Kristianstad University
SE-291 88 Kristianstad
+46 44-250 30 00
www.hkr.se

Independent project
Spring Semester 2021
Faculty of Natural sciences

Fingerfoods; development of in-between meals recipes for home usage among older adults with eating disabilities

Emeline Chambard

ISBN: 978-91-87973-60-4

Author

Emeline Chambard

Title

Fingerfoods; development of in-between meals recipes for home usage among older adults with eating disabilities.

Supervisor

Sarah Forsberg

Examiner

Karin Wendin

Abstract

The study's rationale: Physical difficulties as well as socio-psychological factors have an impact on the nutritional status and well-being of the elderly, leading to reduced capacity. In addition, feeding difficulties in the elderly after stroke or with illnesses – holding cutlery, bringing food to the mouth, chewing and swallowing – are a factor reducing independence and contributing to malnutrition.

Aim: The aim of this study was to develop and evaluate the acceptability of protein-rich in-between recipes intended as fingerfoods for home usage among older adults with eating disabilities. Recipes intended for publication in a recipe book.

Methods: Several prototypes per recipe were developed using the creative design method. Measurements on physical characteristics – firmness, stickiness, viscosity, colorimetry – as well as consumer tests at home – general appreciation, appearance, smell, taste, texture – were conducted.

Results: The measurements of the physical characteristics helped to reduce the number of samples presented in the hedonic test. The laboratory measurements combined with the results of the hedonic tests (n= 57-77 participants) were used to determine the most suitable and appreciated recipe. The participants' comments enabled the improvement of the recipes.

Conclusion. Four acceptable fingerfood recipes for in-between meal for older adults with eating disabilities were developed: blinis, pancakes, banana drinks, chocolate chip cakes. While the addition of spirulina is not appreciated, the addition of vanilla whey protein or sauce may be good both for acceptability and nutritional reasons. The higher the content of protein, the lower the firmness of the solid fingerfoods. Completing this study by ensuring acceptability and attractiveness among older adults with eating difficulties could confirm the recipes.

Keywords

Fingerfoods, eating disabilities, older adults, recipes, protein

Content

List of figures

List of tables

List of appendixes

Preface

This internship is part of the "Fingerfoods – a vehicle to prevent malnutrition, maintaining a physical and social health as well as quality of life among old people" project led by PhD Sarah Forsberg and funded by The Kamprad Family Foundation for Entrepreneurship.

Introduction

In Europe, the percentage of citizens aged 65 and more was 20% in 2018 and should reach 31% by 2100. The proportion of persons aged 80 and more will increase from 6% to 15% during this period (1). The demographic pressure and in particular the increase of the number of older adults – 65 years old and more – are major challenges in terms of considering the physical and psychological well-being of this specific population (2). Among the different aspects which contribute to the satisfaction of the older adults for a good quality of life, nutrition is a main factor for aging well (3,4). Indeed, nutrition contributes to health and functional abilities and nutritional status has an impact on physical and psychological well-being (2).

Despite the fact that energy requirements decrease in healthy older adults – low basal metabolism, body modification, reduced physical activity – nutrient requirements remain unchanged or even increase (5,6). The nutrient density must then be increased (7). An adequate daily intake of protein contributes to healthy aging and helps reduce age-related loss of strength and muscle mass (5,8). The recommended daily intake for an adult is 0.8 g/protein/kg bw/day. Experts recommend 1.0 to 1.2 g/protein/kg bw/day for healthy older adults and 1.2 to 1.5 g/protein/kg bw/day for morbidly ill older adults to maintain function, prevent deficiencies, and cope with natural loss of mass and muscle (5,9). The recommendation concerning protein for people aged 65 and over is to have an energy intake of this nutrient of 15 to 20% of total energy intake (10). According to Beelen *et al.* (9), the majority of older adults do not reach these recommendations with their current diet.

Socio-psychological factors – depression, isolation, dementia, changes in food preferences, reduced appetite – as well as physical difficulties related to aging –

anorexia of aging, difficulties in preparing meals and eating, decline in sensory perception – have an impact on the nutritional status of the older population leading to a reduction in capacities (4–6,9,11). According to Clegg and Williams (6), the risk of malnutrition increases in older adults from the age of 65. Among the older adults living independently, 3 to 10% are malnourished (12). The prevalence is 33% for hospitalized older adults, 18-21% for institutionalized older adults and 12-16% for older adults receiving home care (9). These values remain uncertain because of the difficulty of identifying malnourished people and their symptoms (13); prevention is therefore necessary for this population. Malnutrition has many consequences; functional and cognitive abilities are affected, the efficiency of the immune system is reduced, the healing process is slowed down and the quality of life of the affected persons and their autonomy is reduced. This scourge also causes economic difficulties for society due to medical complications and care costs (14).

Functional abilities and health are very heterogeneous among the older population. Many stroke and Parkinson's patients experience rigidity, tremors, physical deficiencies, and loss of hand strength resulting in motor eating difficulties. These result in difficulties in sitting, handling cutlery, and carrying food to the mouth (15). Medin *et al*. (16) found that 82% of stroke patients were affected by eating disabilities. Older people with an illness or after-effects of a past event have a high risk of undernutrition (17) linked to the loss of autonomy and the decrease in the attractiveness of food (18). Health, quality of life and independence are then affected (6). Difficulties related to mealtime affect the self-esteem of sufferers, their pleasure but also their social life (19). Indeed, mealtime is often the only social activity of the day (18). Various strategies have been developed to combat these eating disabilities, such as adapting foods by using modified textures (20) or enriching foods with proteins (21). However, the use of cutlery sometimes becomes too complex, and patients can no longer be autonomous. Caregivers, spouses and eating robot can help by assisting the person to eat, which can lead to isolation of the older adults. The transition from independence to dependence can be difficult. In order to maintain autonomy and nutritional intake, the development of food that is easy to handle, hold and ingest is a solution (22).

The proposal of food to be eaten with the fingers can then be an adaptive feeding technique: these are fingerfoods. Fingerfoods are foods that can be eaten with the fingers in a form that is easy to hold and manipulate. Older adults who have difficulty handling cutlery could then become more independent and rediscover the pleasure of eating without assistance (18). Health professionals are in favor of integrating finger foods into the diet, allowing an improvement in the quality of life of patients (22). Soltesz and Dayton (23) found in their study that finger foods allowed an increase in food consumption and weight maintenance among 54 patients with dementia. In Ford's study (24), the food intake of seven patients improved after the introduction of fingerfoods. An increase in nutrient intake and a reduction in weight loss with fingerfoods were also demonstrated by Jean (25). For adults with eating disabilities, introducing 3 to 5 times a day in-between meal is a way to reach the nutritional recommendations (17). The introduction of this food alternative in the meals would then be a strategy to increase food consumption and fight against malnutrition (18).

The concept of fingerfoods is wide as it can include everything from sandwiches and fruit to industrial meal products (18). In-between meals such as *Fika* – a sweet component – and snacks – sandwiches, fruit and vegetables – were found to be acceptable as finger foods (22). Forsberg *et al.* (22) found that acceptance of fingerfoods depends on the type of food offered, for example foods containing low viscosity, whipped cream and icing were not considered acceptable to eat with the fingers. However, foods with a crust that are less sticky were considered appropriate to eat with the fingers and cakes and cookies are preferred for in-between meals (26). Okkels *et al.* (17) mention in their study that older adults prefer sweet foods compared to younger people. In addition, in Sweden, *Fika* – traditional coffee break – is very popular: Swedish people consume a drink with cakes during this time (27). Creating fingerfoods for in-between meals such as *Fika* or snack with an adapted nutritional profile allows to meet the requirements of the target group.

The consumption of protein-rich foods tends to decrease with aging, as well as the capacity to use the available proteins (9). In addition, eating disabilities require additional movement and effort for those suffering from them, necessitating greater energy consumption compared to healthy individuals (19). Age and disease affect

appetite and lead to a reduction in it, while the need for energy and nutrients increases (28). Medin *et al.* (16) also specify that stroke patients have a loss of appetite leading to a lower food consumption and therefore a lack of energy. Optimizing the dietary intake of the older adults remains a priority. The creation of attractive finger foods rich in energy and mainly in proteins is relevant.

Methodological background

The development of fingerfoods should not be limited to satisfying nutritional needs. The products must also taste good and please the older adults (5). A decline in sensory perception occurs with age (6). It has already been admitted that the thresholds of detection and identification of taste increases with age (5) as well as those of smell (29). It is therefore necessary to consider the notion of sensory losses during the development of products by proposing recipes with an intense taste and flavor.

Acceptance and attractiveness of fingerfoods among the older population are essential to introduce this type of food to their diet. These two factors are crucial to ensure that patients are willing to choose and consume the fingerfoods (18). The sensory stimuli produced by the consumption of a food – taste, smell, appearance, texture – are the main determinants of food behavior and choice (4). The acceptability of products can be measured with naïve assessors such as consumers during hedonic tests. Scoring acceptability for the above-mentioned sensory attributes as well as the overall acceptability of the product provides the sensory appreciation of the evaluators (30). Pouyet *et al.* (18) found in their study that contrast is a parameter affecting the acceptability of fingerfoods. This parameter can be measured sensorially but also in the laboratory with the use of colorimetry. Wu and Sun (31) mention that the L*a*b* color space is close to human perception.

In addition, older adults who have difficulty handling cutlery often experience chewing and swallowing difficulties related to age or morbidity (18). It is necessary to consider textural aspects in the creation of fingerfoods. Viscosity, corresponding to the resistance to flow, is the parameter measured for liquids. The firmness and the adhesion force for solids can be evaluated using a technique commonly used in food: the compression test (32). The compression test provides analysis curves

representing the force measured by the sensor in Newtons versus time in seconds as shown in Figure 1. It involves measuring the resistance – firmness parameter – of the product to the compression applied to it; it also enables the adhesion characteristics to be determined (32). The firmness [N] – peak load – is the force required to compress the sample to a given deformation relative to its initial size. The adhesive force [N] of the probe – negative peak – on removal of the probe represents the stickiness of the product. These textural parameters can also be correlated with sensory measurements (32).

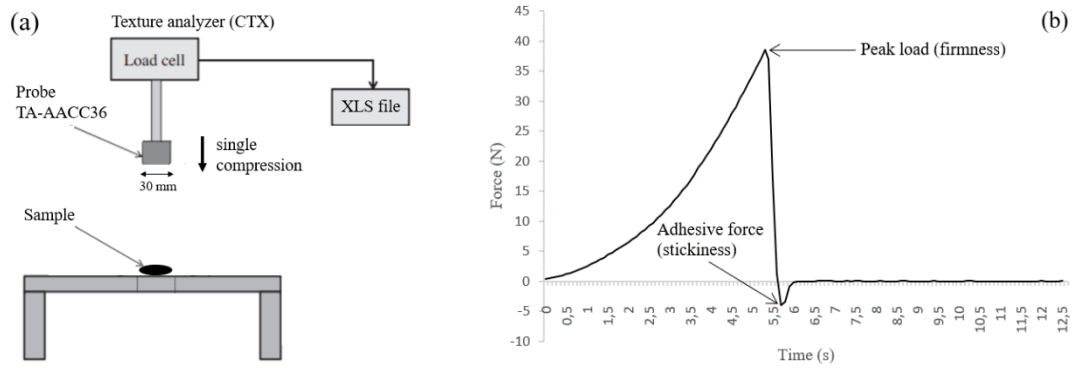


Figure 1. Schematic illustration of the texture analyzer used (a) and example of compression test curve (b).

Ensuring through sensory and physical methods that older adults are ready to consume the products is paramount in this study. Combining and interpreting the results of these two types of data provides insight into the acceptability of the products.

Aim

The aim of this study was to develop and evaluate the acceptability of protein-rich in-between recipes intended as fingerfoods for home usage among older adults with eating disabilities. A choice of the developed recipes was intended for publication in a recipe book.

Materials and methods

The references of the ingredients used are presented in Appendix 1. The majority was purchased from the ICA Kvantum Supermarket at Kristianstad, Sweden.

Recipes making

Experimental design

Recipe development was conducted using the creative design methodology. This technique enables the generation of prototypes according to the desired attributes – food that can be eaten easily with the fingers and rich in protein in this study – that will be tested by consumers. From an initial recipe, a series of prototypes is developed according to the sensory characteristics and usage properties determined. This technique ensures that all the creativity, experience and scientific methodology are exploited to develop efficient product (33).

Three steps were necessary for the development of the products. First, the main ideas were combined with kitchen trials to determine prototypes that corresponded to requirements. These prototypes were created by varying the type of ingredients used and the proportions. Subsequently, physical analyses in the laboratory provided physical characteristics of the products and enabled a selection of products to be tested by consumers. The last step was the realization of the consumer tests whose purpose is to determine which product can be proposed to the future consumers or if it is necessary to carry out new experiments.

Nutritional calculations

The nutritional calculations were done manually. The nutritional calculations were carried for each formula and those presented are protein, fat, carbohydrate, and energy. The amounts of nutrients of each component are known from the nutritional labelling of the product. For specific products that do not have information on the packaging (eggs, fruit, and vegetables), the nutritional data used are those from the Ciqual table of ANSES (*agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail*, France).

Zucchini and cheese blinis

A basic blinis mix was developed with the following ingredients: 3 eggs, 250 mL of 0.5% fat milk, 200 g of flour, 225 g of cheese (feta, parmesan, or gruyere), 150 g of zucchini, 2 g of dried basil, 2 g of baking powder, salt/paper, 2 g of butter for the pan. The basic mix was used as base when developing blinis with six different formulas (Table 1). The type of flour and the type of cheese were the variations studied in this recipe. The raw zucchinis were peeled and grated with a manual grater with 2 mm diameter pores. The gruyere cheese was grated by hand with 2 mm diameter pores. The feta cheese was crumbled by hand. The egg whites were beaten with an electric mixer until firm. The flour, the yolks and all the liquid ingredients were mixed with a hand whisk for 1 minute. After resting for 1 hour, the egg whites were gently folded into the first batter as well as the grated zucchini and cheese. The blinis – 4 cm of diameter – were cooked in a buttered pan: 2 minutes on the first side followed by 1 minute on the second.

Table 1. Energy intake of macronutrients for different formulations of blinis.

	Formulation	Nutrient intake (g/100 g)			Energy (kcal/100 g)
		Protein	Fat	Carbohydrate	
BI	Blini mix with feta (50% of wheat flour / 50% of soy flour)	11,7	9,6	10,5	178
BII	Blini mix with feta (75% of wheat flour / 25% of soy flour)	10,3	8,6	13,1	174
BIII	Blini mix with parmesan (50% of wheat flour / 50% of soy flour)	15,4	10,4	10,4	201
BIV	Blini mix with parmesan (75% of wheat flour / 25% of soy flour)	14,1	9,5	13,0	196
BV	Blini mix with gruyere (50% of wheat flour / 50% of soy flour)	14,1	11,3	10,4	203
BVI	Blini mix with gruyere (75% of wheat flour / 25% of soy flour)	12,7	10,4	13,0	199

Pancakes

Four pancake formulations (Table 2) were developed with a basic mix as base: 100 g of natural quark, 45 g of wheat flour, 30 mL of milk, 10 g of sugar, 5 g of baking powder and 2 g of butter for the pan. The number of eggs to be added and the

percentage of fat in the milk were two variations chosen for this recipe. All the ingredients were mixed approximately 1 minute with a whisk until a smooth and homogeneous paste was obtained. The pancakes – 6 cm of diameter – were cooked in a buttered pan for 1 minute on each side.

Table 2. Energy intake of macronutrients for different formulations of pancakes.

	Formulation	Nutrient intake (g/100 g)			Energy (kcal/100 g)
		Protein	Fat	Carbohydrate	
PI	Pancake mix (0.5% fat milk) + 1 egg	10,0	3,5	19,3	150
PII	Pancake mix (0.5% fat milk) + 2 eggs	10,5	4,7	15,7	148
PIII	Pancake mix (3% fat milk) + 1 egg	10,0	3,7	19,3	152
PIV	Pancake mix (3% fat milk) + 2 eggs	10,5	4,9	15,7	150

Banana drinks

A basic drink mix was developed with the following ingredients: 100 g of quark yogurt, 100 mL of 0.5% fat milk, 60 g of raw banana, 15 g of peanut butter. 4 g of spirulina and 4 g of vanilla whey proteins have been added or not according to the formulation. The four formulations studied are presented in the Table 3. Bananas, milk, and yogurt were mixed for 30 seconds on speed 2 – 3500 rpm – with a blender SB-4 (Hällde, Kista, Sweden). The peanut butter – and eventually the spirulina and the vanilla whey proteins – was then added and the blend was mixed on speed 2 for another 30 seconds.

Table 3. Energy intake of macronutrients for different formulations of banana drinks.

	Formulation	Nutrient intake (g/100 g)			Energy (kcal/100 g)
		Protein	Fat	Carbohydrate	
DI	Drink mix	5,4	3,4	7,8	84
DII	Drink mix with 4 g of spirulina and 4 g of vanilla whey proteins	7,2	3,4	7,9	92
DIII	Drink mix with 4 g of spirulina	6,2	3,4	7,9	88
DIV	Drink mix with 4 g of vanilla whey proteins	6,3	3,4	7,8	89

Chocolate chips cakes

Four chocolate chips cakes formulations (Table 4) were developed with a basic mix as base: quark, 55 g of wheat flour, 55 g of soy flour, 55 g of almond flour, 25 g of chocolate chips, 15 g of sugar and 5 g of baking powder. The flavor of the quark – natural or vanilla – and the quantity were the two variations of this recipe. All ingredients were mixed with a wooden spoon. Once a ball of dough was obtained, small spheres of dough of 5 cm in diameter were rolled between the hands to obtain the final desired shape. The cakes were cooked in the oven for 15 minutes at 180°C.

Table 4. Energy intake of macronutrients for different formulations of chocolate chips cakes.

	Formulation	Nutrient intake (g/100 g)			Energy
		Protein	Fat	Carbohydrate	(kcal/100 g)
CI	Cake mix + 240 g of natural quark	15,1	11,1	20,1	246
CII	Cake mix + 180 g of natural quark	15,6	12,8	22,7	275
CIII	Cake mix + 240 g of vanilla quark	14,6	11,1	20,2	245
CIV	Cake mix + 180 g of vanilla quark	15,1	12,8	22,8	273

Products characterization

Physical characteristics

Viscosity. The viscosity of the banana drink was measured with the DV2T viscometer (Ametex Brookfield, Middelboro, MA, USA) connected to the spindle SCA-27. The viscosity was measured at a shear rate of 1.7 s^{-1} (5 RPM) with a single point at 30 seconds. Measurements were repeated three times for each sample.

Texture. A single compression test cycle to study and compare the texture and deformation of different samples – blinis, chocolate chips cakes and pancakes – under stress was performed by a CTX texture analyzer (Ametex Brookfield, Middelboro, MA, USA). The system consists of a force sensor and a cylindrical probe with a diameter of 30 mm (TA-AACC36) that compresses the samples. Firmness and adhesive force were measured. The measurements were carried out with three replicates after the baking of each prototype. The compression parameters applied to each product are shown in Table 5.

Table 5. Parameters applied for the compression test according to the products.

	Products		
	Blinis	Cakes	Pancakes
Samples dimensions			
Diameter (mm)	30	25	30
Thickness (mm)	8	25	6
Parameters			
Trigger (N)	0,3	0,3	0,3
Deformation (%)	50	50	50
Test speed ($mm.s^{-1}$)	1	10	1

Color measurements. The color of the drinks was measured using the Konica Minolta CM-700d colorimeter (Konica Minolta Co Ltd., Tokyo, Japan) with an 11 mm aperture that produced standardized D65 light. References values used the reference white ceramic square. Measurements were made on freshly prepared samples. The color characterization is carried out using the CIE 1976 L*a*b* color space where L* is lightness from black (0) to white (100), a* is green (-) to red (+) and b* is blue (-) to yellow (+) (34). Three replicates were performed for the measurements.

Hedonic test

Participants. Hedonic tests of the four recipes were conducted in four sessions of one week each. The participants were teachers and students from the university of Kristianstad (Sweden) and their relatives. Participants were informed about the sensory evaluation by email, posts on the university's social networks and flyers displayed in the university. Due to the sanitary context (Covid-19) and the restrictions in place, the tests could not take place in a closed sensory evaluation room. The participants had to collect a bag containing the samples and carry out the tests at home. The online EyeQuestion sensory software (EyeQuestion, Elst, The Netherlands) enabled participants to evaluate the samples. Both Swedish and English were proposed to the participants.

Products. Several samples were tested per recipe due to variations. To reduce the number of samples to facilitate consumer testing, only selected samples were chosen for the tests. The choice of samples to be tested was based on the results of

the physical characteristics. The prototypes selected for sensory evaluation are shown in Table 6.

Table 6. Prototypes evaluated during hedonic tests.

Session			
Blinis	Cakes	Drinks	Pancakes
BI / BII / BII / BIV	CI / CII / CIII / CIV	DI / DII / DIII / DIV	PI / PII

Procedure. Blinis, drinks, and pancakes were preserved at refrigerator at 4°C before delivery. Chocolate chips cakes were stored at room temperature. Samples were labelled with three-digit codes and presented in random order using a Latin square design. The procedure for evaluating the products was indicated in the online questionnaire. Participants were instructed to rinse their mouths with water before testing each sample. Each sample was tested and then evaluated by sensory terms – appearance, odor, taste, texture – followed by overall liking. The 7-point hedonic scale ranging was used to measure the different appreciations (from 1 = dislike very much to 7 = like very much).

A comment line was also provided for suggestions of improvement. A model of the questionnaire presented for the hedonic test is shown in Appendix 2.

These tests were in line with the requirements of the General Data Protection Regulation and the data were collected in an anonymous way. Demographic data were collected, which included gender and age. All the participants signed consent to participate in the study. After each session, each consumer participant received two chocolates as the reward.

Data Analysis

The data were expressed as mean ± Standard Error of Means (SEM). The data of physical characteristics – texture, viscosity, and colorimetry – were analyzed by a multi-way analysis of variance – ANOVA – to investigate the significance of ingredients in discriminating products. Type of ingredients and quantity were treated as fixed factors. In case of a significant difference between two means, a multiple comparison was performed with Newman-Keuls. The validity of the ANOVA has been tested. The student test – t-test – was applied for the hedonic

measurements. A significant difference is observed for p-value ≤ 0.05. The EXCEL version 2105 (Microsoft, Redmond, WA, USA) and RStudio version 3.6.2. software packages were used for data analysis. The statistical tests performed with RStudio are presented in Appendix 3.

Results and discussion

Rheological characterization

Texture and viscosity characteristics

The peak load is representative of the firmness while the adhesive force represents the stickiness of the product (32).

1. *Zucchini and cheese blinis*

A significant negative correlation between the content of protein in blinis and their firmness (r=-0.982; p=0.018) indicated that the higher the protein content of blinis, the lower their firmness. Indeed, there is a significant difference in firmness between the different prototypes depending on the cheese used (Table 7a). Blinis containing feta or gruyere cheese provide a higher firmness than parmesan cheese which one provides the higher content of proteins. The difference in firmness is related to the fact that each type of cheese is characterized by a structure and a consistency depending on its nature (35). The proportions of the flours used also have an impact on the firmness of the products (Table 7b) and their content of proteins. The firmness of blinis containing 75% wheat flour and 25% soy flour is significantly higher than that of blinis containing 50% of each flour. This result is surprising as it is contradictory to the Sabanis and Tzia study (36) in which soy flour tended to give a more compact texture to the product.

The stickiness of the blinis is not significantly different between the different prototypes, which means that the type of cheese used (Table 7a) or the proportions of flour used (Table 7b) have no impact on this parameter. Moreover, the adhesion strength is almost null: it is then possible to consider that the sticky parameter is

almost non-existent for the blinis. The absence of stickiness is an advantage since the target people of these recipes may have chewing difficulties (18).

Table 7. Texture parameters of blini depending on the type of cheese (a) or the percentage of flours (b).

(a)	Feta	Gruyere	Parmesan	ANOVA p-value
Peak load (N)	24.691 ± 1.582[a]	23.339 ± 1.427[a]	18.860 ± 0.729[b]	***
Adhesive force (N)	0.110 ± 0.034	0.043 ± 0.015	0.109 ± 0.016	n.s.

(b)	50% wheat flour 50% soy flour	75% wheat flour 25% soy flour	ANOVA p-value
Peak load (N)	19.899 ± 0.823[b]	24.694 ± 1.245[a]	***
Adhesive force (N)	0.081 ± 0.015	0.094 ± 0,026	n.s.

Results are means ± SEM of n = 3 replicates. Data were analyzed by Multi-way ANOVA (without interaction) followed by a multiple comparison Newman-Keuls test. Different superscripts represent statistically significant differences between formulations for each parameter. ***p ≤ 0.001, n.s.: non-significant.

2. *Pancakes*

A low quantity of eggs corresponds to the PI and PIII prototypes. Conversely, a high quantity of egg corresponds to the PII and PIV prototypes.

The influence of the type of flour used on the physical characteristics of pancakes (37) or the effects of stored wheat flour (38) have already been widely described in the bibliography contrary to the type of milk and the quantity of eggs used in the formulation.

Regarding firmness, the percentage of fat in the milk used has no impact on this parameter (Table 8a). However, there is a significant difference in firmness depending on the quantity of eggs used (Table 8b). The firmness of the pancakes with a low quantity of eggs is significantly higher than that of the pancakes with a high quantity of eggs. In addition, there is a significant negative correlation between the content of protein in pancakes and their firmness (r=-0.980; p=0.020). The higher the protein content of the pancakes, the lower their firmness.

Regarding the adhesion strength, pancakes with 3% milk fat are significantly stickier than those made with 0.5% milk fat (Table 8a). The amount of egg used had no impact on the stickiness of the pancakes (Table 8b).

Table 8. Texture parameters of pancakes depending on the percentage of fat in the milk (a) or the quantity of eggs used (b).

(a)	3% fat milk	0.5% fat milk	ANOVA p-value
Peak load (N)	38.331 ± 2.253	39.839 ± 2.266	n.s.
Adhesive force (N)	3.808 ± 0.498[a]	1.089 ± 0.511[b]	**

(b)	Low quantity of eggs	High quantity of eggs	ANOVA p-value
Peak load (N)	43.145 ± 1.649[a]	35.025 ± 1.060[b]	**
Adhesive force (N)	2.490 ± 0.938	2.406 ± 0.607	n.s.

Results are means ± SEM of n = 3 replicates. Data were analyzed by Multi-way ANOVA (without interaction) followed by a multiple comparison Newman-Keuls test. Different superscripts represent statistically significant differences between formulations for each parameter. **$p \leq 0.01$, n.s.: non-significant.

3. Banana drinks

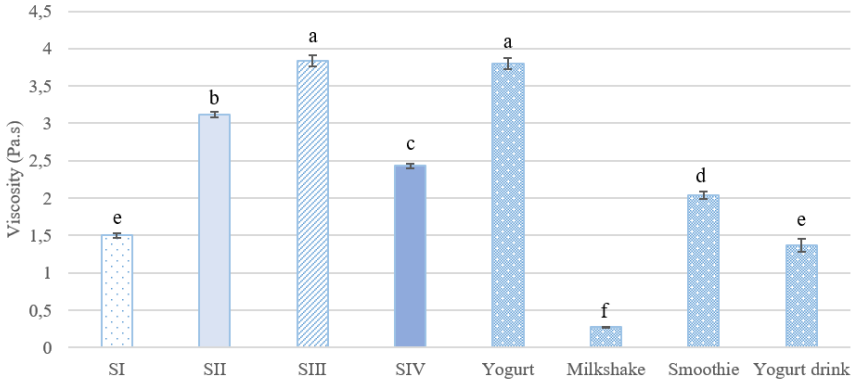
The viscosities of all prototypes are significantly different (Table 9). The drink containing neither spirulina nor vanilla whey protein has the lowest viscosity. The viscosity of the drink containing only vanilla whey protein is lower than those containing spirulina. This means that the additions of spirulina and vanilla whey protein both increase the viscosity of the drinks even though spirulina has a greater impact.

Table 9. Viscosity of banana beverages depending on the quantities of spirulina and whey protein.

	Drink mix (DI)	w/ spirulina w/ vanilla proteins (DII)	w/ spirulina (DIII)	w/ vanilla proteins (DIV)	ANOVA p-value
Viscosity (mPa.s)	1.50 ± 0.03[d]	3.12 ± 0.03[b]	3.83 ± 0.07[a]	2.43 ± 0.03[c]	***

The abbreviation "w/" means "with". Results are means ± SEM of n = 3 replicates. Data were analyzed by Multi-way ANOVA followed by a multiple comparison Newman-Keuls test. Different superscripts represent statistically significant differences between formulations for each parameter. ***$p \leq 0.001$.

Holding a glass in the hand for older adults with eating disabilities is a real challenge (19). Drinks can then be more easily integrated into the diet with a straw (39). For this purpose, the drinks must be convenient to suck and swallow. An extra-study comparison of the prototypes with common beverages found in supermarkets was carried out (Figure 2) in order to characterize banana drinks.



Characterization of the banana drinks

The prototypes containing spirulina and/or vanilla whey proteins – DII, DIII, DIV – have a higher viscosity than a smoothie. The prototype containing only spirulina is similar to a yogurt. The drink mix – DI – is similar to a yoghurt drink.

Figure 2. Comparison of the viscosities of prototypes and commercialized references. SEM of the mean values are represented by the error bars on the histogram ($p \leq 0.001$). Different superscripts represent statistically significant differences between formulations.

Numerous patients with Alzheimer's disease or with praxis difficulties suffer from dysphagia (18), *i.e.* difficulties in swallowing and chewing (17) which can lead to the inability to ingest food and drinks (40). Koyama *et al.* (41) showed that the duration of yoghurt ingestion in dysphagic patients compared to healthy individuals was significantly longer. Consequently, prototypes that are too thick may be difficult to ingest for the target population of this study, especially the DIII prototype which is equivalent to a yogurt.

4. *Chocolate chips cakes*

A high quantity of quark corresponds to the CI and CIII prototypes while a low quantity of quark corresponds to the CII and CIV prototypes.

The flavor of quark (Table 10a) used has no effect on the firmness of the cake. Conversely, the higher the quantity of quark, the lower the firmness (Table 10b). The significant difference means that the quantity of quark used has an influence in the firmness. This is also indicated by the correlation between the content of protein in the cakes and their firmness (r=-0.982; p=0.018). The higher the protein content of the product, the less firm the cake will be.

This result is contradictory to the study conducted by Bent *et al.* (42) who report that fat in cakes produces emulsifying properties that ensure gluten continuity and increase cake softness. The formulation low in quark – which contains the most fat according to Table 4 – is expected to have the lowest firmness. There is no

significant difference in stickiness between the two variations chosen in this recipe (Table 10). Furthermore, the adhesion strength is almost null: the sticky parameter is almost non-existent for the chocolate chips cakes.

Table 10. Texture parameters of chocolate chips cakes depending on the flavor of quark (a) or the quantity of quark (b).

(a)	Natural quark	Vanilla quark	ANOVA p-value
Peak load (N)	14.872 ± 1.324	15.564 ± 1.020	n.s.
Adhesive force (N)	0.021 ± 0.016	0.003 ± 0.000	n.s.
(b)	High quantity of quark	Low quantity of quark	ANOVA p-value
Peak load (N)	13.095 ± 0.671^{b}	17.341 ± 0.767^{b}	**
Adhesive force (N)	0.020 ± 0.005	0.016 ± 0.001	n.s.

Results are means ± SEM of n = 3 replicates. Data were analyzed by Multi-way ANOVA (without interaction) followed by a multiple comparison Newman-Keuls test. Different superscripts represent statistically significant differences between formulations for each parameter. **p $\leq$ 0.01, n.s.: non-significant.

Reduction of the number of samples for hedonic measurements

Conducting a consumer test at home requires a lot of time and concentration from the participants. Moreover, some products had to be reheated, such as blinis or pancakes. Reducing the number of prototypes to be evaluated during these tests reduces the risk of error but also improves the performance of the participants. This step is part of the creative design methodology (33) used in this study.

The results of the physical characteristics measurements allowed the selection of the products to be evaluated in the consumer test. In case the firmness of two prototypes was not significantly different, only one of the two samples was included in the consumer test:

- The firmness of the feta and gruyere blinis were not significantly different but were significantly different from the parmesan blinis. In terms of taste, gruyere and parmesan are similar and both have fruity notes according to Engels and Visser (43). The consumer tests were therefore conducted only on the feta and parmesan blinis to determine the appreciation of these different taste cheese. The use of Gruyere cheese may be suggested in the recipe book.

- The firmness of the pancakes is not significantly different according to the percentage of fat in the milk used, but it is different according to the quantity of eggs. Only the prototypes with a fat percentage of 3% were tested in consumer tests.
- The viscosities of all the drink prototypes were significantly different. In addition, spirulina and vanilla whey protein provided a particular flavor and color. The assessment of the taste appreciation of the products is not irrelevant. All the prototypes were therefore tested in hedonic tests.
- The firmness of the chocolate chips cakes was significantly different according to the quantity of quark used but not according to the flavor. However, the difference in taste between a plain quark and a vanilla quark was too important not to test the appreciation of all the prototypes during the consumer tests.

The prototypes tested during the hedonic tests can be found in Table 6.

Hedonic test

Characterization of the panel

The hedonic testing sessions were carried out over four weeks. Each week, a product was evaluated by the participants. Between 57 and 77 people participated per session in the evaluation of the sensory appreciation. Regarding the gender of the participants, the balance between men and women was respected. Regarding the age of the participants, a relatively young population was in the majority. The demographic data for each session are shown in Table 11.

In sensory science, the sample must be representative of consumers for a hedonic test. For an acceptability test conducted during the product development process, a number of participants between 50 and 100 is satisfactory (44). The products tested in the various sessions were prototypes that were to be improved based on the results and comments of the participants. The number of participants recruited for these sessions was therefore satisfactory in relation to the recommendations on the field.

Table 11. Demographic data of the participants sorted by the product evaluated.

	Session			
	Blinis	Cakes	Banana drinks	Pancakes
n	73	77	57	62
Gender				
Male	31	39	29	32
Female	41	37	28	30
Non-binary	1	1		
Age				
15-24 years	21	23	16	26
25-34 years	15	18	17	13
35-44 years	11	11	7	6
45-54 years	12	9	3	4
55-64 years	9	10	8	8
65-74 years	2	2	2	1
75 years and more	3	4	4	4

Evaluation of the acceptability of the different recipes

The scores given by the participants are shown in Appendix 4.

1. *Zucchini and cheese blinis*

Figure 3 shows the average scores obtained for each sensory attribute evaluated as well as for the overall assessment of the blinis. The scores obtained for the overall appreciation range from 5.0 to 5.6 which means that all the products are considered acceptable. The prototypes are evaluated in the same way for appearance, smell, and texture. Regarding taste and general appreciation, the BIII and BIV prototypes are significantly more appreciated.

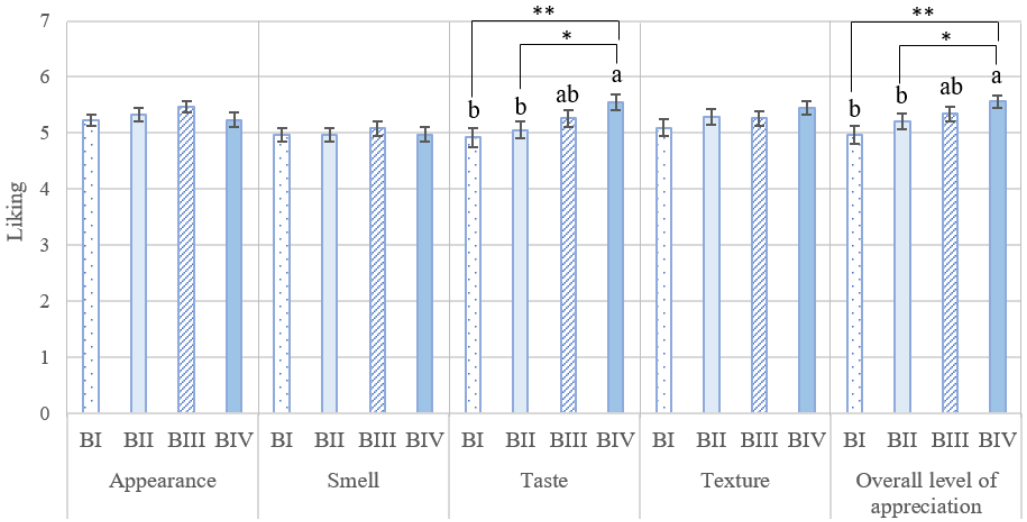


Figure 3. Mean ratings of consumers' acceptability for blinis samples. SEM of the mean values are represented by the error bars on the histogram. Different superscripts represent statistically significant differences between formulations. **p < 0.01, *p < 0.05.

This indicates that parmesan blinis are preferred to feta blinis and that the percentages of flour used are equally appreciated. This is not surprising since the partial replacement of wheat flour by soy flour has already been shown to be acceptable in various products (45,46).

Soy flour is richer in protein than wheat flour: 37.7 g of protein per 100 g compared to 10 g of protein per 100 g. Moreover, the soy proteins contained in the flour are high quality proteins. They are nutritionally complete – with a correct amino acid composition – and highly digestible (8) enabling muscle protein synthesis. The study by Romanchik-Cerpovicz *et al.* (47) showed that enrichment of tortillas with soy flour results in an acceptable, quality product with good protein content and potential health benefits. In addition, the higher the protein content of blinis, the lower their firmness. For the target group of this study, a slightly lower firmness is appropriate due to chewing problems (18). According to the results, a higher proportion of soy flour therefore results in a lower firmness with a high protein product. Therefore, the BIV prototype composed of parmesan and 50% wheat flour, and 50% soy flour is the one most adapted to future consumers in the recipe book. This appreciated product will provide a high content of proteins to the body.

Regarding the comments of the participants, it appears that the samples were too salty with a pronounced taste of cheese. To improve the recipe, the tendency would

be to decrease the quantities of salt and cheese. Whereas it is important to consider the comments of the participants, it is also necessary to keep in mind that the sensory abilities of the sample of participants in this study are not the same as the older adults. Consider the particularities of the target population is primordial. The thresholds of identification and detection of taste increase with age (5). The perception of flavors is then more difficult for the older adults, and it is necessary to propose products with an important flavor. Moreover, the salty taste decreases earlier than the other food flavors (29). Keeping the current proportions of salt and cheese therefore seems appropriate for the tastes of the older adults and would enable a high amount of protein related to the presence of cheese.

2. Pancakes

The average scores obtained for the pancakes are shown in Figure 4. The acceptability of the pancakes is relatively high with an overall rating of 6.0 for both prototypes. There is no significant difference in the ratings for the two prototypes for all the criteria evaluated, which means that neither product is preferred.

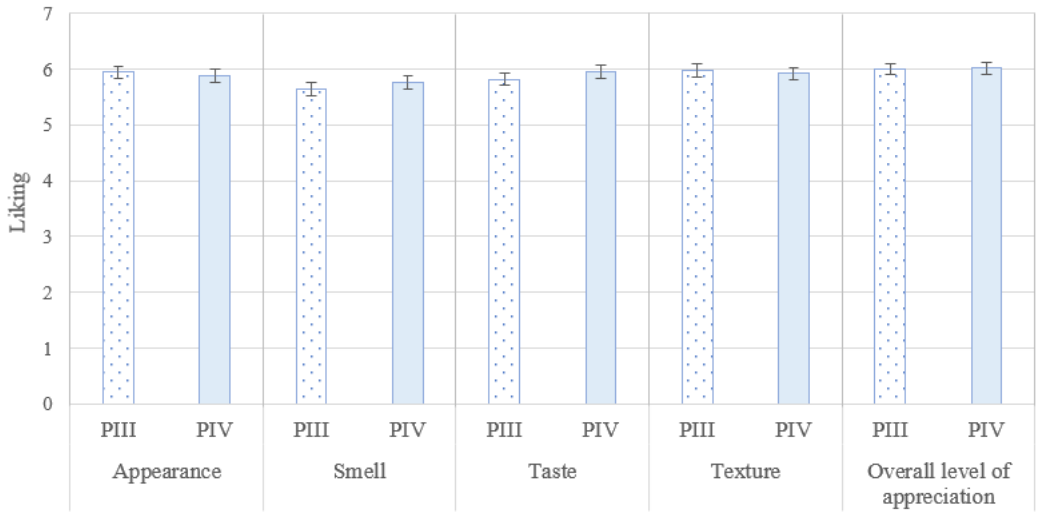


Figure 4. Mean ratings of consumers' acceptability for pancakes samples. SEM of the mean values are represented by the error bars on the histogram.

The results of the sensory analysis do not determine a preferred recipe. The choice of the prototype is based solely on the rheological results while considering the needs of the target population, in particular the highest content of protein attainable. According to the nutritional calculations, the percentage of fat in the milk has no

impact on the content of protein in 100 g of product contrary to the quantity of eggs used. Therefore, the higher the quantity of eggs, the higher the protein content of the pancake. Correlation showed that the higher the protein content of the pancakes, the lower their firmness. Pancakes made with milk with 3% fat are significantly stickier than those made with 0.5% milk (Table 2a). This stickiness can be a discomfort during the tasting of the products for the older adults. Pouyet *et al.* (18) describe that older adults with Alzheimer's disease may suffer from chewing difficulties due to poor dental condition and loss of masticatory efficiency. Therefore, it is preferable to use milk with 0.5% fat. Consequently, the PII prototype with a high quantity of eggs and a 0.5% fat milk will be the final recipe.

During consumer tests, participants were provided with a berry topping that they could enjoy with the pancake even though the evaluation was only of the natural pancake. Participants noted in the comments that the addition of a topping with the pancake was a benefit. Clegg and Williams (6) also describe that the addition of sauce provides additional nutritional value and may lead to an increase in protein intake. The results of a study conducted on 114 patients with Alzheimer's disease (18) show that fingerfoods with sauce are more frequently chosen and consumed than those without sauce. The addition of a sauce can provide an extra flavor that satisfies the taste expectations of the older adults while providing the recommended nutritional intake.

3. Banana drinks

Figure 5 presents the average scores obtained for each sensory attribute evaluated as well as for the overall appreciation of the drinks. Regarding the general appreciation, the drinks obtained acceptability scores between 3.1 and 4.4. There are no significant differences in the appreciation of appearance and texture. On the other hand, there are significant differences between the samples in terms of odor, taste, and general appreciation. The DIII prototype – composed only of spirulina – is the least appreciated in general; the acceptability score of this product does not reach the average.

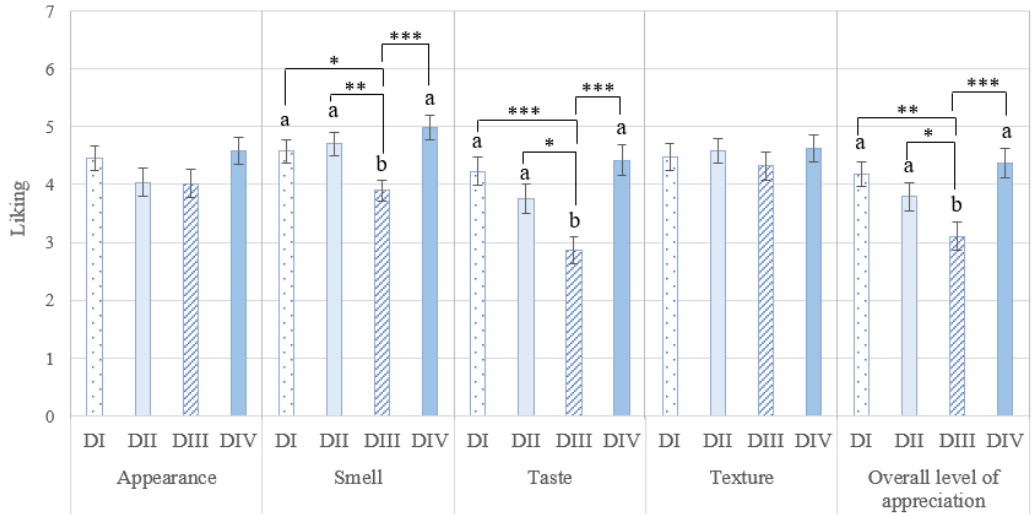


Figure 5. Mean ratings of consumers' acceptability for beverages samples. SEM of the mean values are represented by the error bars on the histogram. Different superscripts represent statistically significant differences between formulations. ***p < 0.001, **p < 0.01, *p < 0.05

Regarding the appearance, the color of the drinks varies totally according to the addition or not of spirulina. The data obtained during the colorimetric analyses given in Appendix 5 shows moreover the effects of the presence of spirulina on the color of the product. This algae gives an intense green color to the product. Even if the samples are evaluated identically in terms of appearance, a significant correlation exists between the scores of the hedonic test and the colorimetry (r=0.988; p=0.012). This correlation indicates that the greener the color of the drink, the lower the score obtained. In comments, some participants indicated that the green color of the drinks was not attractive. In addition, although there was no significant difference in taste ratings, some participants commented that the taste of the spirulina-containing drinks was bitter and had a bad aftertaste. Regarding the smell, the drink containing only spirulina is the least appreciated, probably due to the undesirable aroma of fish (48). Finally, although spirulina is a high-quality source of protein (49), the 1,5% concentration of spirulina in the banana drink does not seem to be appreciated by consumers of this study. This result differs from the study of Castillejo *et al.* (50) in which an addition of spirulina at a concentration of 2.2% was evaluated as acceptable by consumers.

In the consumer tests, participants were asked to use a straw to mimic future usage. Regarding the texture, participants commented that it was too thick without

specifying the samples concerned. This is consistent with the viscosity results indicating that three of the prototypes – DII, DIII and DIV – were more viscous than a commercial smoothie. The DI drink was similar to a yogurt drink. The addition of milk would reduce viscosity and increase texture appreciation.

Finally, based on the overall physical and sensory results, the DI prototype seems to be the most suitable for the recipe book. The addition of an extra flavor such as red fruits would make the drink less bland and more attractive in color. However, the drink would need to be as homogenous as possible to avoid grains, skins, or fibers that are difficult for older adults to swallow.

The proposal of a protein-rich drink in the recipe book to be served with solid foods would provide texture and flavor contrasts which is crucial for palatability (26).

4. Chocolate chips cake

Figure 6 shows the average scores obtained for each sensory attribute evaluated as well as for the overall appreciation of the chocolate chips cakes. The scores obtained for the general appreciation ranged from 4.5 to 5.1. The prototypes are appreciated in the same way for the appearance, the smell, and the taste. Regarding texture, the CIII prototype – high quark content – is significantly more appreciated. Regarding the general appreciation, the CIII and CIV prototypes are significantly more appreciated. Consumers therefore prefer cakes made with vanilla quark.

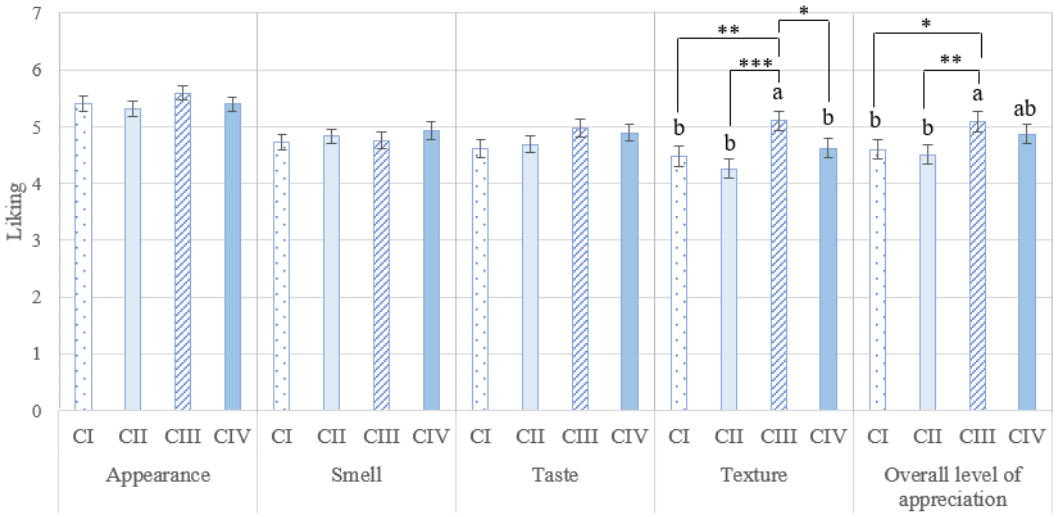


Figure 6. Mean ratings of consumers' acceptability for chocolate chips cakes samples. SEM of the mean values are represented by the error bars on the histogram. Different superscripts represent statistically significant differences between formulations. ***p ≤ 0.001, **p ≤ 0.01, *p ≤ 0.05.

The CIII prototype is one of the most appreciated products and the least firm of the samples, with a high protein energy intake. It therefore seems appropriate to offer this prototype to older adults with eating disabilities.

The participants indicated in comments that the sweetness and the flavor of the cakes were not strong enough. According to the study by Drewnowski and Almiron-Roig (51), the fat in bakery products contributes to the texture while the sugar is responsible for the sweetness. The addition of sugar and/or chocolate would increase the sweetness and the flavor to meet consumer requirements. However, even if the taste identification and detection thresholds increase with age, it is the perception of sweetness that is best preserved from the effects of aging (5). The addition of sugar can then be minimized.

Selected recipes

The final recipes selected and adapted from the physical measurements combined with the results of the consumer tests and proposed to the older adults in the recipe book are given in the Table 12. Consumers will be able to modify the ingredients according to their tastes and desires and adapt the recipe. The recipes provided will serve as a base and guide.

Table 12. Final recipes proposed in the recipe book.

Zucchini and cheese blinis	Protein energy intake	Nutrient intake (g/100 g)			Energy (kcal/100g)
		P	F	C	
3 eggs, 250 mL of 0.5% fat milk, 100 g of wheat flour, 100 g of soy flour, 225 g of parmesan, 150 g of zucchini, salt/paper/dried basil/ baking powder	31%	15,4	10,4	10,4	201

Pancakes	Protein energy intake	Nutrient intake (g/100 g)			Energy (kcal/100g)
		P	F	C	
2 eggs, 30 mL of 0.5% fat milk, 45 g of wheat flour, 100 g of natural quark, 10 g sugar, 5 g of baking powder	29%	10,5	4,7	15,7	148

Banana drink	Protein energy intake	Nutrient intake (g/100 g)			Energy (kcal/100g)
		P	F	C	
100 g of quark yogurt, 100 mL of 0.5% fat milk, 60 g of raw banana, 15 g of peanut butter	26%	5,4	3,4	7,8	84

Chocolate chips cake	Protein energy intake	Nutrient intake (g/100 g)			Energy (kcal/100g)
		P	F	C	
240 g of vanilla quark, 55 g of wheat flour, 55 g of soy flour, 55 g of almond flour, 35 g of chocolate chips, 20 g of sugar, 5 g of baking powder	23%	14,2	11,5	21,7	252

Protein energy intake is the proportion of this intake in relation to total energy intake. The nutritional intakes are given for 100 g (P=protein, F=fat, C=carbohydrate).

Strengths and drawbacks of the methodology

Sensory evaluation panel

Age, cultural influences and many other factors affect sensory perception (52). The restrictions related to the Covid-19 pandemic have also constrained the realization of the consumer test.

The representativeness of the panel and in particular the age of the participants does not correspond to future consumers. Indeed, the recruitment of older adults during this period was forbidden. People aged 65 and above represented only 9% of all participants and did not present eating disabilities. Conducting hedonic tests with a representative panel of consumers avoids bias regarding the reality of product appreciation.

Eating becomes a dull experience without the perception of smell and flavor (29). Sensory detection and identification changes with age. Older adults do not perceive sensory attributes in the same way as younger people. Considerable differences between young and older subjects in sensory perception and acceptance of food flavors have been found by Graaf *et al.* (53). Therefore, the results of the assessment of recipe acceptability may be different. However, the specific needs of the elderly such as a strong flavor or easily ingested foods were considered in the choice of recipes. In fact, the open-ended questions proposed to the participants made it possible to obtain suggestions for improvement and optimization of the prototypes by collecting information that could have been omitted with the quantitative questions (30). The comments of the participants enabled the adaptability of the recipes to the target group.

Finally, the environment in which a hedonic test is conducted is of paramount importance to its success. Eliminating negative environmental factors so that the test area does not interfere with the sensory judgment action is essential (30). Conducting the tests at home does not exclude external factors that could distract the panelist and bias the evaluation of the product. In addition, the scoring system could have been misinterpreted by the participants despite the online instructions. Indeed, the organizer has no interaction with the participants, which prevents him from giving explanations if necessary. The control is then weak or even absent, contrary to a hedonic test carried out in a laboratory or central location (44).

Furthermore, a sensory evaluation at home is usually carried out to study the influence of the environment of the test on the appreciation of 1 or 2 products (44). The samples are then tested under actual conditions of use and can be integrated into a meal. In this study, between 2 and 4 samples were proposed at each session. This is not a limit to the results since the aim of this study was not to know the effect of context but the appreciation of the product itself without external effects. Indeed, the sanitary measures imposed to adapt with the realization of the hedonic test at home. Ideally, this type of evaluation should be done in the future using sensory testing facilities such as sensory evaluation laboratories.

Influence of the statistical test selected on the results

The choice of a statistical test must be made according to the available data and their distribution. In this study, regarding the analysis of consumer test data, the possibility of performing a t-test or a Friedman test was presented. The t-test is a parametric test while the Friedman test is a non-parametric test. However, when the sample size is large enough ($n > 30$), the presence of normality is no longer a problem. According to the central limit theorem, the sampling distribution tends to follow a normal distribution when the sample size is greater than 30. This suggests that even if the data do not follow normality, a t-test is applicable.

In this study, the sample sizes were between $n=57$ and $n=77$. Thus, the choice of performing the heteroscedastic t-test – two samples of different variances – was made. This test allows to abstain from normality and equality of variances while comparing the means of the scores between two prototypes.

Conclusion

The development of these fingerfoods – blinis, pancakes, banana drinks, chocolate chip cakes – with a high flavor, rich in proteins and energy – helps to prevent the risk of malnutrition by providing the necessary nutrients.

The higher the protein content, the lower the firmness of the solid components. While color is a parameter influencing the attractiveness of fingerfoods, some colors such as green for drinks are not appreciated by consumers. The addition of spirulina to enrich fingerfoods in protein is not appreciated by consumers in terms of taste, contrarily to the addition of whey protein with vanilla. Moreover, a sauce may be good to add both for acceptability and nutritional reasons.

In addition, finger foods will enable the older adults to rediscover their independence by allowing them to eat on their own. Consequently, the older adults will recover the pleasure of eating while being in good health. However, completing this study by ensuring acceptability and attractiveness among older adults with eating difficulties would allow the recipes to be perfected to reach a maximum number of people in this target population.

The selected recipes will be published in a recipe book available in three languages: Swedish, English and French.

References

1. Eurostat. The EU's population projected up to 2100 [Internet]. 2019 [cited 2021 Jul 2]. Available from: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190710-1

2. Pirlich M, Lochs H. Nutrition in the elderly. Best Practice & Research Clinical Gastroenterology. 2001 Dec 1;15(6):869–84.

3. Bernstein M, Munoz N, Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: food and nutrition for older adults: promoting health and wellness. J Acad Nutr Diet. 2012 Aug;112(8):1255–77.

4. Grunert KG, Schnettler B, Dean M, Raats MM. Food for the Aging Population Ed. 2 [Internet]. Elsevier Science; 2016 [cited 2021 Jun 22]. Available from: http://univ.scholarvox.com/catalog/book/docid/88836844?searchterm=food%20for%20aging

5. Giacalone D, Wendin K, Kremer S, Frøst MB, Bredie WLP, Olsson V, et al. Health and quality of life in an aging population – Food and beyond. Food Quality and Preference. 2016;47:166–70.

6. Clegg ME, Williams EA. Optimizing nutrition in older people. Maturitas. 2018 Jun;112:34–8.

7. Rothenberg E, Wendin K. 7 - Texture modification of food for elderly people. In: Chen J, Rosenthal A, editors. Modifying Food Texture [Internet]. Woodhead Publishing; 2015 [cited 2021 Mar 24]. p. 163–85. (Woodhead Publishing Series in Food Science, Technology and Nutrition). Available from: https://www.sciencedirect.com/science/article/pii/B9781782423348000079

8. Song X, Perez-Cueto FJA, Bredie WLP. Sensory-Driven Development of Protein-Enriched Rye Bread and Cream Cheese for the Nutritional Demands of Older Adults. Nutrients. 2018;10(8).

9. Beelen J, de Roos NM, de Groot LCPGM. Protein Enrichment of Familiar Foods as an Innovative Strategy to Increase Protein Intake in Institutionalized Elderly. J Nutr Health Aging. 2017;21(2):173–9.

10. Nordic Council of Ministers. Nordic nutrition recommendations 2012: integrating nutrition and physical activity [Internet]. 2014 [cited 2021 Jun 22] p. 629. Available from: https://www.norden.org/en/publication/nordic-nutrition-recommendations-2012

11. Morley JE. Anorexia, body composition, and ageing. Curr Opin Clin Nutr Metab Care. 2001 Jan;4(1):9–13.

12. Saletti A, Lindgren EY, Johansson L, Cederholm T. Nutritional status according to mini nutritional assessment in an institutionalized elderly population in Sweden. Gerontology. 2000 Jun;46(3):139–45.

13. Ouellette S. La problématique de malnutrition chez les personnes âgées. Québec: Ordre professionnel des diététistes du Québec; 1999 p. 46.

14. Sellier C. Malnutrition chez la personne âgée, dépister et prendre en charge. Soins Gérontologie. 2018 Sep 1;23:12–7.

15. Westergren A, Unosson M, Ohlsson O, Lorefält B, Hallberg IR. Eating difficulties, assisted eating and nutritional status in elderly (> or = 65 years) patients in hospital rehabilitation. Int J Nurs Stud. 2002;39(3):341–51.

16. Medin J, Windahl J, von Arbin M, Tham K, Wredling R. Eating difficulties among stroke patients in the acute state: a descriptive, cross-sectional, comparative study. J Clin Nurs. 2011 Sep;20(17–18):2563–72.

17. Okkels SL, Saxosen M, Bügel S, Olsen A, Klausen TW, Beck AM. Acceptance of texture-modified in-between-meals among old adults with dysphagia. Clinical Nutrition ESPEN. 2018;25:126–32.

18. Pouyet V, Giboreau A, Benattar L, Cuvelier G. Attractiveness and consumption of finger foods in elderly Alzheimer's disease patients. Food Quality and Preference. 2014;34:62–69.

19. Westergren A, Hagell P, Wendin K, Hammarlund CS. Conceptual relationships between the ICF and experiences of mealtimes and related tasks among persons with Parkinson's disease. Nordic Journal of Nursing Research. 2016;36(4):201–8.

20. Penman J, Thomson M. A review of the texture diets developed for the management of dysphagia. Journal of Human Nutrition and Dietetics. 2008 Oct 9;11:51–60.

21. Hanson LC, Ersek M, Gilliam R, Carey TS. Oral feeding options for people with dementia: a systematic review. J Am Geriatr Soc. 2011 Mar;59(3):463–72.

22. Forsberg S, Westergren A, Wendin K, Rothenberg E, Bredie W, Nyberg M. Perceptions and attitudes about eating with the fingers. Sweden; 2021.

23. Soltesz KS, Dayton JH. Finger foods help those with Alzheimer's maintain weight. Journal of the American Dietetic Association. 1993 Oct 1;93(10):1106–8.

24. Ford G. Putting Feeding Back Into the Hands of Patients. Journal of Psychosocial Nursing and Mental Health Services. 1996 May 1;34(5):35–9.

25. Jean LA. “Finger food menu” restores independence in dining. Health Care Food Nutr Focus. 1997 Sep;14(1):4–6.

26. Forsberg S, Bredie W, Wendin K. Sensory preferences and requirements for every meals - A pilot study among Swedish older adults with motoric eating difficulties. Sweden; 2021.

27. Wendin K, Höglund E, Andersson M, Rothenberg E. Protein enriched foods and healthy ageing: effects of protein fortification on muffin characteristics. Agro Food Industry Hi Tech. 2017;5:16–8.

28. Nyberg M, Olsson V, Pajalic Z, Örtman G, Andersson H, Blucher A, et al. Eating Difficulties, Nutrition, Meal Preferences and Experiences Among Elderly A Literature Overview From a Scandinavian Context. Journal of Food Research. 2014;4(1):22–37.

29. Honnens de Lichtenberg Broge E, Wendin K, Rasmussen MA, Bredie WLP. Changes in perception and liking for everyday food odors among older adults. Food Quality and Preference. 2021 Oct 1;93:104254.

30. O’sullivan M. A Handbook for Sensory and Consumer-Driven New Product Development : Innovative Technologies for the Food and Beverage Industry [Internet]. Elsevier Science; 2016 [cited 2021 Jun 22]. Available from: https://univ-scholarvox-com.ezmediadoc.agrosupdijon.fr/catalog/book/docid/88835343?searchterm=feta%20and%20related%20cheeses

31. Wu D, Sun D-W. 6 - Food colour measurement using computer vision. In: Kilcast D, editor. Instrumental Assessment of Food Sensory Quality [Internet]. Woodhead Publishing; 2013 [cited 2021 Jun 22]. p. 165–195e. (Woodhead Publishing Series in Food Science, Technology and Nutrition). Available from: https://www.sciencedirect.com/science/article/pii/B9780857094391500067

32. Scher J. Rhéologie, texture et texturation des produits alimentaires. Techniques de l’ingénieur. 2006;21.

33. Naes T, Nyvold TE. Creative design - an efficient tool for product development. Food Quality and Preference. 2004;15(2):97–104.

34. ISO/CIE. ISO 11664-4:2019. Joint ISO/CIE standard: Colorimetry — Part 4: CIE 1976 L*a*b* colour space. Geneva, Switzerland: International Organisation for Standardisation [Internet]. 2019 [cited 2021 Jun 16]; Available from: https://www.iso.org/cms/render/live/fr/sites/isoorg/contents/data/standard/07/41/74166.html

35. Gliguem H, Bornaz S, Ghorbel D, Attia H. Influence de la composition physico-chimique de la matière première fromagère sur les propriétés

rhéologiques et microstructurales d'un fromage fondu tunisien. Sciences des Aliments. 2005 Feb 28;25:37–52.

36. Sabanis D, Tzia C. Effect of Rice, Corn and Soy Flour Addition on Characteristics of Bread Produced from Different Wheat Cultivars. Food and Bioprocess Technology. 2007 Mar 1;2:68–79.

37. Cho E, Kim J-E, Baik B-K, Chun J-B, Ko H, Park C, et al. Influence of physicochemical characteristics of flour on pancake quality attributes. J Food Sci Technol. 2019 Mar 1;56(3):1349–59.

38. Nakamura C, Seguchi M. Improving Effects of Stored Wheat Flour on Pancake Texture. Food Science and Technology Research. 2007;13(3):221–6.

39. Li M, Wang Z, Han W-J, Lu S-Y, Fang Y-Z. Effect of feeding management on aspiration pneumonia in elderly patients with dysphagia. Chinese Nursing Research. 2015 Jun 1;2(2):40–4.

40. Bozorgi C, Holleufer C, Wendin K. Saliva Secretion and Swallowing-The Impact of Different Types of Food and Drink on Subsequent Intake. Nutrients. 2020;12(1).

41. Koyama Y, Ohmori N, Momose H, Kondo E, Yamada S, Kurita H. Detection of swallowing disorders using a multiple channel surface electromyography sheet: A preliminary study. Journal of Dental Sciences. 2021 Jan 1;16(1):160–7.

42. Bent AJ, Bennion EB, Bamford GST. The Technology of Cake Making [Internet]. 6th ed. Springer US; 1997 [cited 2021 Jul 8]. Available from: https://www.springer.com/gp/book/9780751403497

43. Engels WJM, Dekker R, de Jong C, Neeter R, Visser S. A comparative study of volatile compounds in the water-soluble fraction of various types of ripened cheese. International Dairy Journal. 1997 Apr 1;7(4):255–63.

44. Stone H, Bleibaum R, Heather T. Sensory Evaluation Practices. Academic Press. Vol. 4th Edition. 2012. 446 p.

45. Romanchik-Cerpovicz JE, Abbott AE, Dent LA. Sensory Evaluation Ratings and Moisture Contents Show that Soy Is Acceptable as a Partial Replacement for All-Purpose Wheat Flour in Peanut Butter Graham Crackers. Journal of the American Dietetic Association. 2011 Dec 1;111(12):1912–6.

46. Ghaddar S, Sim J, Josef S. The Effects on the Appearance, Texture, and Flavor of Banana Cake Made with all-purpose Flour, Soy Flour and Whole Wheat Flour. Journal of the American Dietetic Association. 1997 Sep 1;97(9, Supplement):A83.

47. Romanchik-Cerpovicz JE, Campbell AMC, Bailey SA. Physical and Sensory Measures Indicate That Systematic Replacement of Flour With Soy in

Tortillas Is Feasible. Journal of the Academy of Nutrition and Dietetics. 2012 Sep 1;112(9, Supplement):A61.

48. Fradinho P, Niccolai A, Soares R, Rodolfi L, Biondi N, Tredici MR, et al. Effect of Arthrospira platensis (spirulina) incorporation on the rheological and bioactive properties of gluten-free fresh pasta. Algal Research. 2020 Jan 1;45:101743.

49. Phillips GO, Williams PA. Handbook of Food Proteins [Internet]. Elsevier Science; 2011 [cited 2021 Jul 8]. Available from: https://univ-scholarvox-com.ezmediadoc.agrosupdijon.fr/catalog/book/docid/88819155?searchterm=feta%20and%20related%20cheeses

50. Castillejo N, Martínez-Hernández GB, Goffi V, Gómez PA, Aguayo E, Artés F, et al. Natural vitamin B12 and fucose supplementation of green smoothies with edible algae and related quality changes during their shelf life. Journal of the Science of Food and Agriculture. 2018;98(6):2411–21.

51. Drewnowski A, Almiron-Roig E. Human Perceptions and Preferences for Fat-Rich Foods. In: Fat Detection: Taste, Texture, and Post Ingestive Effects. 2010.

52. Michon C, O'Sullivan MG, Sheehan E, Delahunty CM, Kerry JP. Investigation of the influence of age, gender and consumption habits on the liking of jam-filled cakes. Food Quality and Preference. 2010 Jul 1;21(5):553–61.

53. Graaf C de, Polet P, Staveren WA van. Sensory perception and pleasantness of food flavour in elderly subjects. Journal of gerontology. 1994;49(3):P93–9.

Appendices

Appendix 1. References of the food items used in this study.

Name	Reference
0.5% fat milk	Skånemejerier. Färsk lätt mjölk, fetthalt 0.5%.
3% fat milk	Skånemejerier. Färsk mjölk, fetthalt 3%.
Almond flour	Risenta. Mandel mjöl.
Baking powder	Santa Maria. Bakpulver.
Banana	ICA. Banan Eko.
Butter	Svenskt smör. Smör normalsaltat 82%.
Chocolate chips	Odense. Chokladknapp mörk.
Dried basil	Santa Maria. Basilika.
Egg	Kronägg. Ägg från Skåne.
Feta	ICA. Feta.
Filo pastry	Pop! Bakery. Filodeg.
Gruyere	ICA. Gruyère AOP 5-6 mån.
Icing sugar	Dansukker. Florsocker.
Milkshake	Barebells Milkshake Banana flavor
Natural quark	Lindahls. Kvarg naturell.
Parmesan	Zeta. Parmigiano Reggiano riven.
Peanut butter	KRAV Green choice. Peanut butter creamy.
Pepper	Santa Maria. Svartpeppar.
Quark yogurt	Lindahls. Yoghurt kvarg naturell.
Raspberries	ICA. Hallon klass 1.
Salt	Falksalt. Salt finkornigt.
Smoothie	Froosh Summer smoothie blueberry & raspberry
Soy flour	Risenta. Soja mjöl.
Spirulina	Renée Voltaire. Spirulina ekologisk.
Superfine sugar	Dansukker. Svenskt strösocker.
Vanilla quark	Lindahls. Kvarg vaniljsmak.
Vanilla whey proteins	ProteinPro. Whey 100 Vanilla.
Wheat flour	ICA. Vetemjöl.
Whipping cream	ICA. Vispgrädde, fetthalt 36%.
Yogurt	Valio yoghurt banan & vanilj
Yogurt drink	ICA Drick yoghurt Tropiska frukter
Zucchini	ICA. Zucchini styck.

Appendix 2. Model questionnaire presented for the hedonic test at home.

Welcome to this session!

We invite you to read this homepage carefully. Its purpose is to inform you about the objectives of the study and how it will be conducted.
We are two students in food science doing an internship at Högskolan Kristianstad. Our project is to formulate finger foods. These recipes are intended for elderly people who have difficulties to eat with cutlery (Parkinson disease, stroke...). This population has specific nutritional needs: the food must be as rich in protein as possible. For each recipe, you will taste several different samples of the same type of product. Thanks to your participation, our objective is to determine which sample would be the most appreciated by these future consumers. Moreover, by giving your opinion and your remarks it will enable us to improve the formulation of the preferred sample to meet the requirements.

We thank you for your participation which helps us greatly in this project. We remain at your disposal for any questions. Do not forget to press "submit" at the end of the test so that your answers are recorded. You are now ready to start the test. Good luck!

Consent

The products included in this session are x samples of [name of the recipe]. The products contain [allergen list]. The given data are anonymous, and the collected data will be treated in an anonymous way. When analyzed the results will be reported in a student report.
It will take approximately 10 minutes to answer the questionnaire. All questions should be answered, but you have the choice to leave the study whenever you want to.
By clicking on the below button, you approve your participation in this study.

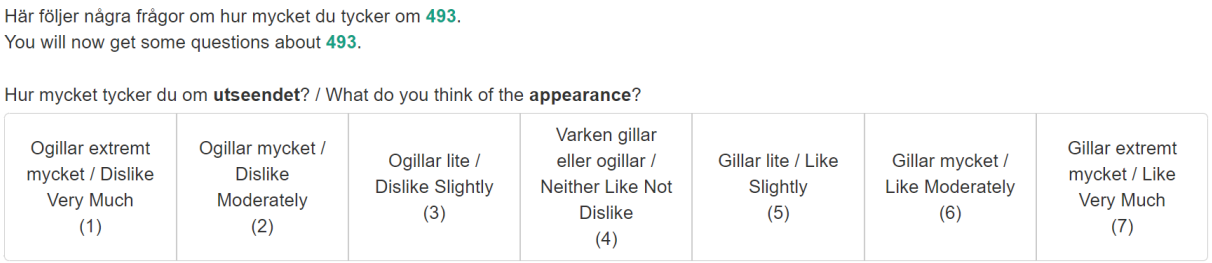
Demographic questions

Please indicate your gender: male, female, non-binary
Which of the following age groups do you fall into? [15-24], [25-34], [35-44], [45-54], [55-64], [65-74], [75 and more] years.

Instructions

Please follow the instructions below:
- Rinse your mouth with water before eating the first sample.
- Taste the products in the order in which they are given in the questionnaire, taking care to rinse your mouth between each sample. You cannot go back after tasting a sample.

Design questions (appearance, odor, taste, texture, overall level of appreciation)



Do you have any comments on the samples that would enable us to improve the product?
Thank you very much for your participation.

Appendix 3. Statistical tests performed with RStudio.

Multi-way ANOVA without interaction

```
rm (list=ls ())
table <- read.table(file.choose(),h=T)
attach(table)
factor1 = as.factor (factor1)
factor2 = as.factor (factor2)
anova = aov(result ~ factor1 + factor2 + factor1 : factor2)
summary(anova)
shapiro.test(residuals(anova))
bartlett.test(result ~ factor1)
bartlett.test(result ~ factor2)
library(agricolae)
comp1 = SNK.test(anova, “factor1”)
comp2 = SNK.test(anova, “factor2”)
```

Multi-way ANOVA without interaction

```
rm (list=ls ())
table <- read.table(file.choose(),h=T)
attach(table)
factor1 = as.factor (factor1)
factor2 = as.factor (factor2)
combination = paste(table[,1], table[,2], sep=”_“)
anova = aov(result ~ combination)
summary(anova)
shapiro.test(residuals(anova))
bartlett.test(result ~ factor1)
bartlett.test(result ~ factor2)
library(agricolae)
comp = SNK.test(anova, “combi”)
```

Correlation

```
rm (list=ls ())
data=read.table(file.choose(),h=T)
summary(data)
attach(data)
rl = lm(parameter1 ~ parameter2, data=data)
shapiro.test(residuals(rl))
cor.test(sensorielle,rheologie,method="pearson")
```

Appendix 4. Scores obtained during the hedonic test of the in-between meal product samples.

Product	Appearance	Odor	Taste	Texture	Overall level of appreciation
Blinis					
BI	5.2 ± 0.1	5.0 ± 0.1	4.9 ± 0.2^{b}	5.1 ± 0.1	5.0 ± 0.2^{b}
BII	5.3 ± 0.1	5.0 ± 0.1	5.1 ± 0.2^{b}	5.3 ± 0.1	5.2 ± 0.1^{ab}
BIII	5.5 ± 0.1	5.1 ± 0.1	5.3 ± 0.1^{ab}	5.3 ± 0.1	5.3 ± 0.1^{ab}
BIV	5.2 ± 0.1	5.0 ± 0.1	5.5 ± 0.1^{a}	5.5 ± 0.1	5.6 ± 0.1^{a}
Pancakes					
PI	6.0 ± 0.1	5.6 ± 0.1	5.8 ± 0.1	6.0 ± 0.1	6.0 ± 0.1
PII	5.9 ± 0.1	5.8 ± 0.1	6.0 ± 0.1	5.9 ± 0.1	6.0 ± 0.1
Chocolate chips cake					
CI	5.4 ± 0.1	4.7 ± 0.1	4.6 ± 0.2	4.5 ± 0.2^{bc}	4.6 ± 0.2^{bc}
CII	5.3 ± 0.1	4.8 ± 0.1	4.7 ± 0.2	4.3 ± 0.2^{c}	4.5 ± 0.1^{b}
CIII	5.6 ± 0.1	4.7 ± 0.1	5.0 ± 0.2	5.1 ± 0.2^{a}	5.1 ± 0.1^{a}
CIV	5.4 ± 0.1	4.9 ± 0.2	4.9 ± 0.2	4.6 ± 0.2^{b}	4.9 ± 0.2^{ac}
Banana drinks					
DI	4.5 ± 0.2	4.6 ± 0.2^{a}	4.2 ± 0.2^{ab}	4.5 ± 0.2	4.2 ± 0.2^{ab}
DII	4.0 ± 0.2	4.7 ± 0.2^{a}	3.8 ± 0.3^{b}	4.6 ± 0.2	3.8 ± 0.2^{b}
DIII	4.0 ± 0.2	3.9 ± 0.2^{b}	2.9 ± 0.2^{c}	4.3 ± 0.2	3.1 ± 0.2^{c}
DIV	4.6 ± 0.2	5.0 ± 0.2^{a}	4.4 ± 0.3^{a}	4.6 ± 0.2	4.4 ± 0.2^{a}

Results are means ± SEM. Data were analyzed by t-test followed by a multiple comparison LSD. Different superscripts represent statistically significant differences between formulations for each parameter.

Appendix 5. Colorimetry of banana drinks depending on the quantities of spirulina and vanilla whey proteins.

	Beverage mix (DI)	w/ spirulina w/ vanilla proteins (DII)	w/ spirulina (DIII)	w/ vanilla proteins (DIV)	ANOVA p-value
b*	15.38 ± 0.15^{a}	3.90 ± 0.23^{c}	3.36 ± 0.26^{c}	14.24 ± 0.13^{b}	***
L*	77.75 ± 0.11^{a}	46.75 ± 0.36^{b}	42.92 ± 0.48^{c}	76.24 ± 0.71^{a}	***

	w/ spirulina	w/o spirulina	ANOVA p-value	w/ proteins	w/o proteins	ANOVA p-value
a*	-10.42 ± 0.09^{a}	2.63 ± 0.22^{b}	***	-3.77 ± 2.98	- 4.03 ± 2.86	n.s.

Results are means ± SEM of n = 3 replicates. Data were analyzed by Multi-way ANOVA (without interaction) followed by a multiple comparison Newman-Keuls test. Different superscripts represent statistically significant differences between formulations for each parameter. ***p < 0.001, n.s.: non-significant.