Info: REB.SOP.404 Policy: REB.POL.003

*For more information: http://www.msvu.ca/ethics

XXXXXXXXX

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