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Development of Fingerfood recipes for meals for home usage among older people with eating disabilities

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Title

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Abstract (maximum 250 words)

Background: In the context of demographic changes and age-related diseases, there is a need to focus on the health of older people. Eating disabilities, such as difficulties to use cutlery, caused by various diseases (Parkinson's disease, consequences of a stroke) are becoming more frequent and solutions must be put in place. ***Objective:*** The purpose of this study is to create recipes of Fingerfoods for older adults over 65 years old with eating disabilities. These recipes should be prepared at home and rich in protein and energy. ***Design:*** A creative design was used to create products, and several variations were created from a basic recipe. The differences between the variations of a recipe are the ingredients that can be substituted or changed in quantity. ***Materials and Methods:*** Concerning the physical analysis, texture measurements, viscosity, and colorimetry were performed. The sensory evaluation was a hedonic test to measure the appreciation of the panel according to several criteria: appearance, smell, taste, texture, and overall appreciation. ***Results:*** The samples, according to the type of product, were measured for their hardness, their adhesiveness, their viscosity, and their colour. Results also show the appreciation of each sample, the comparisons of the appreciations, the ideas for improvement of the participants, and correlations between different data sets. ***Discussion:*** Results have been analysed and used to select the suitable recipes at each phase of the study. The milkshake was preferred when vanilla whey protein was added. The cheese balls were preferred with more chicken and less cheese. Soy flour was appreciated equally or more than wheat flour in the fish cakes and the salty muffins while chickpea flour was the least liked. In the set of recipes proposed for sensory evaluation, the most protein-rich ones were the most appreciated. ***Conclusion:*** In the end, four recipes have been selected based on the physical analysis, the sensory evaluation, and the nutritional content. The expected amount of protein was achieved for all products.

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Keywords

Older people, eating disabilities, Fingerfood recipe, protein and energy enrichment, homemade, appreciation test.

Content

Foreword

This project is part of Ms Sarah Forsberg's PhD subject. Her work focuses on the concept of Fingerfood for older people with eating disabilities and the social issues of this population concerning the meal. This study will contribute to the PhD subject by creating recipes of Fingerfoods for older adults over 65 years of age with eating disabilities. These recipes should be adapted to the meals, homemade, and rich in protein and energy. At the end of this project, recipes will be put together in a recipe book that will be available for the target consumers.

Introduction

Life expectancy for both men and women is increasing in European countries (Cambois and Robine, 2017). Moreover, in 2018, citizens over 65 years of age represented 20% of the European population and this figure is expected to rise to 31% by 2100 (Eurostat, 2019). More precisely, 20% of the Swedish population is currently over 65 years old ("Elderly care in Sweden", 2020). Given this major demographic change, caring for the health of the older people is now a major issue. It is necessary to offer this population a diet adapted to their needs and preferences, considering the problems associated with the age.

An important parameter to consider is the specific nutritional needs of the older adults. The specific nutrition of this population is due to age-related diseases such as sarcopenia. Sarcopenia is a disease corresponding to a loss of both muscle mass and function. Age, chronic disease, inactivity, loss of mobility, and malnutrition are factors in this muscle loss. Sarcopenia increases mortality by a factor of 3.7 and the risk of falling by a factor of 2. It also increases the risk of hospitalisation by 50% (Tournadre *et al.*, 2019). The dependency of 30% of people over 60 increases due to sarcopenia (Song *et al.*, 2019). Wu *et al.* (2021) studied indicators of good health in older people with sarcopenia. This review article showed that muscle mass, physical strength, and dynamic balance are higher for people who have combined exercise with nutrition. Protein quantity and quality are key elements in the prevention and care of this disease. In addition, essential amino acids appear to have beneficial effects on muscle mass and function. Recommended daily protein intakes

for older subjects with sarcopenia should be increased from 0.8 g/kg/d (for healthy adults) to 1-1.2 g/kg/d over the age of 65 (Tournadre *et al.*, 2019). According to Giacalone *et al.* (2016), an intake of 1.2-1.5 g/kg/d is more appropriate for older adults with acute or chronic morbidities. This high intake prevents deficiencies and maintains health and function. This also considers the fact that older people have a reduced ability to use available protein (Beelen *et al.*, 2017). Concerning the quality of proteins, Lin *et al.* (2021) showed that whey proteins could further improve gait speed in elderly sarcopenic subjects.

Clegg and Williams (2018) found that the risk of malnutrition (characterised by low body mass and weight loss) increases after age 65. This is especially true for people who have had a stroke in the past as Medin *et al.* (2010) shows. This study found that after a stroke, patients had a poor appetite which resulted in a lower food intake. This problem, combined with physical disabilities to eat, causes a significant lack of energy in older people with health problems. In order to increase the energy intake of these older adults, it is advisable to focus on high energy foods such as high fat dairy products, eggs, fish and meat (Rothenberg and Wendin, 2015b). Concentrating energy in small portions is also preferable to fit the small appetite of this population. In addition, the article by Song *et al.* (2018) shows that high-fat foods stimulate the desire to eat, while high-fibre and high-carbohydrate foods reduce the desire to eat.

Another specific nutritional need of older people is vitamin D intake. This nutrient is recommended at 20 µg/day for people over 75 according to Rothenberg and Wendin (2015a), Rothenberg and Wendin (2015b), and Giacalone *et al.* (2016). Indeed, hypovitaminosis D is a common issue for older adults living in northern latitudes. Low vitamin D levels are a cause of decreased muscle strength as shown in the study of Pfeifer *et al.* (2002).

In addition to adapted diet, older people have other feeding needs. Indeed, ageing brings on illnesses for many people and these illnesses can have an influence on the way they eat. For instance, stroke is associated with significant sequelae in 40% of cases. In patients with sequelae, motor skills in the arms and hands often remain impaired (Inserm, undated a). The study of Westergren *et al.* (2001) was carried out

in a Swedish hospital on patients admitted for rehabilitation after a stroke. The average age was 78.62 years. The study revealed that 80% of the patients had difficulty eating and 52.5% were dependent on assisted eating. The most common eating difficulties occur before the food reaches the mouth: inability to eat the whole portion served, difficulties in handling the food on the plate and in carrying the food to the mouth. Parkinson's disease is another factor in eating disabilities. The main symptoms are akinesia (slowness of movement), hypertonia (excessive rigidity of muscles) and tremors (Inserm, undated b). In the article by Westergren *et al.* (2016), tremolos and involuntary movements have been observed in patients with Parkinson's disease: difficulties in holding cutlery, spilling, or breaking glasses. These frequent involuntary movements consume too much energy at mealtimes, causing weight loss in the patients concerned. Patients over 65 years of age in hospital rehabilitation in the study of Westergren *et al.* (2002) also showed physical inabilities to eat: 82% of the patients had difficulty eating, 36% needed assistance, and 46% were malnourished or suspected of being malnourished. Finally, Alzheimer's disease is another factor in eating disabilities, with patients sometimes having difficulty handling cutlery (Pouyet *et al.*, 2014).

The social factor is very strongly linked to food intake at mealtimes. For the majority of older people, mealtime is one of the only social activities of the day (Pouyet *et al.*, 2014). It is a valued and important part of the day. Social contact at mealtimes encourages greater food intake (Wendin *et al.*, 2017). However, in the case of people with eating disabilities, these social moments may be what prevents food intake. The norms and learned table manners are to eat with cutlery. Eating with fingers is linked to children and poorly educated people. To avoid embarrassment, older people often do without part of the meal. There is also a lot of refusal to attend dinners and more formal events (Westergren *et al.*, 2016). The inability to handle cutlery properly becomes a real social barrier, in addition to the physical barrier.

Older people face increased sensory losses. On average, taste identification and detection thresholds increase with age (Giacalone *et al.*, 2016). In addition, loss of taste and smell is more common in people with Parkinson's disease (Westergren

et al., 2016). It is therefore preferable to offer foods with intense tastes and flavours to be appreciated by older people. A colourful and attractive appearance of the food is also important for this population (Okkels *et al.*, 2018). This population has shown preferences for homemade food that is easy to prepare and eat. They also prefer that portion sizes are not increased (Beelen *et al.*, 2017). Thus, if protein-enriched products are consumed in the same quantity as regular products, total protein intake will increase. According to Nyberg *et al.* (2014), older people have expressed a need for transparency (knowing the ingredients and preparation method) and cultural identity. Indeed, this population prefers traditional and familiar foods (Beelen *et al.*, 2017; Song *et al.*, 2019). The oldest age group (66-80 years) is more likely to reject what is new than other age groups (Nyberg *et al.*, 2014). This article also found that there was a preference for a 'real meal' which older people said was meat or fish.

Previously, Song *et al.* (2018) had developed protein-enriched products for older adults, with the aim of marketing them. The products were rye bread and cream cheese enriched with hydrolysed whey and soy proteins. The products were described in a sensory evaluation. This project was not specifically aimed at people with physical feeding difficulties and the final product was to be commercially available. Individuals could not reproduce the food at home, partly because the hydrolysed proteins used were not commercially available and the recipe was intended for industrial production.

Considering the demographic changes, social issues, nutritional needs, health problems, and preferences of older people, this study aims to propose foods adapted to this population. The target audience is a population over 65 years of age who have difficulties eating with cutlery due to uncontrolled muscle movements. The principle is that food can be eaten without cutlery, with the fingers (or a straw for drinks), from which the name "Fingerfood" comes. Nutritionally, the focus is on energy needs, and thus on macronutrients. The recipes created must be rich in protein and energy. The aim is for protein to cover at least 20% of the Total Energy Intake for a drink, and at least 25% for solid foods. For energy intake in addition to protein, fats are preferred to carbohydrates because they stimulate the appetite and

contain 9 kcal/g compared to 4 kcal/g for carbohydrates. In addition, fibres increase the feeling of fullness by distending the stomach, this can reduce food intake (Slavin, 2013). Recipes should also be easy to prepare by spouses or carers in specialised homes, and ingredients should be available in shops for individuals. To select attractive and suitable recipes, a variety of tests is carried out on the Fingerfoods.

Methodological Background

Concerning physical analysis, there is firstly a texture instrumental test (hardness, peak force of the first compression cycle; and adhesiveness, negative force area for the first compression) (Bourne, 1978) for solid foods and viscosity measurements for beverages. Hardness is an indicator of the difficulty of chewing the product and adhesiveness is an indicator of whether the food sticks too much to the teeth. A product with a measured adhesiveness greater than or equal to 2.90 mJ is considered unsuitable for chewing by the target population and is not presented for sensory evaluation. Hara *et al.* (2018) measured a maximum jaw opening force of 65 N for men and 46 N for women between 70 and 80 years old. Considering that the target population is 65 and more, contains both genders, and has eating disabilities, a hardness of 35.00 N was considered high but not discriminatory in the texture analysis. Regarding the drinks, the more viscous the liquid, the more difficult it is for people to suck it through a straw. Texture is an important element to consider in this type of food for older adults, especially with dysphagia. The swallowing disorder caused by dysphagia can occur in the oral cavity, pharynx or in the coordination between esophagus and trachea when swallowing (Rothenberg and Wendin, 2015b). Colorimetry measurements were also carried out on products that were considered different in appearance. These colorimetry measurements aimed to be linked to the appreciation of the appearance by the participants of the sensory evaluation. Finally, consumer liking was assessed by a sensory evaluation. The appreciation measurement of a panel was used as a tool of selection. Only foods that are appreciated can be selected for presentation in the final book of recipes.

Materials and Methods

To create the products, a creative design was developed, and several variations were created from a basic recipe. The differences between the variations of a recipe are the ingredients that can be substituted or changed in quantity. The recipe creation phase resulted in several types of products, 5 of which were retained for physical analysis. In total, 22 recipes are presented. Based on the results of the physical analysis, some recipes were not proposed for sensory evaluation. As the final objective was to propose functional recipes, some recipes failed and were eliminated before the sensory evaluation phase.

Recipes

After the creative design phase, 5 types of products were presented: milkshakes, cheese balls, fish cakes, salty muffins, and tuna balls. Besides the products, a sauce was created following the results of the sensory analysis for the fish cakes. The ingredients present in the recipes are listed in Appendix 1. The macronutrients in the different recipes are presented as a percentage of Total Energy Intake (TEI) and the Total Energy Intakes of the recipes are presented in kJ/100 g in the nutritional composition tables. Using kilocalories/100 g for Total Energy Intake is more common but kilojoules/100 g is the standard unit. The quantity of proteins, fats, and carbohydrates per recipe in g/100 g and the Total Energy Intakes in kcal/100 g are presented in Appendix 2. The nutritional values of the different recipes were calculated from the information on the nutrition label of the ingredients used.

Milkshakes

The milkshake base is composed of 75 g of quark, 250 g of berries and 26 g of sugar. The different variations of the recipe are presented in Table 1 with the percentages of macronutrients in total energy intake and the total energy intake of the recipes. The milkshake was prepared by putting all the ingredients in the blender (HÄLLDE, Model SB-4, Kista, Sweden) and blending for 10 s at a speed of 9280 rpm.

Table 1: Variations, percentages of macronutrients in total energy intake and the total energy intake (TEI) of the milkshakes recipes.

Code	Recipe	Proteins (TEI %)	Fats (TEI %)	Carbohydrates (TEI %)	TEI (kJ/100 g)
M1	Milkshake base + 0.5 L 0.5% fat milk	26.8	8.2	65	218
M2	Milkshake base + 0.5 L 0.5% fat milk + 5 g whey proteins	28.9	8.6	62.5	226
M3	Milkshake base + 0.5 L 0.5% fat milk + 10 g whey proteins	30.8	8.9	60.3	234
M4	Milkshake base + 0.5 L 3% fat milk	21.2	27.4	51.4	272
M5	Milkshake base + 0.5 L 3% fat milk + 5 g whey proteins	23.1	27.0	49.9	281
M6	Milkshake base + 0.5 L 3% fat milk + 10 g whey proteins	24.8	26.7	48.5	289

Cheese balls

The cheese ball base is composed of 50 g of Philadelphia cheese. The different variations of the recipe are presented in Table 2 with the percentages of macronutrients in total energy intake and the total energy intake of the recipes. The cheese balls were prepared by mincing the chicken in a mincer during 3 s at a speed of 3450 rpm. All the ingredients were then mixed. With the preparation, balls of 1.5 cm in diameter were formed.

Table 2: Variations, percentages of macronutrients in total energy intake and the total energy intake (TEI) of the cheese balls recipes.

Code	Recipe	Proteins (TEI %)	Fats (TEI %)	Carbohydrates (TEI %)	TEI (kJ/100 g)
CB1	Cheese ball base + 30 g paesano + 30 g chicken	30.2	65.3	4.5	1151
CB2	Cheese ball base + 60 g paesano	27.6	68.6	3.8	1574
CB3	Cheese ball base + 15 g paesano + 65 g chicken	36.5	58.7	4.8	875

Fish cakes

The cake base is composed of 125 g of mozzarella cheese, 4 eggs, 8 black olives, 28 g of mustard and 2 g of dry thyme. The different variations of the recipe are presented in Table 3 with the percentages of macronutrients in total energy intake and the total energy intake of the recipes. To prepare the fish cakes, the fish and mozzarella cheese were minced separately in a mincer (KitchenAid, Model 5KFC3516ECU, St. Joseph, Michigan USA) during 3 s at a speed of 3450 rpm. The tuna came directly from a can, while the salmon was previously cooked in a pan. The olives were cut in four. All ingredients were then mixed. The preparation was distributed in silicone moulds (diameter: 2 cm) and these were put in the oven at 180°C during 20 min.

Table 3: Variations, percentages of macronutrients in total energy intake and the total energy intake (TEI) of the fish cakes recipes.

Code	Recipe	Proteins (TEI %)	Fats (TEI %)	Carbohydrates (TEI %)	TEI (kJ/100 g)
FC1	Cake base + 300 g tuna + 50 g wheat flour	44.6	42.2	13.2	624
FC2	Cake base + 300 g tuna + 25 g wheat flour + 25 g soy flour	46.4	45.1	8.5	636
FC3	Cake base + 300 g salmon + 50 g wheat flour	36.2	53.8	10.0	821
FC4	Cake base + 300 g salmon + 25 g wheat flour + 25 g soy flour	37.6	56.0	6.5	833

A lemon sauce has been created following the results of the sensory analysis to be used with the fish cakes. The consumer is supposed to add 2 grams of sauce for 10 grams of fish cake. The lemon sauce is composed of 50 g of butter, 20 g of whipping cream, 1 egg yolk, 7 g of mustard and 12 g of lemon juice. Table 4 shows the percentages of macronutrients in total energy intake and the total energy intake of the recipe. The lemon sauce was prepared by melting the butter in a pan. Then the mustard was added to the butter. The whipping cream, egg yolk and lemon juice were then added to the mixture and left on the electric plate at a temperature of 100°C during 5 min.

Table 4: Percentages of macronutrients in total energy intake and the total energy intake (TEI) of the lemon sauce recipe.

Proteins (TEI %)	Fats (TEI %)	Carbohydrates (TEI %)	TEI (kJ/100 g)
3.4	94.8	1.8	2005

Salty muffins

The muffin base is composed of 50 g of bacon, 2 eggs, 50 g of paesano, 60 mL of 0.5% fat milk, 40 g of green olives, 18 g of tomato purée, 13 g of olive oil, 1 g of salt, 1 g of black pepper and 2 g of dry thyme. The different variations of the recipe are presented in Table 5 with the percentages of macronutrients in total energy intake and the total energy intake of the recipes. To prepare the salty muffins, the olives were cut in four and the bacon was minced during 3 s at a speed of 3450 rpm. All ingredients were then mixed, and the preparation was distributed in silicone moulds (diameter: 2 cm). It was then put in the oven at 180°C during 15 min.

Table 5: Variations, percentages of macronutrients in total energy intake and the total energy intake (TEI) of the salty muffins recipes.

Code	Recipe	Proteins (TEI %)	Fats (TEI %)	Carbohydrates (TEI %)	TEI (kJ/100 g)
SM1	Muffin base + 80 g wheat flour	21.7	53.4	24.9	1017
SM2	Muffin base + 80 g chickpea flour	24.6	55.1	20.3	1063
SM3	Muffin base + 80 g soy flour	28.9	62.9	8.2	1084
SM4	Muffin base + 40 g wheat flour + 40 g chickpea flour	23.2	54.3	22.5	1042
SM5	Muffin base + 40 g wheat flour + 40 g soy flour	25.4	58.3	16.3	1051

Tuna balls

The tuna ball base is composed of 150 g of canned tuna and 36 g of tomato purée. The different variations of the recipe are presented in Table 6 with the percentages of macronutrients in total energy intake and the total energy intake of the recipes. The tuna balls were prepared by mincing the tuna in a mincer during 3 s at a speed of 3450 rpm. When the ryebread was used, it was also minced with the same parameters. Then all the ingredients were mixed. With the preparation, balls of 2.5 cm in diameter were formed.

Table 6: Variations, percentages of macronutrients in total energy intake and the total energy intake (TEI) of the tuna balls recipes.

Code	Recipe	Proteins (TEI %)	Fats (TEI %)	Carbohydrates (TEI %)	TEI (kJ/100 g)
TB1	Tuna ball base + 125 g Philadelphia cheese	36.2	54.6	9.2	632
TB2	Tuna ball base + 70 g Philadelphia cheese	45.9	44.4	9.7	565
TB3	Tuna ball base + 125 g Philadelphia cheese + 20 g ryebread	34.1	51.9	14.0	657
TB4	Tuna ball base + 70 g Philadelphia cheese + 20 g ryebread	42.0	42.0	16.0	599

Physical analysis

Instrumental texture analysis

A compression test was performed using the Texture Analyzer (Brookfield Ametek, Model CTX, Middleboro, Massachusetts USA) fitted with a 5 kg load cell. The test performed was a compression test and the trigger used was 0.3 N. The samples were 25 mm long and 25 mm wide. The fish cakes and salty muffins were 20 mm high. The cheese balls were 14 mm high. The tuna balls were 10 mm high. Each sample was deformed 50% of its height with a speed of 5 mm/s, using a 36 mm diameter

aluminium cylindrical probe (Brookfield Ametek, Model TA-AACC36, Middleboro, Massachusetts USA). The measurements were performed in three replicates for each product.

Viscosity

The viscosity was measured using a viscosimeter (Brookfield Ametek, Model DV2TLVTJ0, Middleboro, Massachusetts USA). The viscosity of the milkshakes was measured with the spindle SC4-27 and a speed of 20 rotations per minute during 30 s. The measurements were performed in three replicates for each product.

Colorimetry

Colour of cheese balls was measured just after preparation, using the Chroma meter (Konica Minolta, Model CM-600d, Konica Minolta Sensing, Inc., Osaka, Japan) and values were determined with CIELab space values (L* = relative lightness, a* = red-green scale, b* = yellow-blue scale). Results were reported in Lab colour space where L* is lightness from black (0) to white (100), a* is green (−) to red (+) and b* is blue (−) to yellow (+) (Leblanc, undated). The color measurements of a product were made in three replicates.

Sensory analysis

Procedure

The sensory evaluation took place under special conditions due to health constraints related to the Covid-19 pandemic. Sensory evaluations were not allowed to be conducted at the Högskolan Kristianstad University site. The sensory evaluations were therefore conducted at the consumers' homes. The participants collected bags containing the samples and chocolates as a reward for their participation. The consumers tasted the samples at home. The questionnaire was online and the link to access it was in the bag with the samples.

The samples were prepared in the kitchens in the same way as in the physical analysis. However, the samples for the sensory evaluation did not come from the same batch as those for the physical analysis due to time constraints. The products were prepared in the morning between 8 am and 12 noon and stored in the

refrigerator. Each sample was stored in an individual sealed paper package and coded with a random 3-digit number. The participants came in the afternoon between 12 noon and 6 pm to collect their products and tested them at home.

Samples

The maximum number of variations of the same product to be presented for sensory evaluation was 4 for practical reasons. The choices were made based on the results of the physical analysis. The variations M4, M5, and M6 of the milkshakes recipes were not presented for sensory evaluation. This is also the case for the variation SM3 of the salty muffins recipes and all the tuna balls recipes.

The participants were asked to drink the milkshakes with a straw provided. Since this was considered to get closer to the food intake conditions of the target population.

Subjects

Recruitment was carried out through advertisements within the university. The participants were university staff and students and their relatives. All the variations of one product were tested the same day by the panel. Panels were different for each product. The demographic characteristics of the panels are presented in Table #. The demographic characteristics are the number of participants, their gender, and their age according to the type of product. The target number of participants chosen was 55 participants minimum. This number was reached for each of the tests.

No responses to any of the questionnaires used in this study include information that can be traced to, or used to identify any individual, according to General Data Protection Regulation (GDPR). All participants received written information about the test and gave informed consent to participate. According to Data Protection Ordinance, the questions about food opinions in this study are not classified as sensitive personal data. The personal integrity was protected and participants could leave the test at any time. All participants were informed about the ingredients of the products in order to avoid any allergy and intolerance reactions.

Table 7: Demographic characteristics of the panels according to the products.

		Milkshakes	Cheese balls	Fish cakes	Salty muffins
Number of participants		76	74	57	60
Gender	Male	32	38	32	33
	Female	43	35	25	26
	Non-binairy	1	1	0	1
Age (years old)	15 to 24	21	21	16	24
	25 to 34	15	18	16	13
	35 to 44	13	9	8	4
	45 to 54	11	10	4	6
	55 to 64	10	10	8	8
	65 and more	6	6	5	5

Questionnaire

The data collection was made by a web application for Sensory and Consumer Research (EyeQuestion, Elst, The Netherlands). The questionnaire was in Swedish and English. It started with a welcome page where the principle of the project was explained. The second page was the consent form which also gave the allergens. The third page contained the demographic questions: gender and age of the participant. The instructions were described on the fourth page of the questionnaire. The instructions were to rinse the mouth before each sample, to taste the products in the order in which they are given in the questionnaire, and to warm the samples in the microwave when necessary. The following pages were about the appreciation of the products. After tasting all the samples and filling in the questionnaire, an open question was displayed so that participants who wished to do so could make comments or give ideas for improvement. It was called the Improvements section. The last page of the questionnaire contained a thank you note.

The aim was to find out how the products were appreciated. A hedonic test was therefore carried out. In the pages of the questionnaire concerning the appreciation of the products, the subjects were asked to perform an acceptability test. It was a monadic sequential test. The order of the samples for each participant was randomised by a Latin Square Design.

Each page of the test was assigned to a single sample and included 5 ratings on a 7-point semantic and numerical scale ranging from ‘dislike very much’ (=1) to ‘like very much’ (=7). Questions about the appreciation of a product on scales are presented in Appendix 3. The scales assessed the following 5 criteria: Appearance, Smell, Taste, Texture, and the Overall appreciation of the sample.

Statistical analysis

The appreciation of the products was determined by the χ^2 test for independence. For this test, a product was considered to have been liked by its judge if its score was strictly above 4. If a judge's score for a product was less than or equal to 4, the product was not appreciated. Differences of hardness, adhesiveness, and colorimetry were analysed using an Analysis of Variance (ANOVA) followed by a

Student-Newman-Keuls (SNK) procedure after checking for normality and equality of variances. A one-way ANOVA was performed for the cheese balls and the salty muffins and it was a two-way ANOVA for the milkshakes, the fish cakes, and the tuna balls. Differences of appreciation during the sensory evaluation were analysed using the Student T test. Correlations between different results were analysed using the Pearson correlation.

Statistical analysis for the χ^2 test for independence, verification of normality, ANOVA, SNK procedure, and Pearson correlation were done using RStudio Version 1.4.1106. Statistical analysis for Student T test were done using the t.test command in two-sided type 3 of Microsoft Excel Version 2105. All continuous variables are presented as means ± Standard Error of the Mean (SEM). A $P<0.05$ was considered statistically significant.

Results

Physical analysis

Milkshakes

In Table 8, the viscosities of the different milkshakes are presented. The three most viscous variations are those from the 3% fat milk, two of which are significantly different from the other viscosities.

Table 8: Viscosity of the milkshakes according to the fat percentage of the milk and the percentage of whey proteins. 0.5% fat milk and 0% (M1), 0.6% (M2) or 1.2% (M3) of whey proteins or 3% fat milk and 0% (M4), 0.6% (M5) or 1.2% (M6) of whey proteins.

	M1	M2	M3	M4	M5	M6	P-value ANOVA
Viscosity (mPa.s)	835.17 ± 19.77^{b}	820.73 ± 18.30^{b}	806.23 ± 35.50^{b}	1075.67 ± 28.49^{a}	887.50 ± 21.36^{b}	1012.03 ± 11.50^{a}	***

*Results are means ± SEM. ***P <0.001. Different superscript letters represent significant differences at a 5% level.*

In order to decrease the number of milkshakes recipes to present for the sensory evaluation, variations with 3% fat milk were removed due to their high viscosity. It was preferable to keep the three less viscous products to suit the sucking up constraints and swallowing constraints of older adults.

Cheese balls

In Table 9, hardness, adhesiveness and colorimetry parameters of the cheese balls are listed. There is a significant difference of hardness between all the variations. The product CB2 is the hardest and the product CB3 is the least hard. The product CB1 has the highest adhesiveness and is significantly different from the others. Regarding the parameter L* of colorimetry, the variation CB3 is significantly darker than the two others. It is also the one which is most on the red side according to the parameter a* where all the parameters are significantly different. The product CB2 is most on the green side. There is no significant difference between the samples concerning the parameter b*.

Table 9: Hardness, adhesiveness and colorimetry parameters of the cheese balls according to the quantity of paesano and chicken. 30 g of paesano and 30 g of chicken (CB1), 60 g of paesano (CB2) or 15 g of paesano and 65 g of chicken (CB3).

	CB1	CB2	CB3	P-value ANOVA
Hardness (N)	24.43 ± 0.21^{b}	43.14 ± 2.64^{a}	11.73 ± 0.20^{c}	***
Adhesiveness (mJ)	1.98 ± 0.62^{a}	0.00 ± 0.00^{b}	0.48 ± 0.18^{b}	*
L*	80.63 ± 0.41^{a}	80.52 ± 0.42^{a}	75.89 ± 1.47^{b}	*
a*	4.12 ± 0.21^{b}	0.69 ± 0.03^{c}	7.44 ± 0.56^{a}	***
b*	18.41 ± 0.31	19.71 ± 0.44	18.10 ± 0.50	n. s.

*Results are means ± SEM. n. s. non-significant, *P <0.05, ***P <0.001. Different superscript letters represent significant differences at a 5% level.*

Fish cakes

Table 10 shows hardness and adhesiveness of the fish cakes according to the type of fish. The hardness of the variations with tuna is significatively higher than the hardness of the variations with salmon. There is no difference of adhesiveness between the two types of fish.

Table 10: Hardness and adhesiveness of the fish cakes according to the type of fish. Tuna or salmon.

	Tuna	Salmon	P-value ANOVA
Hardness (N)	12.06 ± 0.50^{a}	9.60 ± 0.44^{b}	**
Adhesiveness (mJ)	0.01 ± 0.00	0.01 ± 0.00	n. s.

*Results are means ± SEM. n. s. non-significant, **P <0.01. Different superscript letters represent significant differences at a 5% level.*

Table 11 shows hardness and adhesiveness of the fish cakes according to the type of flour. There is no significant difference of hardness or adhesiveness between the products with 50 g of wheat flour and the products with 25 g of wheat flour added to 25 g of soy flour.

Table 11: Hardness and adhesiveness of the fish cakes according to the type of flour. 50 g of wheat flour (W) or 25 g of wheat flour and 25 g of soy flour (WS).

	W	WS	P-value ANOVA
Hardness (N)	11.34 ± 0.68	10.32 ± 0.70	n. s.
Adhesiveness (mJ)	0.01 ± 0.00	0.01 ± 0.00	n. s.

Results are means ± SEM. n. s. non-significant. Different superscript letters represent significant differences at a 5% level.

Salty muffins

Table 12 shows hardness and adhesiveness of the salty muffins according to the type of flour. The sample SM3 with 80 g of soy flour is the hardest, compared to the products SM2, SM4 and SM5 the difference is significant. The sample SM1 has a hardness in between the other samples and does not significantly differ from any other sample. Adhesiveness shows no significant difference between the products.

In order to present only 4 recipes of salty muffins for sensory evaluation, variation SM3 was removed due to its high hardness. It was preferable to keep the four less hard products to suit the chewing constraints of older people.

Table 12: Hardness and adhesiveness of the salty muffins according to the type of flour. 80 g of wheat flour (SM1), 80 g of chickpea flour (SM2), 80 g of soy flour (SM3), 40 g of wheat flour and 40 g of soy flour (SM4) or 40 g of wheat flour and 40 g of soy flour (SM5).

	SM1	SM2	SM3	SM4	SM5	P-value ANOVA
Hardness (N)	31.33 ± 1.31^{ab}	27.83 ± 3.40^{b}	39.50 ± 3.37^{a}	23.50 ± 4.19^{b}	21.73 ± 0.98^{b}	*
Adhesiveness (mJ)	0.01 ± 0.00	0.00 ± 0.00	0.01 ± 0.00	0.01 ± 0.01	0.02 ± 0.00	n. s.

*Results are means ± SEM. n. s. non-significant, *P <0.05. Different superscript letters represent significant differences at a 5% level.*

Tuna balls

Tables 13 and 14 show hardness and adhesiveness of the tuna balls according to the presence or not of ryebread and the quantity of Philadelphia cheese. There is a significant difference between the samples for each criterion.

Table 13: Hardness and adhesiveness of the tuna balls according to the presence or not of ryebread. With ryebread (With) or without ryebread (Without).

	With	Without	P-value ANOVA
Hardness (N)	3.13 ± 0.34^{a}	2.05 ± 0.07^{b}	**
Adhesiveness (mJ)	3.30 ± 0.24^{b}	4.78 ± 0.74^{a}	*

*Results are means ± SEM. *P <0.05, **P <0.01. Different superscript letters represent significant differences at a 5% level.*

Table 14: Hardness and adhesiveness of the tuna balls according to the quantity of Philadelphia cheese. 70 g of Philadelphia cheese (Low quantity) or 125 g of Philadelphia cheese (High quantity).

	Low quantity	High quantity	P-value ANOVA
Hardness (N)	2.96 ± 0.40^{a}	2.21 ± 0.13^{b}	**
Adhesiveness (mJ)	3.16 ± 0.21^{b}	4.92 ± 0.69^{a}	**

*Results are means ± SEM. **P <0.01. Different superscript letters represent significant differences at a 5% level.*

All tuna balls have an adhesiveness greater than 2.90 mJ. They are therefore considered unsuitable for chewing by the target population and will not be presented for sensory evaluation. They are not considered for further discussion.

Sensory analysis

The appreciation marks of the sensory evaluation are available in Appendix 4.

Appreciation

Table 15 shows the appreciation of the products according to the sensory evaluation. None of the products were disliked. Concerning the milkshakes, the products M2 and M3 are appreciated while M1 is neither liked nor disliked. M2 and M3 are the only products that contain whey proteins. Among the different variations

of cheese balls, CB3 is the only one appreciated. CB3 is the product with the most chicken. Regarding the fish cakes, FC1 was neither liked nor disliked. It contains tuna and only wheat flour. The variations FC2, FC3, and FC4 were significantly appreciated. Among the salty muffins, the products SM1, SM4 and SM5 were appreciated while SM2 was not. SM2 contains only chickpea flour.

Table 15: Appreciation of the recipes presented in sensory evaluation. The test was carried out based on the notes of the overall appreciation. A significant difference means that the product is appreciated. A non-significant difference means that the product is neither liked nor disliked.

				Fish cakes		Salty muffins	
Milkshakes		Cheese balls		Product	P-value	Product	P-value
Product	P-value	Product	P-value	FC1	n. s.	SM1	**
M1	n. s.	CB1	n. s.	FC2	**	SM2	n. s.
M2	**	CB2	n. s.	FC3	*	SM4	*
M3	***	CB3	**	FC4	*	SM5	*

*n. s. non-significant, *P <0.05, **P<0.01, ***P<0.001.*

Milkshakes

Figure 1 shows the appreciation of the milkshakes according to 5 criteria: appearance, smell, taste, texture, and overall. There are no significant differences between the samples for the criteria of appearance and texture. The smell is more appreciated for the samples M2 and M3. The taste is more appreciated for the variation M3 while the taste of the product M1 is the least appreciated. The sample M3 is significantly the most appreciated among the three milkshakes. Meaning that the sample with the highest level of protein seemed to be the most appreciated.

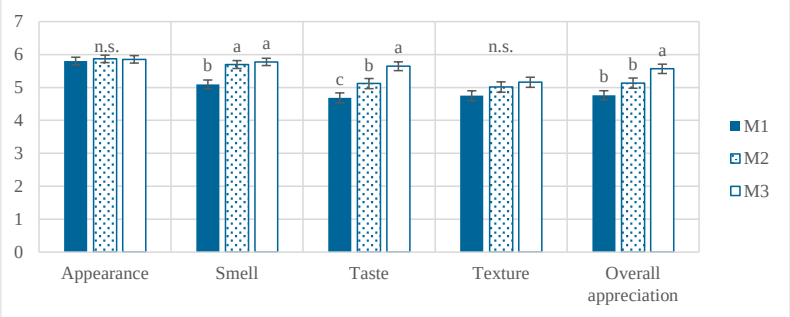

Figure 1: Sensory appreciation of 5 criteria of the milkshakes rated on 7-point scales. *n. s. non-significant. Different superscript letters represent significant differences at a 5% level.*

Cheese balls

Figure 2 shows the appreciation of the cheese balls according to 5 criteria: appearance, smell, taste, texture, and overall product. There is no significant difference between the samples for the criterion of smell. The products CB1 and CB3 are the most appreciated concerning the appearance, the taste, the texture, and the overall product. Meaning that samples with both cheese and chicken are most appreciated.

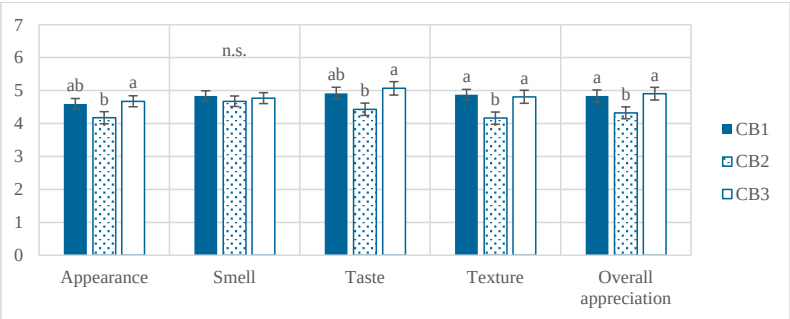

Figure 2: Sensory appreciation of 5 criteria of the cheese balls rated on 7-point scales. *n. s. non-significant. Different superscript letters represent significant differences at a 5% level.*

Fish cakes

Figure 3 shows the appreciation of the fish cakes according to 5 criteria: appearance, smell, taste, texture, and overall product. There is no significant difference between the samples for the criteria of smell, taste, texture, and overall appreciation. The appearance is preferred for the samples FC2, FC3, and FC4. Meaning that samples with soy flour or salmon are most appreciated in appearance.

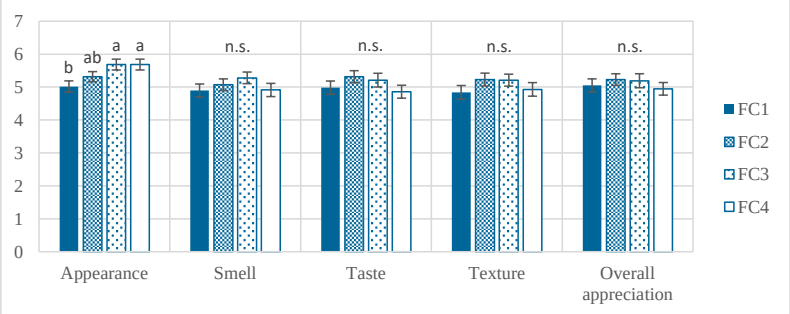

Figure 3: Sensory appreciation of 5 criteria of the fish cakes rated on 7-point scales. *n. s. non-significant. Different superscript letters represent significant differences at a 5% level.*

Salty muffins

Figure 4 shows the appreciation of the salty muffins according to 5 criteria: appearance, smell, taste, texture, and overall product. There is no significant difference between the samples for the criteria of appearance, smell, and taste. The texture is preferred for the samples SM1, SM4, and SM5. The products SM1 and SM5 are preferred regarding the overall appreciation and SM1 has the highest mean. Meaning that samples without chickpea flour are most appreciated.

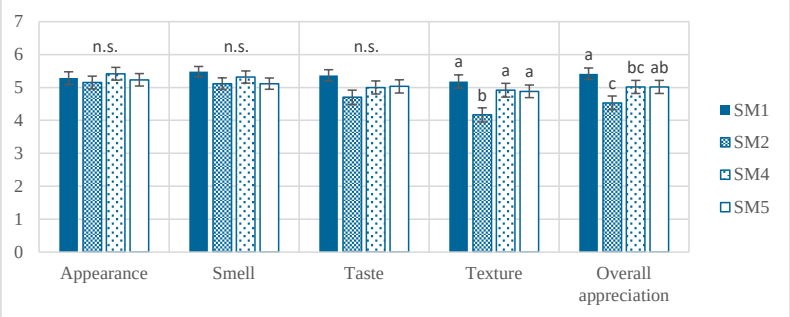

Figure 4: Sensory appreciation of 5 criteria of the salty muffins rated on 7-point scales. *n. s. non-significant. Different superscript letters represent significant differences at a 5% level.*

Improvements section

Some of the comments in the Improvements section were repeated several times for each type of product. Table 16 lists the comments found in the Improvements section with the number of times they appear.

Table 16: Comments of the Improvements section according to the type of product.

Milkshakes	Cheese balls	Fish cakes	Salty muffins
Dislike the presence of fruit pieces (8 times)	Too dry (4 times)	Would have preferred more spice (4 times)	Too dry (4 times)
Lack of taste (6 times)		Too dry (2 times)	
Too watery (4 times)		Would have been better with a sauce (2 times)	

Correlations

Table 17 shows correlations concerning the results of the sensory evaluation, the texture measurements, and the percentage of proteins. The milkshakes, the cheese balls, the fish cakes, and the salty muffins are concerned. The correlations are significant only for milkshakes. For this product, there is a correlation between the percentage of proteins and the viscosity measured, and between the percentage of proteins and the overall appreciation. For the milkshakes, there is no correlation between the texture appreciation and the viscosity measured. For the three other products, there is no correlation.

Table 17: Correlations between different groups of data concerning the results of the sensory evaluation, the texture measurements, and the percentage of proteins. (1) Correlation between the texture appreciation and the viscosity (milkshakes) or the hardness (cheese balls, fish cakes and salty muffins), (2) Correlation between the percentage of proteins and the viscosity or the hardness, (3) Correlation between the percentage of proteins and the overall appreciation.

	Milkshakes	Cheese balls	Fish cakes	Salty muffins
(1)	n. s.	n. s.	n. s.	n. s.
(2)	*	n. s.	n. s.	n. s.
(3)	*	n. s.	n. s.	n. s.

*n. s. non-significant, *P <0.05.*

Discussion

Creating protein-rich and energy-rich Fingerfood recipes for the older generation was the first phase of the study. The choice of ingredients was mainly based on their protein content, with consideration of the dietary preferences of Swedish older people. In the milkshake, it was decided to add whey proteins for their nutritional properties. Indeed, whey proteins have shown a positive effect on muscle protein synthesis in older adults due to their amino acid composition (Pennings *et al.*,

2011). In addition, the vanilla flavour was suitable for this sweet milkshake recipe. Concerning savoury foods, the wishes of the older people were respected. They expressed a preference for homemade and familiar food in small portions and containing meat or fish.

The results of the physical analysis were used to make a pre-selection of products to be presented for sensory evaluation. After this phase, the sensory evaluation had several roles. This made it possible to see whether a product is appreciated or not, and to compare the appreciations between the different products according to different criteria: appearance, smell, taste, texture, and overall appreciation. Regarding the appreciation, none of the products were disliked. The selection was made on the products that were neither liked nor disliked. As these were not liked, there was no interest in presenting them to the participants. With the sensory evaluation, it was also possible to collect ideas of improvements, and to find some correlations between marks from the sensory test, physical analysis, and percentage of proteins.

Milkshakes

The milkshakes were initially 6 variations. After the physical analysis, the variations containing the 3% fat milk were removed because they were the most viscous. It was preferable to keep the less viscous products to suit the sucking up constraints and swallowing constraints of older adults. The milkshakes retained for the rest of the project were the three containing 0.5% fat milk. Considering the appreciation, the one without whey proteins was removed because it was neither liked nor disliked. The selection of the milkshake to be proposed to the consumers will therefore be between the milkshake with 0.5% fat milk and 5 g of whey proteins and the milkshake with 0.5% fat milk and 10 g of whey proteins.

Concerning the comparisons, the milkshakes with whey proteins were preferred in smell. It can be caused by the vanilla flavour of the whey proteins, which had a noticeable smell. The sample with the most whey proteins was preferred in taste and in overall appreciation. Indeed, there is a correlation between the percentage of proteins of the milkshakes and the overall appreciation. A possible explanation is

that the vanilla taste is stronger when the whey proteins concentration increases. However, it is interesting to note that the study by Hansen and Heinis (1991) found that the intensity of the vanilla taste decreased when the whey protein concentration increased. This difference in results can be explained by the fact that in these milkshakes vanilla is part of the whey proteins. Therefore, when the whey proteins increase, so does the vanilla taste. Furthermore, Bertelsen *et al.* (2021) found that the presence of vanilla aroma increased the sweet taste intensity. There was no significant preference for the texture and no correlation between the texture appreciation and the viscosity. However, there was a correlation between the percentage of proteins of the milkshakes and the viscosity. The viscosity decreases when the percentage of proteins increases. Since the measured viscosities were not significantly different, it is likely that the consumers did not perceive the difference of texture. This explains the fact that viscosity correlates with protein percentage but not with texture appreciation. Finally, for every criterion for which there was a preference, it was for the sample containing 10 g of whey proteins. This product is the most preferred and richest in protein, so it was chosen to be presented to consumers.

According to the comments found in the Improvements section, 8 participants disliked the presence of fruit pieces in the milkshakes. This can be improved by filtering the beverage in a colander. However, in the study of Tarrega *et al.* (2016), yoghurts were considered “easy to swallow” and with “pleasant fruit particles”. As this is an individual preference, filtration can be offered as a suggestion in the recipe for people who do not like these pieces or for people who cannot swallow them. 6 participants found that there was a lack of taste. Adding more sugar could be an option but it would decrease the percentage of proteins. The problem of the taste can be fixed by adding more whey proteins for the vanilla taste or by substituting frozen berries with fresh berries. Indeed, fresh berries might have a stronger taste than the frozen ones. In the end, 4 persons found the products too watery. It is then possible to defrost the berries before adding them to the milkshake or to increase the quantity of quark. These possibilities will be proposed in the recipe book.

Cheese balls

The physical analysis of the cheese balls concerned hardness, adhesiveness, and colorimetry. The hardness of the product containing only paesano was considered high but not discriminatory. These results show that hardness increases when the quantity of paesano increases. Indeed, parmesan, which can be associated with paesano as grated Italian hard cheeses, showed a very high hardness of 50 N in the article by Chen *et al.* (1979). The adhesiveness was higher for the sample containing 30 g of paesano and 30 g of chicken, but the number is still under the threshold. Regarding the colorimetry, the most chicken-rich sample was darker and redder than the two others. This can be explained by the fact that the chicken sauce was red while the paesano and the Philadelphia cheese where white. The results of the physical measurements were conform to the defined threshold. It was therefore decided to keep all the cheese balls for the sensory evaluations, including the one with a high hardness.

Among the cheese balls, only the one containing 65 g of chicken and 15 g of paesano was appreciated. Considering the parameter a* of colorimetry and the appearance appreciation, the sample the most appreciated in appearance was the reddest and the least appreciated was the least red. In the sensory evaluation, for each criterion that showed a difference in appreciation (appearance, taste, texture, and overall appreciation), the sample with the most chicken was among the favourites. The sample with the most paesano was the least appreciated, particularly for its texture. Parmesan was rated with the highest firmness in the study of Foegeding and Drake (2007). If paesano is associated with parmesan, perhaps this high firmness is unpleasant for consumers. No correlation was found between sensory evaluation results, texture measurements and protein percentage. Since the sample containing 65 g of chicken and 15 g of paesano was the only one appreciated and the one richest in protein, this is the recipe that will be proposed to elderly people with eating disabilities. This sample was also the least hard which will make it easy for older people to chew. The cheese balls were found too dry 4 times in the comments of the Improvements section. To fix this problem, increasing the quantity of Philadelphia cheese can be proposed in the recipe.

Fish cakes

Considering the texture measurements, the fish cakes were harder with tuna and there was no difference of hardness according to the type of flour. The fish cakes were all retained for the next tests because both criteria were under the threshold. Regarding the samples, only the one containing 50 g of wheat flour and tuna was not appreciated. This sensory result is in agreement with the article by Ghaddar *et al.* (1997), showing that cakes with soy flour instead of all-purpose flour were more appreciated. It was therefore eliminated at this phase. The appreciation is different between the products only for the criterion of appearance. The one that was neither liked nor disliked is the least appreciated in appearance. The fact that the salmon cakes were liked may be related to the study by Larsen *et al.* (2011) which shows that, among several methods of cooking salmon, oven baking was the most preferred by consumers. Regarding the correlations, none were found between the results of the sensory evaluation, the texture measurements, and the percentage of proteins.

As the three selected samples are appreciated equally, the choice of the recipe to be presented to the consumers will be based on the protein percentage. In this case, the most protein-rich product is the one containing tuna, 25 g of wheat flour and 25 g of soy flour. That recipe will therefore be proposed to the target population. The quantity of proteins of this variation is 46.4% of the Total Energy Intake. However, the version with salmon was also high in protein and, in addition, was high in fat. According to Sprague *et al.* (2020), 130 g of farmed salmon provides 26–67 % of the 3.5 g weekly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) recommendation and 14–70 % of the recommended daily intake for selenium. EPA and DHA are essential molecules that ensure the development and integrity of the nervous system. Because of its good nutritional properties, salmon will be offered in the recipe as a possible substitution for tuna.

In the Improvements section, comments showed that 4 people would have preferred more spice. It is therefore possible to add more mustard, dry thyme and optionally add salt and pepper. 2 persons found the fish cakes too dry and 2 other participants expressed a desire for a sauce to accompany the product. A sauce has then been

created to fix these two issues, its recipe is available in the Materials and Methods section. The recipe of the sauce will be proposed beside the fish cake recipe.

Salty muffins

Regarding the texture measurements, the sample of salty muffins that contained 80 g of wheat flour and the one that contained 80 g of soy flour where the hardest. Given these results, a hardness of the same rough estimate could have been expected for the sample containing 40 g wheat flour and 40 g soy flour. However, this was not the case. An interaction between the two flours might be the source of this result. It was necessary to reduce the number of variations of salty muffins to four for the sensory evaluation for time and material reasons. It was therefore decided to remove the variation with a hardness considered high which would be the least suitable for the chewing constraints of older people. The salty muffin variations were therefore all kept except for the one containing 80 g of soy flour. Concerning the appreciation, the salty muffins that were liked were the one with 80 g wheat flour, the one with 25 g wheat flour and 25 g chickpea flour, and the one with 25 g wheat flour and 25 g soy flour. That left three salty muffins at the end of this phase.

With regard to the criteria of texture and overall appreciation, for which there are preferences between the samples, the products containing 80 g of wheat flour, and the product containing 40 g of wheat flour and 40 g of soy flour were among the favourites each time. The sample with 80 g of chickpea flour was the least appreciated in texture and this can be linked to the study of Gómez *et al.* (2008). This article found that substituting all-purpose flour by chickpea flour decreased the air incorporation and therefore increased the density and the firmness of the cakes. This difference in texture can explain the difference in texture appreciation observed during the sensory evaluation. However, this difference in texture was not significant when only 50% chickpea flour was present, and this is also the case for the texture appreciation in this study. As the cheese balls and the fish cakes, no correlation was found between sensory evaluation results, texture measurements and protein percentage. The selection of the final recipe will be between the two preferred samples according to the percentage of proteins. The recipe containing 40 g of wheat flour and 40 g of soy flour is therefore selected to be presented to the

older adults. Indeed, the proteins cover 25.4% of the Total Energy Intake which is in accordance with the expected threshold of 25% of proteins for solid food.

In the comments of the Improvements section, 4 people found the salty muffins too dry. Decreasing the quantity of paesano or increasing the quantity of milk can be solutions. However, if the quantity of paesano is decreased, then the percentage of proteins will decrease too. It is therefore preferable to increase the amount of milk for those who find this recipe too dry.

In the set of recipes proposed for sensory evaluation, the most protein-rich ones were the most appreciated. The addition of vanilla whey proteins in milkshakes provided odour and taste properties that were appreciated by consumers. Increasing the chicken concentration and decreasing the paesano concentration in cheese balls was also preferred. In fish cakes and salty muffins, the type of flour played an important role. Wheat flour and soy flour were preferred, while chickpea flour was the least appreciated, as confirmed by the literature. Photos of the final recipes are presented in Appendix 5.

Limitations and further outlook

The sensory evaluation did not take place under the required conditions. Firstly, a hedonic test is supposed to have at least 60 people according to the AFNOR Standard (2017). However, in the case of this study, the constraints of the pandemic were a barrier in the recruitment of consumers as the number of people present at the university and sensory lab was limited. The target number of participants chosen was then low: 55 participants minimum. Since this is a preliminary study, this number was intended to have an idea of the appreciation of the consumers. The fact that the test is taking place at home is also controversial as the participants' homes, can be sources of distractions during the test, it was not a neutral environment. However, conducting the test at home was representative of the desired meal intake conditions, such as reheating the products in a microwave oven. The reason for doing the test at home was that it was forbidden to conduct it at the university site because of the pandemic restrictions. In addition, the panel was not representative of the target population as these products are intended for people over 65 with eating

disabilities. However, the panel was composed of 7.9% to 8.8% of people over 65. Due to the restrictions of the pandemic, this population was difficult to reach. Sensory testing was not allowed at nursing homes. The results obtained with this panel must therefore be put into perspective. It has been observed in the literature (Giacalone *et al.*, 2016) that older people's sensory perceptions decline with age. It could therefore be interesting to increase the flavour of products when some participants notice a lack of taste. For a more indicative result, a consumer test with a higher number of participants and a representative panel of the target population should be carried out.

For practical and time matters, it was not possible to conduct the sensory evaluation on the same batch of products than the one used for the physical analysis. It is therefore possible that there were uncontrollable differences between the physical analyses and the sensory test. In addition, all the products were handmade which also added a considerable variability between them, it was not possible to perform an industrial production. Finally, concerning the statistical analysis of the sensory evaluation, a Student T test was done. Usually, when there is no normal distribution, the Friedman test is used to compare all the products at the same time. The reason for doing a Student T test was that the Friedman test compares ranks whereas it was a comparison of means that was desired. Another statistical test that can be discuss is the Pearson correlation. Indeed, this test was performed on the means, the significance is therefore not considered.

To go further, there is opportunity for improvement. This project aimed to cover the protein and energy needs of the older population. However, considering the important role of vitamin D in muscle strength, it might be interesting to offer vitamin D enriched products to older people. In addition, the quality of the macronutrients (such as unsaturated fatty acids, essential amino acids) and the quantity of the micronutrients (vitamins, minerals) could be studied. Regarding sensory evaluation, performing a descriptive test in addition to the hedonic test would be useful. The two tests would be complementary, and appreciation could be linked to the intensity of sensory attributes.

Conclusion

Following the physical analysis and sensory evaluation, four recipes were selected to appear in the final book recipe which will be presented to the target population: people over 65 with eating disabilities. The selected products are the milkshake containing 0.5% fat milk and the most whey proteins (M3), the cheese ball containing the most chicken (CB3), the fish cake made from tuna, and containing 50% of wheat flour and 50% of soy flour (FC2), and the salty muffin containing 50% of wheat flour and 50% of soy flour (SM5). According to the results of the hedonic test, proteins generally had positive effects on the sensory properties of products. Considering the Total Energy Intake, the milkshake contains 30.8% of protein, the cheese ball 36.5%, the fish cake 46.4%, and the salty muffin 25.4% of protein. The objective for protein to cover at least 20% of the Total Energy Intake for a drink, and at least 25% for solid foods, has been achieved. The selected products were all appreciated. However, as the results are not generalizable to the target group, further assessments under more controlled conditions are recommended.

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Appendices

Appendix 1: References of the ingredients.

Name of the product	Reference
0.5% fat milk	Lättmjölk 0,5% 1l Skånemejerier
3% fat milk	Mjölk 3% 1l Skånemejerier
Bacon	Bacon Tärnat 350g ICA
Berries	Hallon & blåbär Fryst 250g ICA
Black olive	Oliver Spanska Svarta Urkärnade 235g Zeta
Butter	Smör Normalsaltat 82% 500g Svenskt smör
Chicken	Kyckling Stekt & Tärnad BBQ smak 200g Kronfågel
Chickpea flour	Kikärtsmjöl Ekologisk Glutenfri 400g Risenta
Dry thyme	Timjan 15g Santa Maria
Egg	Ägg från Skåne 10-p Kronägg
Green olive	Oliver Grekiska Gröna Urkärnade 227g ICA
Lemon juice	Citronjuice Från koncentrat 200ml ICA
Mozzarella cheese	Mozzarella 125g ICA
Mustard	Dijonsenap 215g Grey Poupon
Olive oil	Extra virgin Olivolja 2l ICA
Paesano	Paesano 80g Galbani

Pepper	Svartpeppar Grovmalen 217g Santa Maria
Philadelphia cheese	Original Naturell 300g Philadelphia
Quark	Kvarg Naturell 0,2% 500g Lindahls
Ryebread	Rågbröd Danskt 400g Pågen
Salmon	Laxfilé i bit Färsk 600g ICA Gott Liv
Salt	Finkornigt Hushållssalt med jod 1kg Falksalt
Soy flour	Sojamjöl 250g Risenta
Sugar	Strösocker 2kg Dansukker
Tomato purée	Tomatpuré 200g ICA
Tuna	Tonfisk i vatten 160g Pedros
Wheat flour	Vetemjöl 5kg ICA
Whey proteins	Proteinpulver Vanilj 900g ProteinPro.
Whipping cream	Vispgrädde 36% Längre hållbarhet 5dl ICA

Appendix 2: Variations, quantity of macronutrients in g/100g and the total energy intake (TEI) of the different recipes.

Milkshakes

Code	Recipe	Proteins (g/100g)	Fats (g/100g)	Carbohydrates (g/100g)	Total Energy Intake (kcal/100g)
M1	Milkshake base + 0.5 L 0.5% fat milk	3.3	0.5	8.1	52
M2	Milkshake base + 0.5 L 0.5% fat milk + 5 g whey proteins	3.8	0.5	8.1	54
M3	Milkshake base + 0.5 L 0.5% fat milk + 10 g whey proteins	4.2	0.5	8.1	56
M4	Milkshake base + 0.5 L 3% fat milk	3.3	1.9	8.1	65
M5	Milkshake base + 0.5 L 3% fat milk + 5 g whey proteins	3.8	2.0	8.1	67
M6	Milkshake base + 0.5 L 3% fat milk + 10 g whey proteins	4.2	2.0	8.1	69

Cheese balls

Code	Recipe	Proteins (g/100g)	Fats (g/100g)	Carbohydrates (g/100g)	Total Energy Intake (kcal/100g)
CB1	Cheese ball base + 30 g paesano + 30 g chicken	20.7	19.9	3.0	275
CB2	Cheese ball base + 60 g paesano	25.9	28.6	3.6	376
CB3	Cheese ball base + 15 g paesano + 65 g chicken	19.0	13.6	2.5	209

Fish cakes

Code	Recipe	Proteins (g/100g)	Fats (g/100g)	Carbohydrates (g/100g)	Total Energy Intake (kcal/100g)
FC1	Cake base + 300 g tuna + 50 g wheat flour	16.6	7.0	4.9	149
FC2	Cake base + 300 g tuna + 25 g wheat flour + 25 g soy flour	17.5	7.6	3.2	152
FC3	Cake base + 300 g salmon + 50 g wheat flour	17.7	11.7	4.9	196
FC4	Cake base + 300 g salmon + 25 g wheat flour + 25 g soy flour	18.6	12.3	3.2	199

Lemon sauce

Proteins (g/100g)	Fats (g/100g)	Carbohydrates (g/100g)	Total Energy Intake (kcal/100g)
4.1	50.5	2.2	479

Salty muffins

Code	Recipe	Proteins (g/100g)	Fats (g/100g)	Carbohydrates (g/100g)	Total Energy Intake (kcal/100g)
SM1	Muffin base + 80 g wheat flour	13.2	14.3	15.1	243
SM2	Muffin base + 80 g chickpea flour	15.4	15.3	12.6	254
SM3	Muffin base + 80 g soy flour	18.4	17.8	5.2	259
SM4	Muffin base + 40 g wheat flour + 40 g chickpea flour	14.3	14.8	13.9	249
SM5	Muffin base + 40 g wheat flour + 40 g soy flour	15.8	16.1	10.1	251

Tuna balls

Code	Recipe	Proteins (g/100g)	Fats (g/100g)	Carbohydrates (g/100g)	Total Energy Intake (kcal/100g)
TB1	Tuna ball base + 125 g Philadelphia	13.7	9.2	3.5	151
TB2	Tuna ball base + 70 g Philadelphia	15.5	6.6	3.3	135
TB3	Tuna ball base + 125 g Philadelphia + 20 g ryebread	13.3	9.0	5.4	157
TB4	Tuna ball base + 70 g Philadelphia + 20 g ryebread	14.9	6.6	5.7	143

Appendix 3: Questions about the appreciation of a product on 7-point semantic and numerical scales.

Här följer några frågor om hur mycket du tycker om **267**.

You will now get some questions about **267**.

Hur mycket tycker du om **utseendet**? / What do you think about the **appearance**?

Ogillar extremt mycket / Dislike Very Much (1)	Ogillar mycket / Dislike Moderately (2)	Ogillar lite / Dislike Slightly (3)	Varken gillar eller ogillar / Neither Like Nor Dislike (4)	Gillar lite / Like Slightly (5)	Gillar mycket / Like Moderately (6)	Gillar extremt mycket / Like Very Much (7)

Hur mycket tycker du om **lukten**? / What do you think about the **smell/odour**?

Ogillar extremt mycket / Dislike Very Much (1)	Ogillar mycket / Dislike Moderately (2)	Ogillar lite / Dislike Slightly (3)	Varken gillar eller ogillar / Neither Like Nor Dislike (4)	Gillar lite / Like Slightly (5)	Gillar mycket / Like Moderately (6)	Gillar extremt mycket / Like Very Much (7)

Hur mycket tycker du om **smaken**? / What do you think about the **taste/flavour**?

Ogillar extremt mycket / Dislike Very Much (1)	Ogillar mycket / Dislike Moderately (2)	Ogillar lite / Dislike Slightly (3)	Varken gillar eller ogillar / Neither Like Nor Dislike (4)	Gillar lite / Like Slightly (5)	Gillar mycket / Like Moderately (6)	Gillar extremt mycket / Like Very Much (7)

Appendix 4: Appreciation marks of the sensory evaluation for each variation of the products.

The appreciation was marked for the appearance, the smell, the taste, the texture, and the overall product.

Product	Code	Appearance	Smell	Taste	Texture	Overall appreciation
Milkshakes	M1	5.80 ± 0.12	5.09 ± 0.14	4.68 ± 0.15	4.75 ± 0.15	4.76 ± 0.14
	M2	5.87 ± 0.11	5.70 ± 0.12	5.12 ± 0.15	5.01 ± 0.16	5.13 ± 0.15
	M3	5.86 ± 0.11	5.78 ± 0.11	5.64 ± 0.13	5.16 ± 0.15	5.57 ± 0.14
Cheese balls	CB1	4.59 ± 0.16	4.84 ± 0.16	4.92 ± 0.18	4.88 ± 0.16	4.84 ± 0.18
	CB2	4.17 ± 0.18	4.68 ± 0.16	4.43 ± 0.19	4.16 ± 0.19	4.32 ± 0.18
	CB3	4.68 ± 0.17	4.77 ± 0.17	5.07 ± 0.20	4.81 ± 0.20	4.91 ± 0.19
Fish cakes	FC1	5.02 ± 0.17	4.89 ± 0.20	4.98 ± 0.20	4.84 ± 0.21	5.05 ± 0.20
	FC2	5.32 ± 0.15	5.07 ± 0.18	5.32 ± 0.18	5.23 ± 0.20	5.23 ± 0.18
	FC3	5.68 ± 0.16	5.28 ± 0.18	5.21 ± 0.21	5.21 ± 0.18	5.19 ± 0.21

	FC4	5.68 ± 0.16	4.91 ± 0.20	4.86 ± 0.20	4.93 ± 0.21	4.94 ± 0.19
Salty muffins	SM1	5.28 ± 0.19	5.48 ± 0.15	5.37 ± 0.17	5.18 ± 0.20	5.42 ± 0.18
	SM2	5.15 ± 0.19	5.12 ± 0.18	4.70 ± 0.22	4.17 ± 0.22	4.53 ± 0.21
	SM4	5.42 ± 0.19	5.32 ± 0.18	5.00 ± 0.20	4.92 ± 0.21	5.02 ± 0.20
	SM5	5.23 ± 0.19	5.12 ± 0.17	5.03 ± 0.20	4.88 ± 0.19	5.02 ± 0.20

Results are the means ± SEM.

Appendix 5: Photos of the final recipes.

Milkshake

Cheese balls

Fish cakes

Salty muffins