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

Heritage Cereals
Product development

Sidonie Bridonneau - Romane Chauveteau

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Acknowledgment

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At the same time, we would like to thank project leader PhD Karin Gerhardt, Swedish University of Agricultural Sciences for accepting our participation in the project.

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Abstract

Local or regional crop production is increasingly attractive to consumers due to a growing interest in environmental friendliness and sustainability. Heritage cereals are an example of this as they are suitable for organic farming. Moreover, they can also contribute to a healthy and balanced diet, which is what consumers are aiming for these days. For a more regular consumption of heritage cereals, it would be interesting to build on popular food products such as bread, pasta and biscuits. The aim of this study is to develop innovative recipes based on heritage cereals. To appeal to consumers, it was decided to focus on pasta and biscuits (shortbread and cookies). Following a design with three different cereals (Vete Helkorn, Ölands Vete and Kallunda Varvete Evolutionar), 12 biscuit samples and 10 pasta samples were selected for each type of cereal. For the biscuits, the modified ingredients were butter, flour, sugar and particle size, while for the pasta the modified ingredients were salt, olive oil and also particle size. Sensory and instrumental analyses were carried out on the samples. It can be concluded that the different types of cereals have an impact on sensory aspects as well as on extension. The use of the cereal Kallunda Varvete Evolutionar decreases the intensity of the colour and the number of visible particles in the pasta. Furthermore, for both biscuits and pasta, the ingredients influence many sensory attributes. For pasta, it is mostly the coarse particles that have an impact, while for biscuits, it is mostly the type of flour. Increasing the particle size of the flour increases the hardness and grittiness of the pasta. For biscuits, flour affects colour, thickness and many other attributes. For example, reducing the amount of flour gives a more yellow colour, causes a lower density and thickness and reduces the number of visible particles. However, only pasta is concerned by a significant impact of ingredients on texture.

Keywords: heritage cereals, product development, shortbread, cookies, pasta, design, innovation, texture, sensory analysis

Background

Today, as part of a healthy and local diet, heritage cereals are increasingly attractive to consumers because of their nutritional and sensory properties. Indeed, these cereals make a positive contribution to the environment and to human health thanks to their many advantages. Among the heritage cereals, we can find einkorn, spelt, emmer, millet, Khorasan and many more.[1] [2]

Interested in sustainable and healthy food, consumers are increasingly turning their attention to products made from heritage grains. Bread, pasta and biscuits, being the most popular products, may be the products that could potentially be consumed most if they were made from heritage cereals.[2]

Definition

There is no universal definition of heritage cereals. This would facilitate the labelling of food products that have them. According to Giambanelli et al. (2013), ancient cereals are defined as “forms which are represented by populations not subjected to any modern breeding or selection, and sometimes retaining characteristics of wild ancestors, such as individual variability, height, brittle rachis, low harvest index and, in some taxa, hulled kernels”. For instance, they can be defined as cereals that have not been fundamentally changed over hundreds or thousands of years.[1]
Nowadays, the consumption of modern cereals is important but decreasing in contrast to the consumption of heritage cereals. The differences between heritage and modern cereals are many and varied. First of all, there are differences in nutrition and composition. In addition, the production of these two types of wheat is different. Modern wheat is selectively cultivated and then refined and hybridised. Hybridisation is the act of crossing two different varieties of the same species.[3] Ancient cereals, on the other hand, are natural and have not been modified over the years. Examples of ancient cereals include spelt, einkorn and emmer. Some grains date back thousands of years before modern wheat.[1]

All cereal based products may be based on heritage cereals. We find for example pasta, bread, cookies, pancakes, etc. Bread and pasta are the most consumed, at least once a week according to the study "Consumer Awareness, Attitudes and Preferences towards Heritage cereals".[2] These are then products that should be focused on for a more regular consumption of heritage cereals.

Assets

Heritage cereals have a number of advantages that are making them increasingly popular as part of a healthy diet.[1]
Firstly, the higher protein, carbohydrate, mineral and vitamin content of heritage cereals compared to modern cereals is an important advantage. Indeed, all these elements have beneficial properties for health. For example, vitamins are essential for the body because they participate in growth and are involved in the muscular, nervous and immune systems... Secondly, heritage cereals can also have a positive impact on certain diseases. For example, they may be less toxic than modern cereals for people with coeliac disease. Celiac disease is an autoimmune disease characterized by a permanent intolerance to different gluten protein fractions contained in different types of cereals such as wheat, barley or rye. Ancient cereals may have lower immunogenic properties than modern cereals and therefore be less toxic to people with celiac disease. In addition, regular consumption of heritage cereals could reduce the risk of non-communicable diseases such as cardiovascular disease, type 2 diabetes and cancer. Finally, the heritage cereals consumed could protect against oxidative stress which plays an important role in the development of human diseases. However, for all the diseases mentioned, further research needs to be carried out in order to conclude on the beneficial role of heritage cereals on them.[1]

Thirdly, modern cereals have attractive sensory properties that enable them to provide tasty and palatable products. For example, a sensory study showed that sourdough bread made from emmer and spelt received a higher score for its acidic taste than wheat bread.[1]

Finally, heritage cereal crops are suitable for environmentally friendly and climate change resistant organic farming. Indeed, heritage cereals are adapted to organic production and are more resistant than modern cereals to certain extreme climatic conditions. Furthermore, the production of heritage cereals is mainly local or regional, which supports small and medium-sized farmers and millers and also allows for sustainability. [1]

Given the benefits of heritage cereals, there are many reasons to why consumers and farmers are showing increasing interest in them. Indeed, they offer new, tasty, locally produced and healthy products.

Consumers

Nowadays, the population is consuming more and more heritage cereals based foods because of their many advantages described in the previous section. Indeed, these foods seem to be healthy, beneficial to health and respectful of the environment. It has been shown that products with the claims "ancient", "natural" and "local" are more likely to be chosen by consumers because they tend to be locally and regionally produced.[2]

According to a study of Swedish consumers from two different universities, spelt is the most well-known heritage grain variety, unlike Halland wheat. It is increasingly found in bakeries and pastry creations. Nevertheless, it has been shown that knowledge of cereals differs according to geographical location.[2]

In general, consumers place a high value on the texture and taste of foods containing heritage grains. However, factors such as age and gender influence consumer attitudes and preferences. For example, women are more interested in the origin of cereals and prefer to consume foods containing wholemeal flour than men. In addition, a study also showed that age influences attitudes toward heritage grains. Older people are more likely to spend more on heritage grain foods.[2]

Product development

Market trends are changing very quickly and so are consumer expectations. It is therefore important to innovate as much as possible. Product development involves several methods. In this case, it was decided to create designs for shortbread, cookies and pasta.

First of all, a design[4] is a set of recipe variations to understand how the ingredients influence the product together. To do this, "high" and "low" levels were selected for some of the ingredients chosen in the pre-tests. The levels should "stretch" the design so that we can still tell that it is a product (e.g. a cookie), but it does not necessarily have to be a good cookie. In addition, these "high" and "low" levels should be symmetrical to the normal value of the recipe.

Analysis of products

To study our products, several analyses can be carried out: sensory analysis, texture analysis and color measurements. In the following studies on the development of gluten-free pasta and biscuits[5] [6], sensory analysis, texture analysis and color measurements have been used.

Sensory analysis

Sensory analysis[7] is an analysis of products that requires the use of the human senses. This allows us to discover the influence of the different ingredients in the product as well as the different cereals on different attributes describing visual appearance, aroma, taste and texture.

In view of the current health situation related to Covid-19, it was decided to use a consensus method bases on the traditional “flavour profile method”[7], which involves several steps.

Prior to evaluating the samples, attributes describing visual appearance, aroma, taste and texture were discussed for evaluation on the products. A consensus was reached on the definition of each attribute.

In a second step, each extract was examined one by one by rating each attribute on an intensity scale from 0 to 100, where 0 = no intensity and 100 = the highest possible intensity. Each assessor was asked to consider the positioning of each attribute along the intensity axis. Then, after discussion, a consensus was to be reached to determine a single intensity value for each attribute.

Each assessor signed up for participation after being informed about the products and the terms of participation: voluntary participation, freedom to leave the test without giving a reason and the right to decline to answer specific questions.

Texture analysis

Texture analysis was used to determine the influence of the different ingredients and grains on the extension, compression and rupture of the doughs and finished products from the design.

During compression, the deformation was measured in mm. It corresponds to the change in size or shape of the dough. [8] The final load of compression and extension was measured on both doughs and pasta. It refers to the force, in Newtons, required to break the dough or the final products.
Following the compression analysis, the adhesive force was obtained. When the dough is in contact with a surface, adhesive forces act on it. They refer to the forces of attraction between the different surfaces to make the dough rise when measuring the compression.[9]

Finally, the rupture load was obtained and used only for biscuits. It corresponds to the force, in Newton, to break shortbread and cookies.

Colour measurements

The colour analyses provided information on the impact of the cereals and ingredients of the final products on the colour of the product. Following the color measurement, three values are obtained: L*, a* and b* which belong to the chromatic space called CIELAB. The L* corresponds to the brightness or luminosity, it takes values between 0 (black) and 100 (white). The parameter a* represents the value on a green → red axis while the parameter b* represents the value on a blue → yellow axis.[10]

Aim

To develop innovative recipes from heritage cereals that would appeal to consumers, it was decided to focus on pasta and biscuits. In addition to the visual assessment of the final product, sensory and texture analyses were performed.

Research questions

- Does the use of different heritage cereals have an impact on the texture, taste and visual appearance of the products developed?
- How do the common ingredients in a recipe influence the texture and sensory aspects of the final products?

Materials and Methods

Materials

Pre-trials

In a first step, pre-tests were conducted to observe the impact of each ingredient in the different recipes. They will then be used to produce the designs. To do this, the recipes were run many times, changing the quantity of one or more ingredients each time. So, Ingredient levels 1 and 2 were found in order to select those that work. In this case, industrial flour bought in the supermarket was used. Then the visual appearance, taste and texture of each final product were noted on a table. The results of the pre-tests can be found in Appendix 1.

Design

In a second step, designs for the pasta and biscuits were made.
A design was made by choosing 10 recipe variants for fresh pasta, 6 for biscuits and 6 for shortbread. To check whether the variations are feasible, they were made using the heritage cereals that we milled into flour from cereal kernel. Indeed, a heritage cereal flour was used to make the designs to confirm the recipes and thus the "low" and "high" levels defined previously. The design tests for the cereal Ölands Vete can be found in Appendix 2 and Appendix 3 for Vete Helkorn.

Biscuit design

Shortbreads

For the design of the shortbread, 6 recipes were chosen which gave different final products in the pre-tests. Among these 6 recipes, the following were used: the normal recipe, a recipe in which the amount of butter has been increased, a recipe in which the amount of butter has been increased and the amount of sugar has been decreased, a recipe in which the amount of butter and flour has been increased, a recipe in which the amount of sugar has been increased and the amount of flour has been decreased, and finally a recipe in which the size of the flour particles has been increased. These 6 recipes were made with the three types of cereals, which equals 18 final samples.
A decision was made to vary the amount of sugar and butter by 50 grams and to vary the amount of flour by 100 grams from the amount specified in the normal recipe. For example, in the case of the recipe in which the amount of butter was increased from 75 grams to 125 grams, see table 1.

Recipe n°	1	2	3	4	5	6
Sugar	75g	75g	25g	75g	125g	75g
Butter	75g	125g	125g	125g	75g	75g
Flour	165g	165g	165g	265g	65g	165g
Particle size	Middle	Middle	Middle	Middle	Middle	Big
Recipe :	Normal	Butter +	Butter + / sugar -	Butter + / Flour +	Sugar + / Flour -	Big particles

Table 1 : Design of the shortbreads

In the table, the coloured boxes correspond to the quantities that have been modified from the original recipe.

After making this design with flour from the three heritage cereals, it was confirmed that the results were as expected.

Cookies

To make the design of the biscuits, 6 recipes were kept from the pre-tests. Among these 6 recipes, the following were used: the normal recipe, a recipe in which the amount of flour was decreased, a recipe in which the amount of butter and sugar was increased, a recipe in which the amount of butter and flour was increased, a recipe in which the amount of butter and flour was decreased and finally, a recipe in which the size of the flour particles was increased. These 6 recipes were made with the three types of cereals, which equals 18 final samples.

However, as a result of designing with flour from heritage cereals, some of the resulting recipes did not meet expectations. For example, the dough in which the amount of flour was reduced could not be used. It was therefore decided to replace it with a recipe in which the amount of sugar was increased. Also, when the recipe with less flour and butter was made, the biscuits were very flat and sticky. They didn't look like biscuits. It was therefore decided to change the quantities, which resulted in products that can be considered as biscuits.

As a result of these changes, a new design with 6 recipes was obtained. These 6 recipes include the normal recipe, a recipe in which the amount of sugar has been increased, a recipe in which the amount of butter and sugar has been increased, a recipe in which the amount of butter and flour has been increased, a recipe

in which the amount of butter and flour has been decreased and finally a recipe in which the size of the flour particles has been increased.

In this new design, the amount of butter and sugar varies by 25 grams and the amount of flour by 70 grams, see Table 2.

Recipe n°	1	2	3	4	5	6
Sugar	85g	110g	110g	85g	85g	85g
Butter	85g	85g	110g	110g	60g	85g
Flour	150g	150g	150	250g	50g	150g
Particle size	Little	Little	Little	Little	Little	Big
Recipe :	Normal	Sugar+	Butter + / sugar +	Butter + / flour +	Butter - / flour -	Big particles

Table 2: The final design of the cookies

Fresh pasta design

The fresh pasta design includes 10 recipes previously tested in the pre-test and giving correct final products. Among these 10 recipes, the following are used: the normal recipe, then a recipe where the amount of salt has been increased, another where the amount of salt has been increased even more, then a recipe where the amount of olive oil has been increased and a recipe where the amount of olive oil has been increased more.

Then four recipes varying both ingredients at the same time: one recipe where the amount of olive oil and salt were increased with the lowest levels, one recipe where salt and olive oil were increased in large quantities, one recipe where salt was added in small quantities and olive oil in large quantities, and one recipe with salt in large quantities and olive oil in small quantities. Finally, one recipe was made with large flour particles. It was decided to increase the amount of salt by 2g and 4g compared to the amount specified in the normal fresh pasta recipe. As for the olive oil, 2 tablespoons and 4 tablespoons may be added to the recipe compared to the normal recipe. For example, in the recipe with a lot of salt and olive oil, 4g of salt and 4 tablespoons of olive oil have been added to the recipe, see Table 3.

These 10 recipes were made with the three types of cereals, which equals 30 final samples.

The normal recipe calls for 300g of flour. A normal recipe design was tested with 300g of heritage grain flour. However, the dough was very floury and impossible to pass through the pasta machine. So, it was decided to change the amount of flour to 250g. All the recipes in the design were therefore changed to use 250g of heritage flour, see Table 3.

Recipe n°1	1	2	3	4	5	6	7	8	9	10
Flour	250g	250g	250g	250g	250g	250g	250g	250g	250g	250g
Eggs	3	3	3	3	3	3	3	3	3	3
Salt	0g	0g	2g	4g	0g	0g	2g	2g	4g	4g
Olive oil (tablespoon)	0	0	0	0	2	4	2	4	2	4
Particule size	middle	larger	middle	middle	middle	middle	middle	middle	middle	middle
Recipe :	Normal recipe	Normal recipe with high particule	salt +	salt ++	Olive Oil +	Olive Oil ++	salt + / Olive Oil +	salt + / Olive Oil ++	salt ++ / Olive Oil +	salt ++ / Olive Oil ++

Table 3: The design of the pasta

After making this design with flour from heritage cereals, it was confirmed that the results were as expected.

Methods

Sensory analysis

In order to carry out the sensory analysis of the products in our design, the consensus method was used because of the current health situation. Under better conditions, i.e. in the absence of the current pandemic, methods with statistical analysis could have been carried out and more participants could have been involved in the sensory analysis. The selected sensory panel consisted of seven assessors, three of whom were part of the analytical panel. The sensory analysis was divided into two days: one day for the pasta and one day for the biscuits.

During the sensory analysis, the pasta was cooked in two stages. Indeed, the day before the analysis, the pasta was made and pre-cooked in boiling salted water (3L of water and 3 grams of salt) for 2 minutes. Then, on the day of the analysis, they were cooked again for 1 minute to test them hot and thus to have a better overview of the taste and smell. The pasta was served in a small individual container with a handful amount.
For the cookies and shortbread, each evaluator had one biscuit to evaluate taste, appearance, aroma and texture.

As described earlier in the background section, the consensus method was used to describe the visual appearance, aroma, taste and texture of the products. Definitions have been agreed for each attribute, see tables 4 & 5.

Appearance	Aroma	Taste	Texture
Colour : from yellow to brown	Butter	Sweet	Fatty : oiliness
Particules : number of particules	Caramel	Butter	Particules / grainy : number of particles (in mouth)
Thickness : from thin to thick		Cereals	Chewy : from very brittle to elastic
Density : from air to dense			Sticky : in hand and teeth

Table 4: Definition of attributes for shortbread and cookies

Apperance	Aroma	Taste	Texture
Colors intensity : Shades of brown	Fresh, grass : Freshness of the pasta: smell of herbs	Salt : From not salty to very salty	Sticky and doughy : gelatinous
Particules : Coarse, fibrous, rough, grians, grainly	Old, stale	Cereals, flour, porridge	Hardness : 0: over cooked and 100 :al dente
	Cereals, strach, dough	Rancidity : britter, astringent	Grainy : Starting to smooth (white pasta) to grainy (rye bread damish)

Table 5: Definition of attributes for fresh pasta

Preference assessment

At a seminar on heritage cereals, participants had the opportunity to test some samples of cookies and pasta. The test procedure was as follows: participants were asked to taste the three samples offered for the two types of products and then to indicate their favourite sample.

During the coffee break, the numbered samples were placed on a table. Participants were invited to taste them and then place the token corresponding to their favourite sample in a closed box. At the end of the coffee break, the tokens were counted.

Texture analysis

Texture analyses were carried out on the doughs and the final products obtained after the designs were made. For the pastes, extension and compression were analysed. For the final products, breakage was tested for biscuits while extension was tested for doughs. All measurements were performed using the Ametek Brookfield CTX texture analyser (US).
The values obtained for the different indicators (peak load, deformation peak, final load, adhesive force, rupture load, deformation rupture) were recorded in a table. All measurements were performed three times to obtain better accuracy and to be able to use statistic evaluation, see Appendix 4.

Colour analysis

The colour was measured at 3 points on the surface of the biscuits and doughs using a colorimeter (Spectrophotometer CM-600d, made in Japan). The following parameters were recorded: L*, a*, b*.

Statistics

The data of texture analysis and colour measurements were evaluated in Microsoft Excel Version X, version 16.43 and mean values and standard deviations were calculated for each indicator. To identify significant differences between the different cereals and recipes, t-tests were performed on the resulting data. The results of the t-test can be found in Appendix 5. Different letters indicate a significant difference while identical letters imply that there is no significance.

To see if there was a correlation between the texture and sensory analyses, the Pearson correlation was used. It was decided that a value greater than or equal to 0.7 in the Pearson test indicates a correlation. In addition, it was also decided to measure the correlation only between attributes that are related (e.g. between hardness and deformation).

Results and discussion

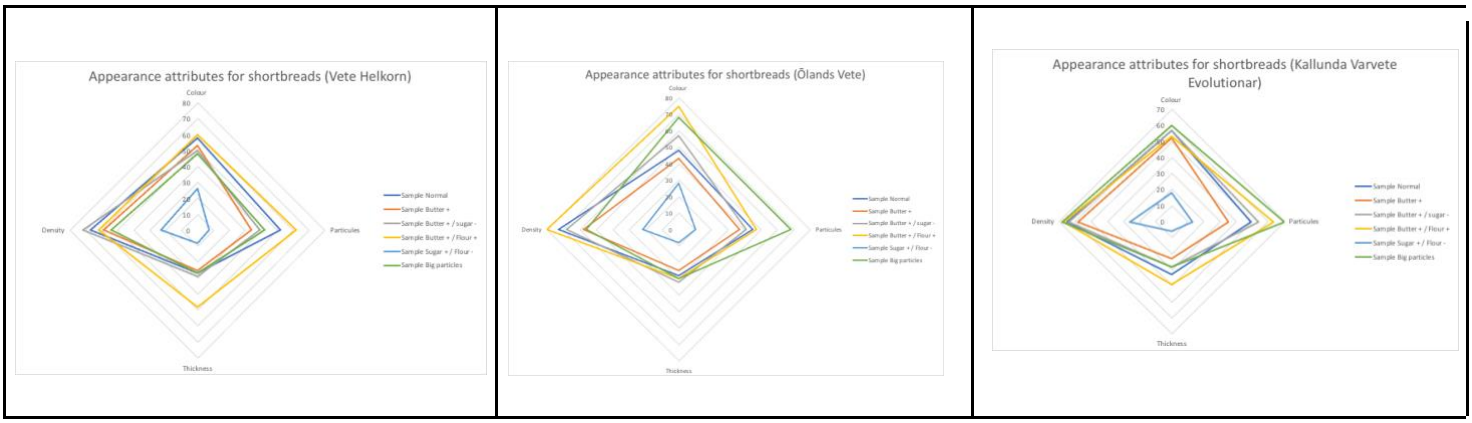
Results

Sensory analysis

The values obtained in the sensory analysis were grouped into "spider web" figures. The results of the different products were divided by cereal (Vete Helkorn, Ölands Vete and Kallunda Vete Evolutionar) and by major category (appearance, aroma, taste and texture).

Shortbreads

Appearance



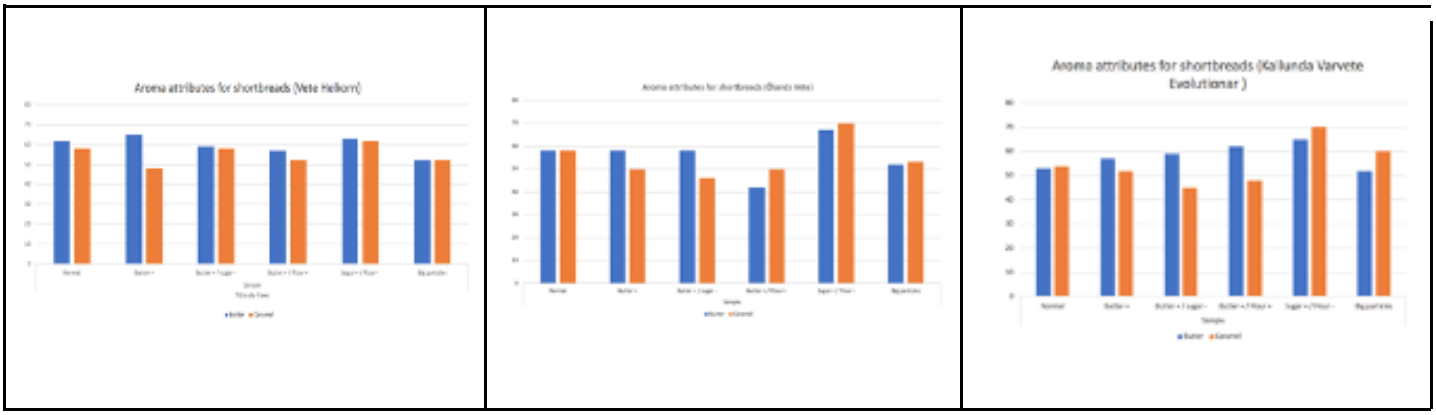
Figures 1, 2 & 3

In figures 1, 2 and 3, it can be seen that the reduction in the quantity of flour has a real impact on the various attributes measured: the colour is more yellow than for the other shortbreads, the thickness and density are lower and the number of particles is smaller.

For the cereals Ölands Vete and Kallunda Varvete Evolutionar, the higher particle size leads to an increase in the number of visible particles. Surprisingly, this is not the case for the cereal Vete Helkorn.

Regarding colour and density, the results are very different between the three cereals. It can then be said that the type of cereal can impact the influence of the ingredients on the different attributes.

Aroma

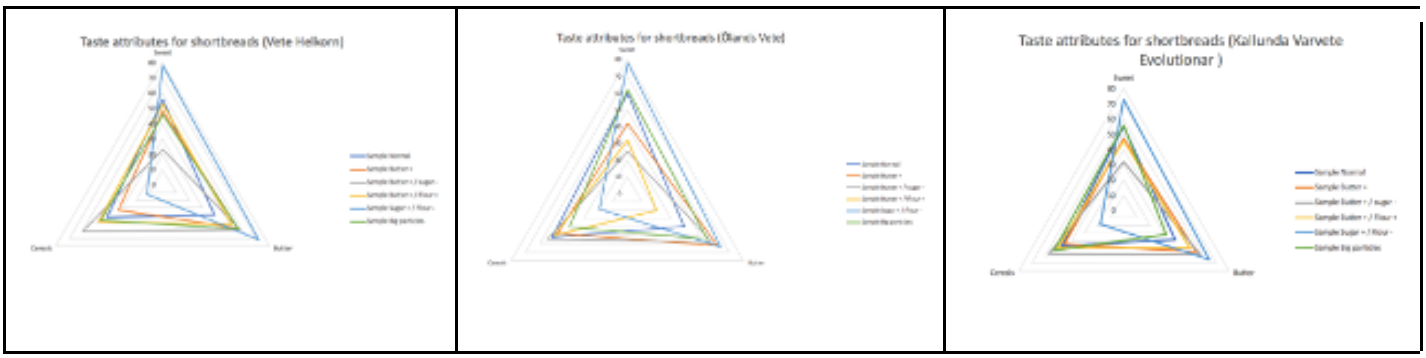


Figures 4,5 & 6

Figures 4, 5 and 6 show that for the same recipe, increasing the sugar and decreasing the flour leads to an increase in the aroma of butter and caramel.

Surprisingly, increasing the amount of butter in a recipe has no particular impact on the aroma. Similarly, increasing the particle size of the flour does not change the aroma of the product.

Taste

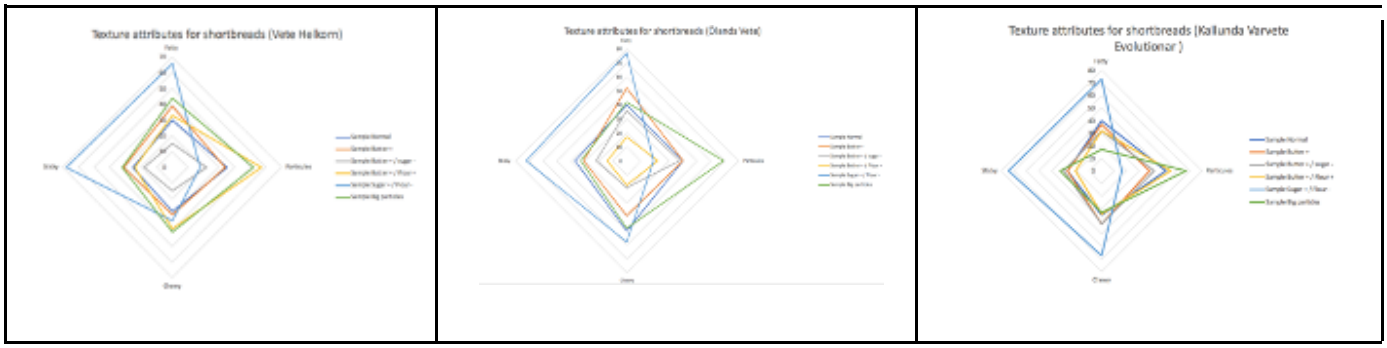


Figures 7, 8 & 9

Naturally, adding more sugar to a recipe increases its sweetness, while adding more butter results in a stronger butter taste. This can be seen in the figures 7, 8 and 9. Increasing the flour, on the other hand, decreases the sugar and butter taste and increases the cereal taste.

For the same recipe, increasing the sugar and decreasing the flour results in a much more intense sugar and butter taste than the other recipes and a much less intense grain taste. It is the increase in butter and decrease in sugar combined that results in a stronger cereal taste.

Texture

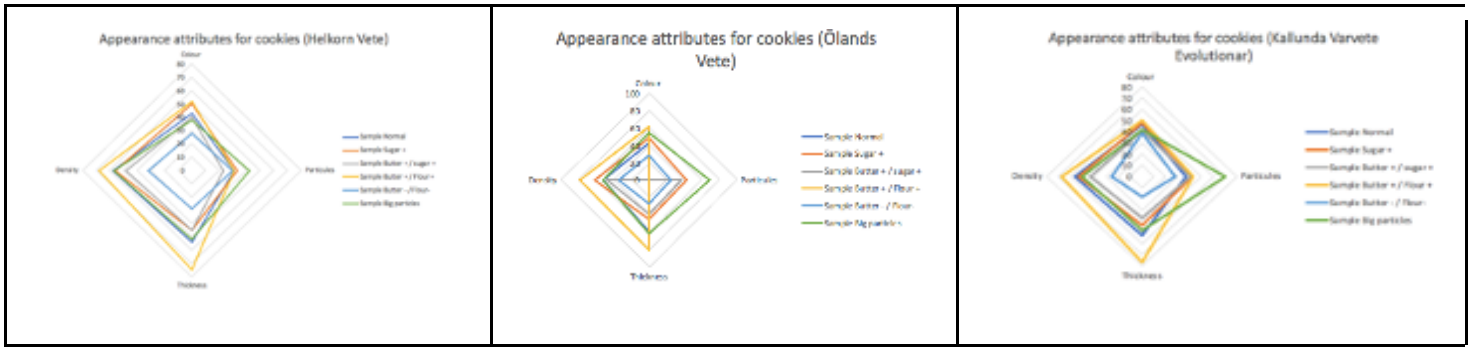


Figures 10, 11 & 12

Blatantly, in figures 10, 11 and 12, the reduction in flour makes the shortbread fatter, chewier and stickier. Surprisingly, however, increasing the butter in a recipe does not make the biscuits stickier or fatter. Naturally, the increase in particle size makes them more easily discernible by consumers.

Cookies

Appearance



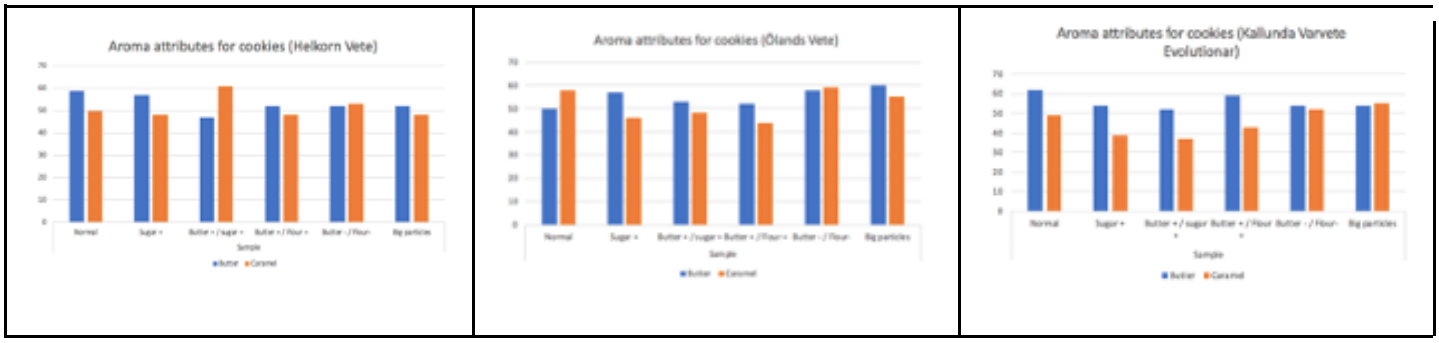
Figures 13, 14 & 15

The reduction of flour in the cookie recipe has a real impact on the different attributes measured: the colour is more yellow than for the other cookies, the thickness and density are lower and the number of particles is smaller. This can be seen in the figures 13, 14 and 15.

The increase in butter and flour combined results in a greater density and thickness of the cookies than other recipes.

Naturally, particle size increases the number of perceived particles.

Aroma



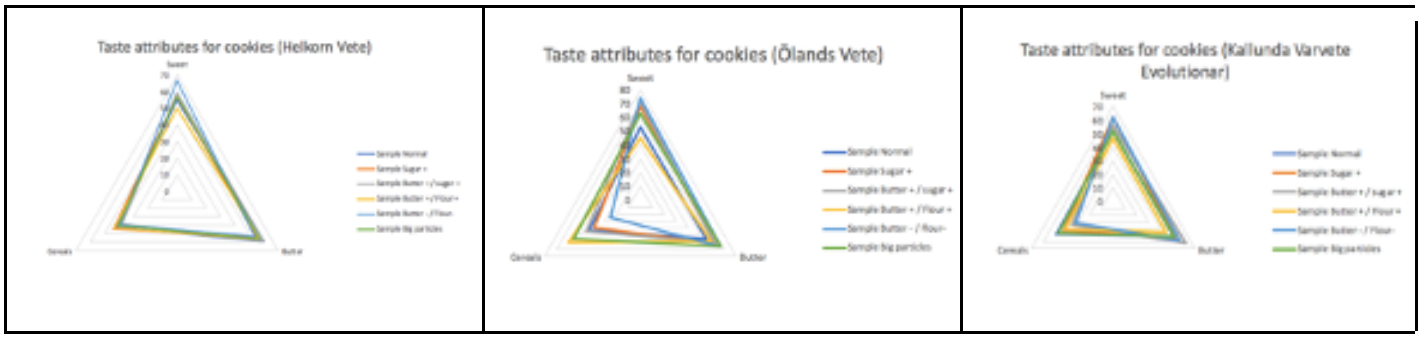
Figures 16, 17 & 18

It is observed in figures 16, 17 and 18 that no ingredient has a real impact on the aroma.

In general, the "caramel" aroma is less perceived than the "butter" aroma.

The "caramel" aroma is slightly less intense when using the Kallunda Varvete Evolutionar cereal than when using the other two cereals.

Taste

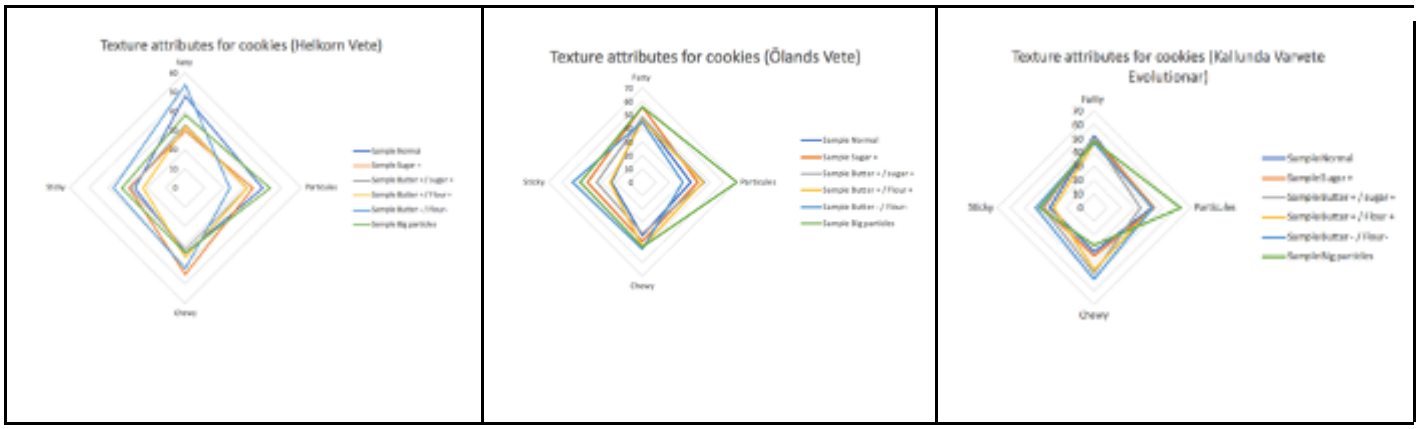


Figures 19, 20 & 21

Surprisingly, the results obtained in figures 19, 20 and 21 are quite similar between each recipe: a very intense taste in butter and sugar. Cookies with more butter or sugar are not perceived as more buttery or sweeter than "normal" cookies.

The combined reduction of butter and flour results in a slightly more intense taste in sugar but less intense in cereals.

Texture



Figures 22, 23 & 24

Blatantly, the reduction in flour makes the shortbread fatter, chewier and stickier. Surprisingly, however, increasing the butter in a recipe does not make the biscuits stickier or fatter. This can be seen in the figures 22, 23 and 24.

Naturally, the increase in particle size makes them more easily discernible by consumers.

Comparison between shortbread and cookies

Regarding visual appearance, the same results are obtained for cookies and shortbread. The decrease in flour and the increase in butter have a strong impact on the different attributes.

However, there is no real impact of the ingredients on the aroma for cookies and shortbread.

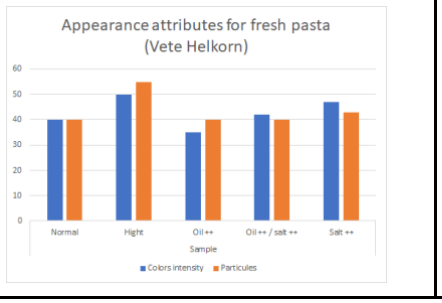
Concerning the taste, we observe a significant impact of the ingredients for the shortbread while none is observed for the cookies.

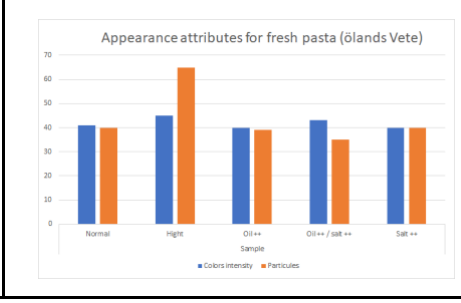
For shortbread and cookies, the reduction in flour causes a change in texture while butter has no impact.

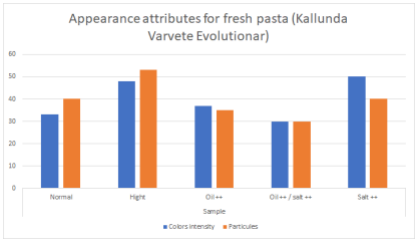
Finally, the increase in particle size has no real impact on the different attributes except for the perception of the particles.

Pasta

Appearance







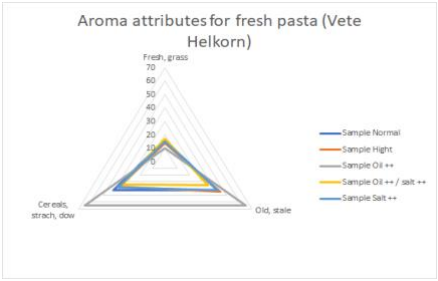
Figures 25, 26 & 27

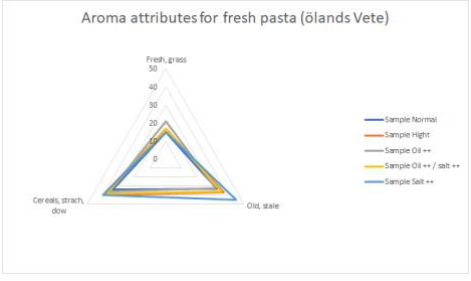
Unsurprisingly, in figures 25, 26 and 27, for all three cereals, the increase in flour particle size leads to an increase in the number of visible particles and thus the intensity of the pasta colour.

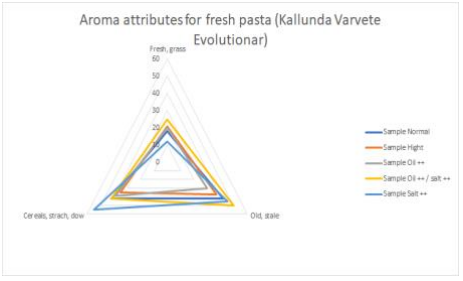
Surprisingly, the addition of olive oil does not influence the colour of the pasta compared to the normal recipe.

The type of cereal used seems to influence the appearance of the pasta with high salt content. The same is true for pasta with a lot of salts and olive oil.

Aroma





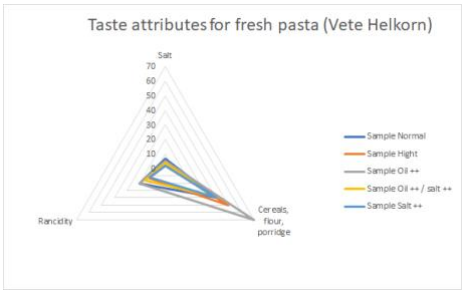


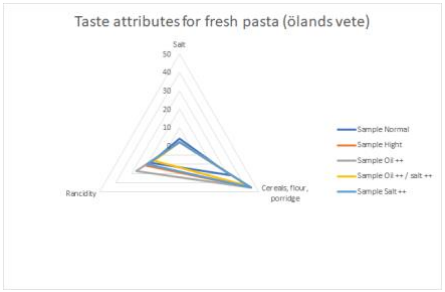
Figures 28, 29 & 30

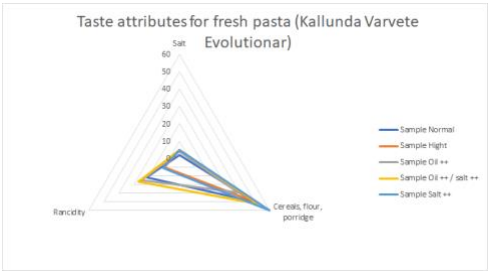
First of all, figures 28, 29 and 30 show that the combined addition of salts and olive oil has an influence on the fresh grass aroma.

Surprisingly, for all three cereals, the increase of the flour particle size has no influence on the pasta aroma since the values are almost similar to those of the normal recipe.
The type of grain used influences the aroma of "old", "grain" and "starch". The aroma of the pasta does not depend on the added ingredients but rather on the cereals used.

Taste





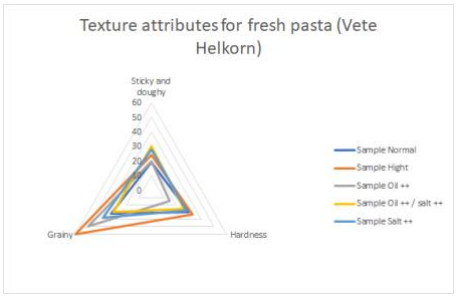


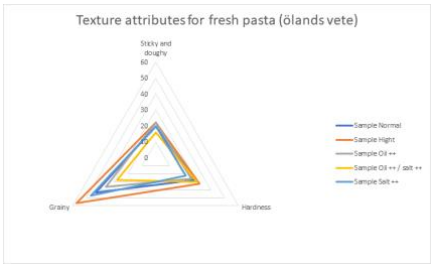
Figures 31, 32 & 33

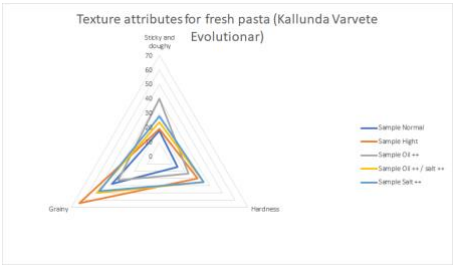
Surprisingly, salt was not perceived in the samples containing a lot of salt for the 3 cereals in figures 31, 32 and 33. This can be explained by the cooking of the pasta. Indeed, they were cooked for 2 minutes the day before the sensory analysis and then 1min30 the same day to evaluate them hot. The NaCl dissolved in the cooking water which explains the absence of a salty taste.

The rancidity and "cereal and flour" taste does not depend on the sample but on the type of cereal used - the cereals give a different taste to the pasta.

Texture







Figures 34, 35 & 36

Clearly, increasing the particle size of the flour increases the grainy texture of the pasta. This can be seen in the figures 34, 35 and 36.
Surprisingly, the pasta is not stickier when oil is added in large quantities for the cereals Vete Helkorn and Öland Vete. This is because the texture (softening and stickiness) of the pasta varies according to the type of cereal used and does not depend on the added oil or salt.
The samples with larger flour particles are much harder compared to the other recipes.

Preference assessment

The results of the preference assessment are shown in Table 7. The number of participants is not the same for pasta and biscuits because the test took place in the afternoon, which did not favour the appeal of pasta.

	Cookies			**Pasta**		
Recipe	Normal	Butter + / flour +	Butter + / sugar +	High particles	Olive oil ++	Salt ++
Number of votes	1	8	8	1	4	6

Table 7: Results of the preference test

For the cookies, there is a perfect equality between the cookies in which the amount of butter and sugar has been increased and the cookies in which the amount of butter and flour has been increased. On the other hand, the "normal" cookies were the least popular.

With regard to pasta, it can be observed that the participants preferred the sample with a higher salt content. Pasta with a larger flour particle size was not appreciated.

This test only allows us to know the preferences of the seminar participants. It does not allow any conclusions to be drawn. This would have required more than 100 participants.

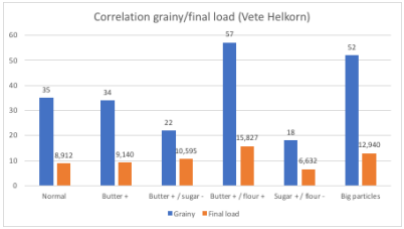
Texture analysis and colour measurements

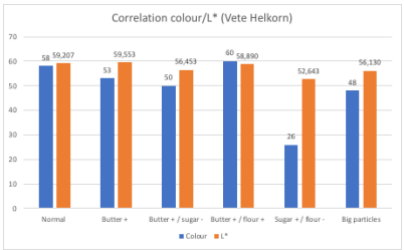
As previously mentioned, correlations between the texture and sensory analyses were performed using the Pearson test and presented in figures. All samples are included in each figure.

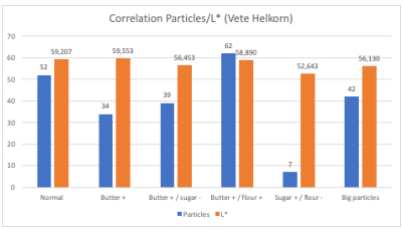
Shortbreads

The t-test between the cereals allows us to see if the type of cereal has an impact on the texture. In the case of shortbread, the type of grain has no impact on compression, extension, breakage or colour. No significant differences were observed, see Appendix 5 (b).

The t-test between the recipes allows us to conclude whether the samples differ significantly and whether the ingredient can be said to have had an impact on the texture.





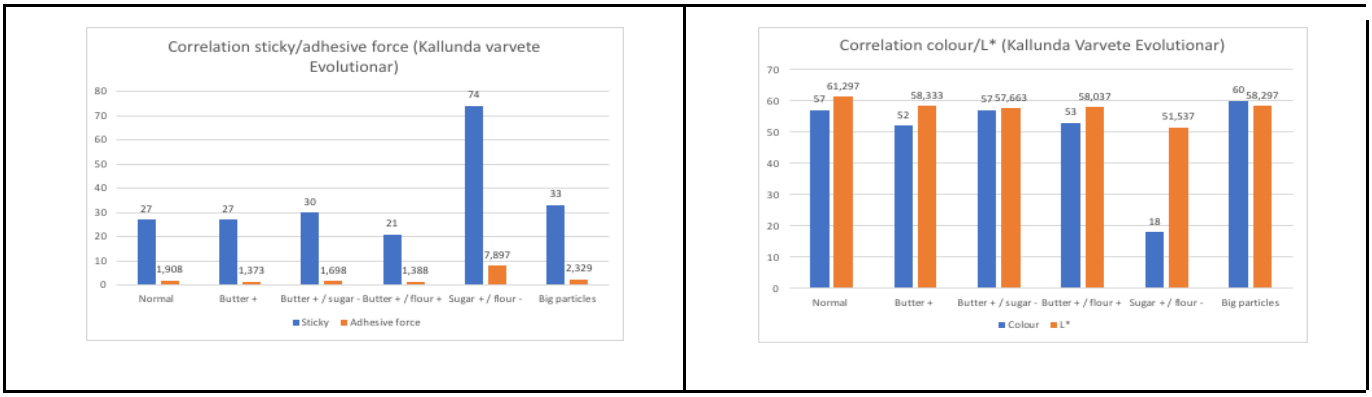


Figures 37, 38 & 39

Figure 37 shows the correlation (0,781) between the sensory analysis attribute "grainy" and the texture analysis compression final load for the Vete Helkorn cereal. Butter and flour content or larger flour particle size seem to impact the grainy appearance and compression of the shortbread. Indeed, higher values were observed by a higher content of the ingredients. A high content of sugar seemed to lower the graininess and compression value. However, following the t-test, no significant difference was observed between the recipes, so it is not possible to say that the design parameters have a significant impact on grainy and compression.

Figure 38 shows the correlation (0,936) between the sensory analysis attribute "color" and shortbread lightness for the Vete Helkorn cereal. It can be observed that an increase in the amount of sugar and a decrease in the amount of flour combined can slightly impact the color and brightness as slightly lower values are obtained. However, the t-test does not indicate a significant difference between this recipe and the others and may therefore not have a significant impact on these measurements.

Figure 39 shows the correlation (0,792) between the sensory analysis attribute "particles" and lightness for the cereal Vete Helkorn. It can be observed, as in figure 38, that an increase in the amount of sugar but a decrease in the amount of flour have an impact on the perception of particles and brightness. Indeed, the values obtained for this recipe are lower. However, the t-test does not indicate a significant difference which means that the ingredients do not have a significant impact on these measures.



Figures 40 & 41

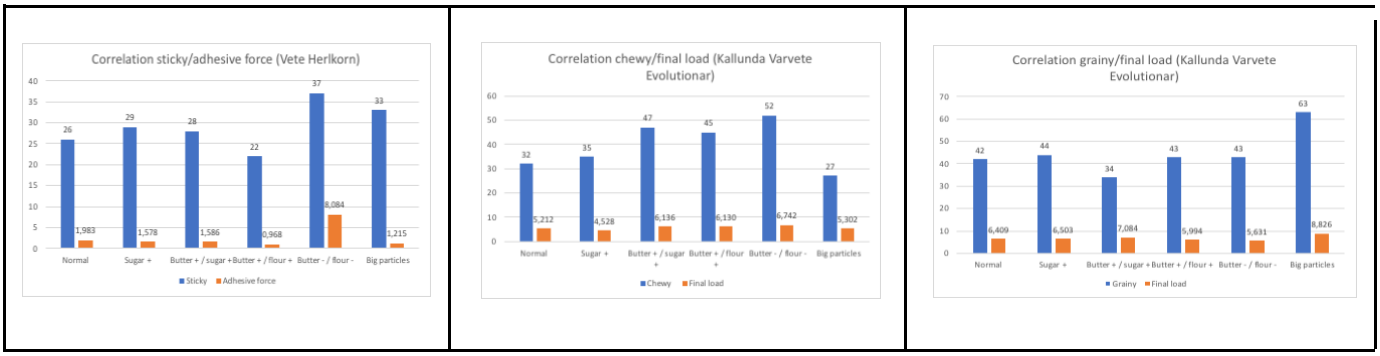
Figure 40 shows the correlation (0,991) between the attribute "sticky" from the sensory analysis and the adhesive force for the cereal Kallunda Varvete Evolutionar. According to the diagram, an increase in the amount of sugar combined with a decrease in the amount of flour has a strong impact on the stickiness and adhesive force of the shortbread. The values obtained for the "sugar + / flour -" recipe are clearly higher than for the others. However, the impact of sugar and flour cannot be confirmed as significant on these parameters as the t-test does not show a significant difference between the recipes, although there is a clear trend.

Figure 41 shows the correlation (0,911) between the attribute "colour" and lightness for the Kallunda Varvete Evolutionar grain. In the diagram, lower values are observed for the recipe "sugar + / flour -". A variation in the amount of sugar and flour would therefore affect the colour and brightness of the shortbread. However, following the results of the t-test, it cannot be confirmed that these two ingredients have a significant impact on the measured parameters.

Cookies

The t-test between the cereals allows us to see if the type of cereal has an impact on the texture. In the case of cookies, the type of cereal only has a significant impact on extension as there is a significant difference between the three cereals, see Appendix 5 (b).

The t-test between recipes allows us to conclude whether or not the different ingredients have a significant impact on texture.

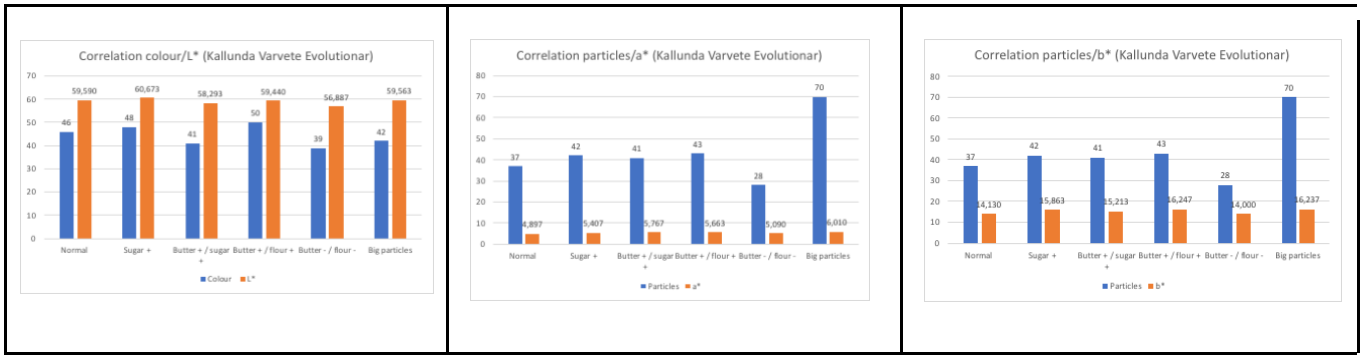


Figures 42, 43 & 44

Figure 42 shows the correlation (0,734) between the attribute "sticky" and the adhesive force for the cereal Vete Helkorn". The amount of butter and flour seem to impact both parameters. Indeed, an increase in the quantities of these two ingredients allows to decrease the stickiness and the adhesive force while a decrease in the quantities allows to obtain higher values of the parameters. However, the results of the t-test do not allow to say that the impact of sugar and flour is significant.

Figure 43 shows the correlation (0,832) between the attribute "chewy" and the final load of the compression for the cereal Kallunda Varvete Evolutionar. It can be observed that a combined decrease of butter and flour can have a slight impact on the chewiness and extension as slightly higher values are obtained. On the contrary, an increase in particle size has an impact on the softness and compression by obtaining slightly lower values. However, according to the results of the t-test, it is not possible to conclude on a significant impact of these ingredients on the parameters.

Figure 44 shows the correlation (0,710) between the attribute "grainy" and the final load of the extension for the Kallunda Varvete Evolutionar grain. In this figure, we can see an impact of the coarse particles on the grainy and the extension. Indeed, higher values can be observed. Following the t-test, it is possible to conclude on the significant impact of coarse particles on extension and graininess.



Figures 45, 46 & 47

Figure 45 shows the correlation (0,774) between the attribute "colour" and lightness for the cereal Kallunda Varvete Evolutionar. It can be seen from the figure that no ingredient affects both parameters. The values obtained are very similar. This can be confirmed by the t-test which shows no significant difference between the recipes.

Figure 46 shows the correlation (0,778) between the attribute "particles" and a* which corresponds to the colours from green to red for the Kallunda grain Varvete Evolutionar. There is a very strong impact of large particles resulting in increased values for particle perception and colour. However, this impact is not considered significant following the t-test.

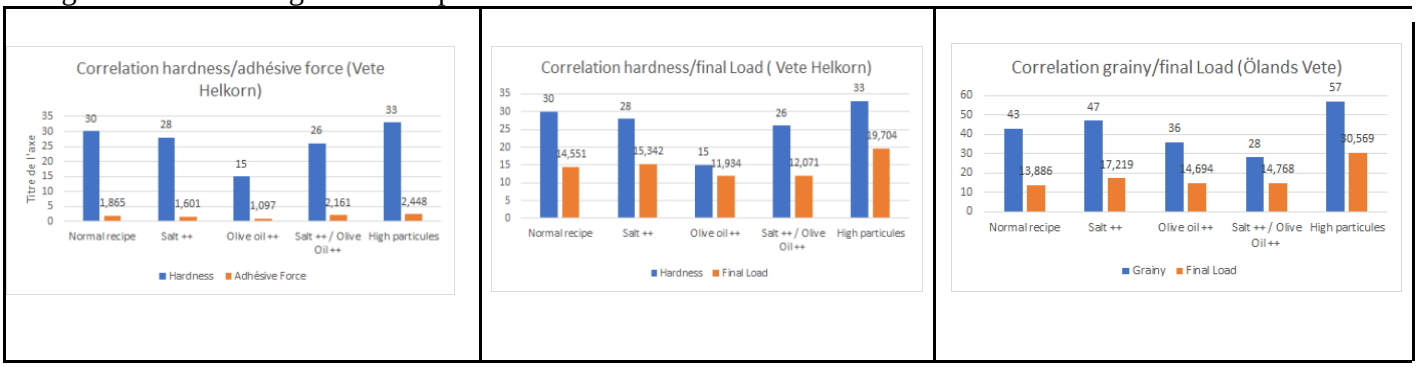
Figure 47 shows the correlation (0,719) between the attribute "particles" and b* which corresponds to the colours from blue to yellow for the Kallunda Varvete Evolutionar grain. As in figure 46, a strong impact of large particles is observed on both parameters, resulting in an increase of the values obtained. However, this impact is not significant according to the t-test.

Fresh pasta

The t-test between the cereals allows us to see if samples with different type of cereals are significantly different.

As far as fresh pasta is concerned, significant differences can be observed between the different cereals for pasta extension. Thus, the type of cereal used does not have a significant impact on the compression and extension of the dough and on the colour of the fresh pasta, see Appendix 5 (b).

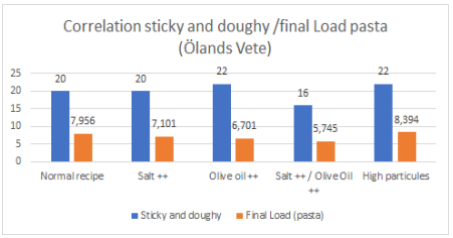
The t-test between recipes allows us to conclude whether or not samples differ and thereby if the different ingredients have a significant impact on texture.

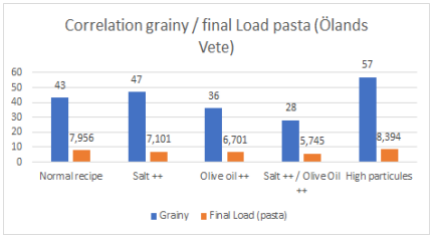


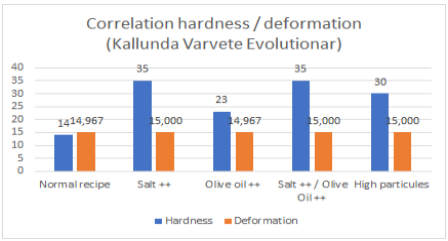
Figures 48, 49 & 50

Figure 48 shows the correlation (0.843) between the attribute "hardness" obtained in the sensory analysis and of the "adhesive force" of compression in the texture analysis for the pasta obtained with the Vete Helkorn cereal. The pasta containing large flour particles seems to have higher values of "hardness" and "adhesive force" compared to the other pasta. However, the difference is significative. The size of the flour particles may have an influence on the texture on both the hardness of the pasta and on the adhesive force. However, when comparing with the t-test values, we do not observe a significant difference between "High particles" and the other recipes. Moreover, a very high amount of olive oil also influences the hardness and the adhesive strength since the values obtained are low compared to the values of the other recipes. The t-test indicates that there is no significant difference, which could be explained by almost similar values of "adhesive force".

The same results can be observed for the attribute "Hardness" and the "Final Load" of the compression (0.759) for Vete Helkorn cereal (Figure 49). Thus, the size of the flour particles may have an influence on the hardness of the pasta and the final load of the dough of the pasta. In comparison with the results of the t-test, the differences are significant with the doughs of the normal recipe and those with a very high amount of salts. However, they are not significant with pasta containing a lot of olive oil and pasta with a high amount of olive oil and salts. In addition, a very high amount of olive oil also influences the hardness and the final load since the values obtained are low compared to the values of the other recipes.The results of the t-test indicate that there is no significant difference between the recipes.
Figure 50 shows the values of the attribute "Grainy" obtained in the sensory analysis of the pasta and the "Final Load" of the dough compression for the cereal Öland Vete (correlation: 0.763). Pastas with higher flour particles seem to have generally higher values than other pasta recipes. Looking at the t-test results, the differences are indeed significant with the other recipes.







Figures 51, 52 & 53

The correlation (0.704) between the attribute "Sticky and doughy" of the sensory analysis and the "Final Load" of the pasta extension, with Öland Vete cereals, can be observed in figure 51. For the pasta with a high amount of salt and olive oil, the values are lower compared to the other recipes. Thus, the combined addition of salts and olive oil may have an influence on the sticky and pasty texture of the pasta as well as on the final load of the pasta extension. Looking at the t-test results, the differences are significant with the other recipes except for the normal recipe. The impact is therefore relatively significant.

Figure 52 shows the correlation (0.905) between the attribute "grainy" and the final load of the pasta extension. Higher values for both indicators can be observed for pasta with larger flour particles. Thus, larger flour particles may have an influence on the grainy texture of the pasta and the final load of the pasta extension. The t-test values obtained indicate that the differences are significant with the other recipes except for the normal recipe. Thus, the impact of the large flour particles is significant.

Finally, Figure 53 shows the correlation (0.907) between the attribute "Hardness" from the texture analysis and the dough compression deformation values for Kallunda Varvete Evolutionar cereals. It can be seen that the addition of salt or olive oil has a significant impact on the hardness of the pasta. Conversely, the deformation values during dough compression are similar. The t-test values, based on the deformation, indicate that the differences are not significant.

Discussion

Sensory and texture analysis

Articles "Sensory profiles of cooked grains from wheat species and varieties"[11] and " Evaluation of wheat and emmer varieties for artisanal baking, pasta making, and sensory quality"[12] presenting sensory analyses obtained between food products composed of different cereals show differences for all sensory aspects between the different cereals. Indeed, for example, in the second article cited, significant differences between emmer varieties for roughness, granulometry, firmness and cohesion of pasta were obtained. The results obtained in these articles coincide with the results obtained for pasta, since in the sensory analysis, differences were observable between the 3 types of cereals for each attribute. However, for biscuits, the type of cereal had only a slight impact on the aroma or the visual appearance of the product.

For shortbreads and cookies, it was found that the reduction in flour causes a change in texture while butter has no impact. However, in the "A new sensory tool to analyse the oral trajectory of biscuits with different fat and fibre contents"[13] analysis, increasing and decreasing the amount of butter plays a role in the texture of the biscuits, particularly in terms of their crispness and crunchiness. The flour used in this analysis is industrial flour. It can then be concluded that the use of heritage cereals reduces the impact of fat on the texture of the biscuits.

Finally, the following study "Mealworms as Food Ingredient-Sensory Investigation of a Model System"[14] concluded that large flour particles have a significant impact on the sensory aspects of the products (texture, smell, colour). Indeed, the larger the size of the flour particles, the greater the perceived coarseness and crispness. This is consistent with the results obtained for pasta in the sensory analysis but not for biscuits (shortbreads and cookies). Furthermore, in this study, increasing the amount of salt increased the salty taste and increasing the amount of oil had an impact on the colour of the pasta. These results do not coincide with those obtained for pasta for either salt or olive oil. This can be explained by the pre-cooking of the pasta, carried out the day before the sensory analysis.

General discussion

This study has some limitations. First of all, during the sensory analysis, choices had to be made in order to facilitate the procedure. For example, it was decided to keep only one value following the consensus. Several values and replicates would have allowed a better precision and statistical analyses could have been applied afterwards. Indeed, in some cases it would have been better to maintain a scale rather than the average value. Furthermore, the sensory analysis of the pasta is questionable because it was pre-cooked the day before and then reheated in boiling water before analysis. This pre-cooking may alter the perception of certain attributes such as saltiness. Finally, few people were able to participate in the sensory analysis because of the current situation with covid-19. The results are therefore less representative.

In a second step, the statistical analyses were only carried out using the Excel tool. This is a simple software, but it would have been interesting to use a specific statistical software like R-studio.

Thirdly, the use of the machine to measure extension, compression and rupture was a breakthrough. Indeed, we had never used a machine of this type for texture analysis. We had to research how to use it and watch tutorials. Thus, the measurements may be questionable and should be taken with caution.

Finally, the wheat milling machine was not very accurate and therefore could produce irregular flour particle sizes. Thus, some analyses may be disturbed by a different particle size.

Conclusion

In this paper, we ask two questions: Does the use of different heritage cereals have an impact on the texture, taste and visual appearance of the products developed? How do the common ingredients in a recipe influence the texture and sensory aspects of the final products?

Firstly, regarding the shortbread, it can be said that the type of cereal used has an impact on the appearance of the product because the results concerning colour and density are very different between the three cereals used. To take one example, the "butter + flour +" sample has a much more yellow colour with the Ölands Vete cereal than with the other two cereals used. On the contrary, the “butter +” sample has a less yellow colour with this cereal. For all other sensory aspects as well as for texture, no impact of the different types of cereals can be visualised. On the other hand, the ingredients only have an impact on the sensory aspects. Reducing the amount of flour gives a more yellow colour, causes a lower density and thickness and reduces the number of visible particles. It also makes the shortbread stickier, chewier and fatter. Sugar and butter impact the sweetness and butteriness respectively, as well as the cereal taste. Finally, naturally, the increase in the number of particles leads to an increase in the visible particles. So, we can see trends for sensory analysis as we can see trends for texture analysis. However, it is not possible to conclude on a significant impact of the ingredients on the textural aspects.
For cookies, the type of cereal has an impact on the aroma of the biscuits but also on the extension. Indeed, the "caramel" aroma is slightly less intense when using the Kallunda Varvete Evolutionar cereal than when using the other two cereals. Otherwise, no impact of the cereal type on the other sensory and textural aspects can be observed. On the other hand, only certain ingredients have an impact on the sensory aspects. As with shortbread, reducing the amount of flour gives a more yellow colour, causes a lower density and thickness and reduces the number of visible particles. It makes them stickier, chewier and fatter. However, butter and sugar do not have an impact on the buttery or sweet taste. Butter also has no impact on the texture of the cookies measured in the sensory analysis. Finally, increasing the particle size leads to an increase in the number of visible particles. Pearson's correlation and t-test also confirmed the impact of large particles in increasing granularity and extension. Moreover, only this impact is significant, the other ingredients do not have a significant impact on texture, although trends can be observed.

Finally, concerning the pasta, the sensory analysis showed that the type of cereal used has an impact on the aroma, appearance and taste of the pasta. Indeed, different values were obtained between each cereal in the sensory analysis, which validates this finding. For the appearance attribute, the lowest values were obtained with the Kallunda Varvete Evolutionar cereal. The use of this cereal reduced the intensity of the colour and the number of visible particles in the pasta. For the sample with a lot of olive oil, the cereal taste is increased with the cereal Vete Helkorn, compared to the other cereals. Regarding the aroma, the use of Vete Helkorn cereal in the sample with a lot of olive oil also increased the "old" and cereal aroma. The t-test values allow to conclude that the differences between the cereals are mainly visible during the extension of the pasta during the texture analysis.
Furthermore, the ingredients have no impact on the texture and sensory aspects of the pasta except for the large flour particles. Indeed, during the sensory analysis, large flour particles have an impact on the texture (harder and more granular), appearance (larger number of visible particles) and taste (during the seminar). Indeed, during the seminar, the pasta sample with large flour particles corresponds to the least appreciated sample. An increase in particle size increased the taste of cereals and flour with Vete Helkorn and Öland Vete. The Pearson correlation and t-test values show that coarse flour particles have a significant impact on the grainy texture and on the final charge during dough compression and pasta extension. A combined increase in the amount of salt and oil decreased the sticky texture as well as the final load of the pasta extension. In the sensory analysis, this combined increase increased the fresh grass aroma.

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Appendix

Appendix 1 : Pre-tests of shortbreads, cookies and pasta

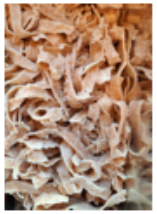
	Normal recipe	Flour +	Flour -	Sugar +	Sugar -	Butter +	Butter -	Butter + / sugar +	Butter - / sugar -	Butter + / sugar -	Butter - / Sugar +	Sugar + / Flour +	Sugar - / Flour -	Sugar + / Flour -	Sugar - / Flour +	Butter + / flour +	Butter - / flour -	Butter + / flour -	Butter - / Flour +	Icing sugar	Larger grains of flour
Visual aspect	++	OK	+	+	-	++	++	++	--	+	--			+		OK	+	Ok		++	++
Taste	++	OK (a little dry)	+	+	- (bland and dry)	++	++	++	--	++	-			+		+	Ok	+		++	OK
Texture	Crispy	Crispy	Crispy and soft	Crispy	Crispy and soft	Crispy	Crispy	Crispy	Very elastic	Crispy and soft	Very crispy			Crispy and soft		Crispy and soft	Crispy and soft	Crispy		Crispy	Crispy and soft
Comments	A little floury, a little more butter? Perfect sugar	Very brittle dough, impossible to spread with the roller	Very sticky dough, impossible to spread with the roller	Rather brittle dough impossible to roll out	Very floury and therefore very breakable dough	Dough possible to roll out	Dough possible to roll out	Good dough but rather sticky	Very floury dough, impossible to spread	Good dough, easy to spread Looks a lot like real shortbread, lacks a little sugar	Disgusting	Dough too floury, impossible to use	Dough much too sticky due to butter	Dough very sticky due to the lack of flour. Too sweet	Dough too floury, impossible to use	Dough not possible to spread	Dough too sticky due to lack of flour	Dough very sticky due to butter	Dough too floury, impossible to use	Very good dough	Good dough
Photos												No picture									
Numéro	///	100	110	140	150	180	190	220	230	240	250			360		370	380	390		400	410

	Normal recipe	Flour +	Flour -	Sugar +	Sugar -	Butter +	Butter -	Butter + / sugar +	Butter - / sugar -	Butter + / sugar -	Butter - / Sugar +	Sugar + / Flour +	Sugar - / Flour -	Sugar + / Flour -	Sugar - / Flour +	Butter + / flour +	Butter - / flour -	Butter + / flour -	Butter - / Flour +	Larger grains of flour
Visual aspect	++	--	--	++	-	+	-	+	--	OK	-	-			-	OK	++		-	+
Taste	+ (because of sugar)	-	++	+	OK (bland)	+	-	+	--	-	OK	OK			-	+	+		- (tasteless)	+
Texture	Crunchy and soft	Soft	Soft	Soft	Soft	Soft	Soft	Crunchy and soft	Crunchy and soft	Soft	Soft	Soft			Soft	Crunchy and soft	Soft		Soft	Soft and granular
Comments	A little too sweet Very good dough (not sticky)	Very long cooking time No taste	Very flat cookies	Good dough but not possible to roll out	Very floury dough and therefore very breakable (like shortbread)	Sticky paste, therefore difficult to handle	Very long cooking time No taste	Good dough Very sweet cookie	Bland, too floury	Too much butter	Good dough Very sweet cookie	Tasteless	Dough much too sticky due to butter	Dough much too sticky due to butter	No taste Dough too floury	Good dough Very good texture, good cookies	Very sticky dough due to lack of flour Too sweet	Dough too sticky due to butter, impossible to use	Dough too floury, difficult to use	Dough a little sticky due to butter Maybe undercooked
Photos													No picture								
Numéro	///	120	130	160	170	200	210	260	270	280	290	300			310	320	330		340	350

Recipe	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	23
Quantities	Normal recipe	High salt +	High salt ++	Low flour	Low flour	Low flour	Low flour without salt	High flour	High flour	High flour without salt	Low eggs	High eggs	With Olive Oil High +	With Olive Oil High ++	Low Flour - Low Eggs - High olive oil	High Flour - High Eggs -High olive oil	Middel with big particuleof flour : **Midel**	Middel with big particuleof flour : **High Flour**	Low Flour - Low Eggs	High Flour - High Eggs	High Flour - High Eggs	High Flour - Low Eggs	Low Flour - High Eggs
Flour	300g	300g	300g	150g	200g	250g	250g	450g	350g	350g	300g	300g	300g	300g	250g	350g	300g	375g	250g	450g	350g	350g or 450g	250g
Eggs	3	3	3	3	3	3	3	3	3	3	2	4	3	3	2	4	3	3	2	4	4	2	4
Salt	0g	1g	5g	1g	1g	1g	0g	1g	1g	0g	0g	0g	0g	0g	0g	0g	0g	0g	0g	0g	0g	0g	0g
Olive oil (tablespoo n)	0	0	0	0	0	0	0	0	0	0	0	0	2 tablespoons	5 tablespoons	2 tablesspoons	5 tablespoons	0	0	0	0	0	0	0
Observatio n of the dough	Very good : flexible and smooth. Dough yellow and sticky	Smooth and flexible. Dough yellow and sticky	Correct but sticky	The dough is sticky, very wet and cannot be used	The dough is very sticky, very wet and cannot be	The dough is sticky and very yellow color	The dough is sticky and very yellow color	The dough cannot be rolled out. It is too floury with large pieces of flour. It is too thick and does not pass through the	the dough is floury, grainy and cracked. It is not smooth	Floury ans tasteless. Some flour in the bowl	The dough is floury. It is not possible to make a ball	The dough is sticky	The dough is smoothy soft	The dough is elastic ans smooth	The dough is very good ans elastic	The dough is floury	The dough is sticky and hard	The dough is breakable/brittle and compact	Impossible to roll out because the dough is floury and breakable	there is still flour in the bowl: floury and breakable	Sticky but correct	Impossible to make a ball : very floury like crumble	Impossible to make a ball : very sticky
Visual aspect	++	+	++	//	//	-	//	+	+	+	//	//	+	+	++	+	-	//	//	++	++	//	//
Taste	++	++	++	//	//	+	//	+	++	+	//	//	-	-	++	+	+	//	//	++	+	//	//
Texture (Pasta)	Correct	Correct	Correct	//	//	Slime	//	Slime	Correct and less slime	Correct and less slime	//	//	Sticky	Very sticky	Correct	Correct	Granular	//	//	Correct	little sticky	//	//
Observatio ns (Pasta)	Nice taste of eggs and good texture but tasteless (no salt)	Nice taste of eggs and good texture	Correct but salted	//	//	the pasta is a little whiter and sticky.	//	they are very easy to cut in the pasta machine. The dough is not smooth and grainy. There is still some flour in the bowl	They look like the pasta of the traditional recipe.	They look like the pasta of the traditional recipe but tasteless	//	//	Olive oil has an impact on the appearance of the pasta. They are sticky and gluey. It has a different taste.				the cooking water is yellow and there is a lot of foam.	//	//		Correct	//	//
Photo																								
Number	201	//	200	//	//		101	110	120	130	//	//	160	170	250	260	180	190	//	210	200	//	//

Appendix 2 : Testing shortbreads and pasta designs with Ōlands Vete cereal

	Normal recipe	Butter +	Butter + / sugar -	Butter + / Flour +	Sugar + / flour -	Big particles (12)
Visual aspect	++	++	++	-	OK	+
Taste	++	+	+	Ok	+	+
Texture	Crispy and soft	Soft	Crispy	Crispy and soft	Crispy and soft	Crispy
Comments	Good dough and good shortbread	Good dough	Good dough Good shortbread but not sweet enough Tasteless	Dough too floury, impossible to spread	Dough very sticky due to the lack of flour	Good dough but difficult to spread
Photos						
Numéro	100	150	110	120	130	140

Recipe testing	0	1	2	3	4	5	6	7	8	9	10
Quantities	Normal recipe	Normal recipe	Normal recipe with high particule	Salt +	Salt + +	Olive Oil +	Olive Oil ++	Salt + / Olive Oil +	Salt + / Olive Oil ++	Salt ++ / Olive Oil +	Salt ++ / Olive Oil ++
Flour	300g	250g	250g	250g	250g	250g	250g	250g	250g	250g	250g
Particule of flour	Middle	Middle	Larger	Middle	Middle	Middle	Middle	Middle	Middle	Middle	Middle
Eggs	3	3	3	3	3	3	3	3	3	3	3
Salt	0g	0g	0g	2g	4g	0g	0g	2g	2g	4g	4g
Olive oil (tablespoon)	0	0	0	0	0	2	4	2	4	2	4
Observation of the dough	Too floury due to flour	//	Correct but sticky	//	Correct but little floury	//	Correct but little sticky	Correct	Correct but little sticky	//	Correct but stichy
Visual aspect (Pasta)	//	//	--	//	++	//	-	++	+	//	++
Taste (Pasta)	//	//	-	//	++	//	-	-	--	//	+
Texture (Pasta)	//	//	Breakable	//	Normal	//	Sticky	Correct	sticky	//	little sticky
Observations (Pasta)	//	//	Dough difficult to spread in the pasta machine: brittle and sticky	//	Correct	//	Tasteless	Correct	sticky	//	correct
Photo		//		//		//				//	

Appendix 3 : Testing cookies and pasta designs with Vete Helkorn cereal

	Normal recipe	Sugar +	Butter + / sugar +	Butter + / Flour +	Butter - / Flour -	Butter - / Flour - (suggestion of new quantities)	Big particles
Visual aspect	Ok (not spread out)	++	+	OK	-	++	+
Taste	++	++	++	+	+	++	+
Texture	Soft	Soft and crispy	Soft and crispy	Soft	Crispy	Soft and crispy	Soft
Comments	Good dough	Good dough and good cookies	Good dough and good cookies but breakable	Good dough. Not much taste	Dough too sticky due to butter Very flat cookies, very sweet	Better dough and better cookies (less sweet)	Dough a little sticky
Photos							
Numéro	200	210	250	260	270	230	280

Recipe testing	1	2	3	4	5	6	7	8	9	10
Quantities	Normal recipe	Normal recipe with high particule	Salt +	Salt + +	Olive Oil +	Olive Oil ++	Salt + / Olive Oil +	Salt + / Olive Oil ++	Salt ++ / Olive Oil +	Salt ++ / Olive Oil ++
Flour	250g	250g	250g	250g	250g	250g	250g	250g	250g	250g
Particule of flour	Middle	Larger	Middle	Middle	Middle	Middle	Middle	Middle	Middle	Middle
Eggs	3	3	3	3	3	3	3	3	3	3
Salt	0g	0g	2g	4g	0g	0g	2g	2g	4g	4g
Olive oil (tablespoon)	0	0	0	0	2	4	2	4	2	4
Observation of the dough	//	compact	//	good	//	good	Correct	Little sticky	correct	correct
Visual aspect (Pasta)	//	++	//	++	//	++	++	++	++	++
Taste (Pasta)	//	-	//	++	//	+	+	-	+	+
Texture (Pasta)	//	granular	//	correct	//	good	good	little sticky	little sticky	little sticky
Observations (Pasta)	//	correct	//	correct	//	correct	correct	correct but sticky	correct but sticky	correct
Photo	//		//		//					

Appendix 4 : Results of the texture analysis for shortbreads, cookies and pasta

SHORTBREADS		Cereals	Normal		Butter +		Butter + / sugar -		Butter + / flour +		Sugar + / flour -		Big particles	
			Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation
COMPRESSION	Peak load (N)	Helkorn Vete	10,423	4,444	10,298	2,421	12,558	4,891	18,586	4,063	11,851	4,144	15,834	5,666
		Ölands Vete	14,257	4,931	12,458	1,035	16,471	1,394	29,701	15,245	5,685	2,081	10,885	3,850
		Kallunda Varvete Evolutionar	10,360	3,004	6,777	0,550	11,630	2,915	29,136	13,304	5,897	2,321	14,081	1,603
	Deformation peak (mm)	Helkorn Vete	15,000	0,000	14,967	0,058	15,000	0,000	15,000	0,000	14,967	0,058	15,000	0,000
		Ölands Vete	15,000	0,000	14,967	0,058	15,000	0,000	15,000	0,000	14,933	0,058	15,000	0,000
		Kallunda Varvete Evolutionar	15,000	0,000	14,933	0,058	15,000	0,000	14,967	0,058	14,900	0,000	15,000	0,000
	Final load (N)	Helkorn Vete	8,912	3,125	9,140	2,023	10,595	3,412	15,827	3,303	6,632	1,646	12,940	4,404
		Ölands Vete	12,211	4,005	10,701	0,976	14,255	0,834	22,590	9,026	4,837	1,572	9,388	3,353
		Kallunda Varvete Evolutionar	9,349	2,299	6,220	0,494	10,424	2,303	22,465	8,264	5,039	1,464	12,152	1,361
	Adhesive force (N)	Helkorn Vete	0,655	0,265	2,306	0,170	1,889	0,531	0,091	0,079	2,649	0,249	1,639	0,816
		Ölands Vete	0,236	0,160	1,758	0,708	3,024	1,525	0,006	0,004	1,538	0,491	1,291	0,208
		Kallunda Varvete Evolutionar	1,908	1,025	1,373	0,523	1,698	0,361	1,388	0,859	7,897	7,574	2,329	0,221
EXTENSION	Peak load (N)	Helkorn Vete	7,411	0,430	7,491	0,915	7,117	0,150	11,626	0,136	5,829	0,259	10,667	0,164
		Ölands Vete	8,694	0,268	8,400	0,734	7,020	0,225	4,868	1,147	5,770	0,155	7,812	0,347
		Kallunda Varvete Evolutionar	6,727	0,064	5,673	0,367	3,248	1,070	6,048	0,189	7,084	0,160	11,238	0,504
	Deformation peak (mm)	Helkorn Vete	20,333	0,709	22,333	0,351	23,000	0,500	23,600	0,819	23,400	1,652	23,867	0,666
		Ölands Vete	21,200	0,436	21,933	0,777	19,733	0,577	18,200	0,985	20,700	1,572	20,933	0,153
		Kallunda Varvete Evolutionar	20,800	0,361	21,933	0,569	18,333	0,153	18,967	0,404	20,800	1,400	24,767	0,981
	Final load (N)	Helkorn Vete	7,222	0,413	7,381	0,913	6,969	0,183	11,272	0,064	5,791	0,258	10,519	0,238
		Ölands Vete	8,407	0,190	8,259	0,729	6,699	0,261	4,565	1,219	5,714	0,163	7,705	0,359
		Kallunda Varvete Evolutionar	6,493	0,036	5,597	0,381	3,142	1,097	5,734	0,153	7,023	0,165	11,012	0,548
RUPTURE	Rupture load (N)	Helkorn Vete	31,445	3,695	10,181	1,345	5,798	1,203	6,811	3,777	4,975	1,383	21,864	3,245
		Ölands Vete	23,683	10,177	7,274	1,795	2,284	0,098	14,296	4,732	10,997	4,752	10,700	2,326
		Kallunda Varvete Evolutionar	18,844	3,324	13,194	1,365	4,008	0,945	7,326	2,151	12,751	2,798	5,134	1,712
	Deform rupture (mm)	Helkorn Vete	0,900	0,100	1,567	0,379	1,476	0,569	0,800	0,100	0,500	0,346	0,933	0,321
		Ölands Vete	1,767	0,306	1,967	0,551	2,433	0,115	1,000	0,100	1,033	0,551	2,233	0,643
		Kallunda Varvete Evolutionar	1,600	0,265	0,900	0,346	1,467	0,058	1,367	0,451	0,633	0,289	1,333	0,252
COLOR	L*	Helkorn Vete	59,207	1,570	59,553	1,348	56,453	1,051	58,890	0,817	52,643	3,476	56,130	0,301
		Ölands Vete	56,760	1,113	58,783	0,196	57,350	1,062	55,737	1,135	55,570	0,351	58,150	1,269
		Kallunda Varvete Evolutionar	61,297	0,293	58,333	0,811	57,663	0,081	58,037	4,025	51,537	5,252	58,297	2,281
	a*	Helkorn Vete	6,570	0,293	8,193	0,587	5,830	0,234	5,597	0,071	6,777	0,140	5,973	0,276
		Ölands Vete	5,877	0,536	5,570	0,157	5,093	0,165	5,967	0,576	5,413	0,072	5,850	0,173
		Kallunda Varvete Evolutionar	5,943	0,391	6,443	0,101	4,943	0,830	5,423	0,462	6,900	1,175	5,483	0,285
	b*	Helkorn Vete	16,280	0,271	17,973	0,404	14,433	0,287	14,877	0,240	14,880	2,046	14,053	0,222
		Ölands Vete	15,087	0,817	15,600	0,249	15,323	0,696	15,127	0,782	15,573	0,221	17,030	0,370
		Kallunda Varvete Evolutionar	17,110	0,405	17,153	0,261	13,487	1,580	14,473	1,474	13,370	2,732	15,160	1,000

COOKIES		Cereals	Normal		Sugar +		Butter + / sugar +		Butter + / flour +		Butter - / flour -		Big particles	
			Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation
COMPRESSION	Peak load (N)	Helkorn Vete	7,367	2,072	6,577	1,101	6,155	1,269	11,838	2,833	20,151	11,933	8,759	4,698
		Ölands Vete	7,182	2,329	10,700	2,409	8,282	2,290	24,647	7,869	8,871	3,282	9,026	0,806
		Kallunda Varvete Evolutionar	5,805	0,338	5,301	0,886	7,003	2,187	6,964	2,435	8,754	1,894	5,949	0,772
	Deformation peak (mm)	Helkorn Vete	14,967	0,058	14,967	0,058	14,900	0,000	15,000	0,000	15,000	0,000	15,000	0,000
		Ölands Vete	14,933	0,058	15,000	0,000	15,000	0,000	14,967	0,058	15,000	0,000	14,967	0,058
		Kallunda Varvete Evolutionar	14,967	0,058	15,000	0,000	14,933	0,058	14,967	0,058	14,967	0,058	14,933	0,058
	Final load (N)	Helkorn Vete	6,300	1,455	5,756	0,661	5,513	1,138	9,449	1,868	10,240	5,874	7,317	3,802
		Ölands Vete	6,204	1,796	8,513	1,106	6,957	1,580	18,822	3,730	6,833	2,329	7,173	0,676
		Kallunda Varvete Evolutionar	5,212	0,399	4,528	0,682	6,136	1,785	6,130	1,995	6,742	0,841	5,302	0,705
	Adhesive force (N)	Helkorn Vete	1,983	0,437	1,578	0,112	1,586	0,467	0,968	0,344	8,084	3,629	1,215	0,449
		Ölands Vete	1,482	0,615	2,253	0,432	3,373	3,949	1,223	1,615	2,910	1,614	2,339	0,163
		Kallunda Varvete Evolutionar	1,394	0,339	3,480	3,576	1,880	0,624	0,530	0,143	3,810	1,109	1,301	0,409
EXTENSION	Peak load (N)	Helkorn Vete	10,259	0,087	10,263	0,096	10,930	0,483	9,718	0,328	6,566	0,462	5,545	0,255
		Ölands Vete	4,032	0,437	4,077	0,664	8,052	0,137	7,681	0,272	6,658	0,315	6,764	0,173
		Kallunda Varvete Evolutionar	6,488	0,088	6,619	0,312	7,647	0,645	6,438	0,818	5,679	0,151	8,916	0,482
	Deformation peak (mm)	Helkorn Vete	25,933	0,351	23,867	0,611	25,233	0,611	23,867	0,850	23,167	1,550	19,033	0,757
		Ölands Vete	18,967	0,058	17,867	1,595	22,233	1,007	19,767	0,404	20,033	2,977	20,900	0,737
		Kallunda Varvete Evolutionar	21,467	0,208	21,500	1,249	19,167	5,787	19,300	1,493	21,233	1,405	21,100	1,000
	Final load (N)	Helkorn Vete	10,175	0,091	10,156	0,072	10,838	0,495	9,707	0,441	6,518	0,472	5,583	0,345
		Ölands Vete	3,954	0,434	3,981	0,663	7,983	0,107	7,378	0,337	6,365	0,145	6,720	0,156
		Kallunda Varvete Evolutionar	6,409	0,080	6,503	0,319	7,084	0,728	5,994	0,508	5,631	0,153	8,826	0,471
RUPTURE	Rupture load (N)	Helkorn Vete	6,009	0,899	5,302	0,077	4,432	1,788	4,169	0,691	4,434	1,259	3,355	0,770
		Ölands Vete	11,788	2,299	13,081	0,893	4,453	0,108	8,444	1,376	2,513	0,222	3,720	1,298
		Kallunda Varvete Evolutionar	27,900	9,118	4,432	0,394	2,392	0,088	7,912	2,552	2,359	0,064	2,865	0,385
	Deform rupture (mm)	Helkorn Vete	2,133	0,651	2,033	0,058	0,013	0,006	1,667	0,513	1,833	0,289	1,433	0,289
		Ölands Vete	6,167	0,929	4,967	1,274	2,067	0,808	4,533	1,429	1,000	0,000	2,333	0,764
		Kallunda Varvete Evolutionar	4,400	1,249	1,633	0,321	1,067	0,115	5,733	3,612	0,800	0,265	1,600	0,141
COLOR	L*	Helkorn Vete	62,303	0,310	59,267	0,715	56,710	0,992	60,987	0,142	58,353	1,242	59,807	0,967
		Ölands Vete	61,037	0,250	59,120	0,278	58,523	1,765	56,907	1,371	56,903	1,651	60,180	0,527
		Kallunda Varvete Evolutionar	59,590	1,149	60,673	1,287	58,293	0,330	59,440	1,840	56,887	1,463	59,563	0,558
	a*	Helkorn Vete	5,627	0,042	5,387	0,385	5,790	0,480	5,940	0,066	5,640	0,161	6,193	0,336
		Ölands Vete	5,750	0,406	5,933	0,500	5,470	0,304	5,517	0,436	5,270	0,183	5,807	0,031
		Kallunda Varvete Evolutionar	4,897	0,256	4,407	0,264	5,767	0,268	5,663	0,169	5,090	0,244	6,010	0,291
	b*	Helkorn Vete	16,403	0,656	15,173	0,365	13,800	0,720	15,967	0,410	15,790	0,973	16,463	0,235
		Ölands Vete	16,850	0,415	16,753	0,236	16,033	1,101	14,400	1,110	15,710	0,894	16,427	0,663
		Kallunda Varvete Evolutionar	14,130	1,250	15,863	0,290	15,213	0,203	16,247	1,080	14,400	0,782	16,237	0,360

FRESH PASTA		Cereals	Normal Recipe		Hight particule		Salt +		Salt ++		Olive oil+		Olive oil++		Salt + / Olive oil +		Salt ++ / Olive oil		Salt + / Olive oil ++		Salt ++ / Olive oil	
			Mean value	Standard deviation	Mean value	Standard	Mean value	Standard	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation
EXTENSION (dough)	Peak load (N)	Helkorn Vete	4,742	0,737	10,696	0,171	10,425	0,413	6,752	0,381	7,262	0,295	11,342	0,766	9,458	0,217	10,219	0,142	10,741	0,410	9,261	0,303
		ölands Vete	7,314	0,268	8,043	0,367	8,660	0,304	8,819	0,117	8,179	0,060	8,808	0,233	7,010	0,052	7,693	0,396	8,093	0,548	8,760	0,209
		Kallunda Varvete Evolutionar	8,808	0,044	8,868	0,534	8,482	0,496	10,896	0,172	6,702	0,140	9,421	0,426	9,214	0,158	8,240	0,230	7,887	0,352	6,840	0,420
	Deformation @PEAK (mm)	Helkorn Vete	27,167	1,304	29,167	0,451	29,367	0,635	25,633	1,069	26,567	1,242	33,000	1,664	28,633	1,193	28,600	0,700	27,367	0,513	29,300	0,520
		ölands Vete	25,733	0,764	25,733	0,907	27,533	1,266	27,933	0,551	27,700	0,265	28,200	1,153	27,000	1,127	22,733	0,462	27,633	0,404	28,133	0,115
		Kallunda Varvete Evolutionar	26,967	0,473	25,967	0,208	28,500	0,624	31,900	1,493	27,667	1,550	30,067	0,289	29,067	0,361	27,667	1,234	27,433	0,416	26,467	0,329
	Final load (N)	Helkorn Vete	4,432	0,723	10,457	0,119	10,021	0,333	6,401	0,426	7,020	0,299	11,074	0,789	9,318	0,210	9,914	0,154	10,472	0,458	9,043	0,292
		ölands Vete	6,923	0,265	7,604	0,335	8,293	0,293	8,555	0,094	7,840	0,086	8,580	0,246	6,651	0,090	7,388	0,391	7,711	0,526	8,448	0,277
		Kallunda Varvete Evolutionar	8,347	0,086	8,367	0,492	8,227	0,526	10,551	0,101	6,440	0,108	9,085	0,415	8,971	0,208	7,947	0,236	7,664	0,309	6,666	0,421
COMPRESSION (dough)	Peak load (N)	Helkorn Vete	17,315	5,613	25,809	4,495	22,612	4,256	18,467	2,868	14,535	0,487	13,461	0,778	14,867	0,463	13,713	2,816	14,293	3,568	14,971	2,256
		ölands Vete	19,441	1,612	48,240	5,879	21,303	2,789	20,647	1,234	17,790	1,361	17,563	4,122	13,935	3,014	17,324	2,118	18,664	3,680	20,039	4,709
		Kallunda Varvete Evolutionar	21,731	7,516	21,210	4,276	21,099	2,102	20,595	4,162	15,263	2,066	16,841	3,085	18,683	5,402	14,624	2,010	13,719	1,052	12,263	2,219
	Deformation @PEAK (mm)	Helkorn Vete	15,000	0,000	15,000	0,000	15,000	0,000	14,967	0,058	15,000	0,000	15,000	0,000	15,000	0,000	15,000	0,000	15,000	0,000	15,000	0,000
		ölands Vete	15,000	0,000	15,000	0,000	14,967	0,058	15,000	0,000	15,000	0,000	15,000	0,000	15,000	0,000	14,967	0,058	15,000	0,000	15,000	0,000
		Kallunda Varvete Evolutionar	14,967	0,058	15,000	0,000	14,967	0,000	15,000	0,000	15,000	0,000	14,967	0,058	15,000	0,000	15,000	0,000	15,000	0,000	15,000	0,000
	Final load (N)	Helkorn Vete	14,551	4,195	19,704	2,003	18,370	30,080	15,342	2,288	12,838	0,436	11,934	0,620	12,926	0,510	12,071	2,475	11,804	2,447	12,653	1,192
		ölands Vete	13,886	3,492	30,569	2,667	18,286	2,403	17,219	1,199	15,274	0,924	14,694	2,131	12,284	2,338	14,768	10251,000	16,564	3,113	17,463	3,411
		Kallunda Varvete Evolutionar	18,308	4,966	17,839	3,110	18,333	1,268	17,584	3,218	13,204	1,245	14,302	2,151	15,049	3,032	12,819	1,628	11,373	0,813	10,683	1,752
	Adhesive Force (N)	Helkorn Vete	1,865	0,449	2,448	0,019	2,082	0,318	1,601	0,386	1,464	0,244	1,097	0,878	1,624	0,132	2,161	0,157	2,094	0,535	2,043	0,292
		ölands Vete	2,120	0,344	2,255	0,344	2,355	0,062	2,438	0,043	2,245	0,531	2,123	0,294	1,675	0,344	2,093	0,293	1,269	0,402	2,729	0,618
		Kallunda Varvete Evolutionar	2,935	1,284	1,805	0,799	2,371	0,079	2,303	0,292	2,351	0,206	1,972	0,570	2,426	0,137	1,782	0,620	2,370	0,179	2,100	0,217
EXTENSION (pasta)	Peak load (N)	Helkorn Vete	6,104	0,508	11,172	0,147	10,582	0,584	8,969	0,496	7,329	0,131	10,865	1,345	8,360	0,467	10,506	0,120	10,106	0,117	7,685	0,221
		ölands Vete	8,347	0,310	9,018	0,503	9,303	0,459	7,749	0,395	8,053	0,188	7,053	0,105	8,934	0,246	6,110	0,230	7,825	0,408	9,113	0,308
		Kallunda Varvete Evolutionar	9,252	0,032	7,497	0,290	8,079	0,062	10,662	0,246	9,188	0,383	10,029	0,193	8,430	0,345	11,256	0,061	7,465	0,304	9,619	0,109
	Deformation @PEAK (mm)	Helkorn Vete	21,333	0,666	27,900	0,173	27,567	0,231	25,133	0,586	24,733	0,473	28,967	1,026	24,533	0,351	28,233	0,379	28,467	1,242	23,388	0,115
		ölands Vete	25,233	1,069	25,233	0,757	27,100	0,529	24,533	0,153	24,633	0,379	23,500	0,200	26,367	0,751	22,033	0,777	25,500	1,015	26,233	0,802
		Kallunda Varvete Evolutionar	26,033	0,115	22,700	0,173	24,700	0,500	27,700	0,173	26,567	0,208	27,467	0,153	25,200	0,300	29,367	1,350	24,067	0,404	26,300	0,500
	Final load (N)	Helkorn Vete	5,111	0,314	10,699	0,153	10,165	0,495	8,166	0,560	7,006	0,113	10,485	1,349	8,046	0,498	10,023	0,200	9,643	0,177	7,277	0,351
		ölands Vete	7,956	0,438	8,394	0,469	8,681	0,409	7,101	0,462	7,696	0,169	6,701	0,124	8,550	0,310	5,745	0,324	7,545	0,346	8,661	0,366
		Kallunda Varvete Evolutionar	8,300	0,100	6,883	0,353	7,549	0,155	10,136	0,206	8,642	0,334	9,387	0,179	7,984	0,182	10,833	0,103	7,047	0,155	9,267	0,099
COLOR	L*	Helkorn Vete	62,213	0,108	51,273	2,526	52,817	1,951	45,290	1,201	55,087	3,090	51,000	6,170	55,663	2,053	57,377	5,686	52,557	1,155	51,353	0,350
		ölands Vete	52,677	3,414	52,587	1,128	43,770	1,244	52,943	3,001	52,477	1,760	55,457	0,817	53,707	1,524	51,997	1,704	57,243	4,619	54,797	0,720
		Kallunda Varvete Evolutionar	54,000	2,930	52,890	5,152	52,367	3,317	57,280	2,126	54,540	2,920	52,983	3,541	52,700	1,731	54,780	1,069	52,537	2,644	53,613	0,539
	a*	Helkorn Vete	5,303	0,631	3,757	0,046	3,670	0,370	2,593	0,587	3,507	0,296	2,617	0,200	3,380	0,289	3,393	0,839	3,923	0,304	3,967	0,859
		ölands Vete	3,933	0,287	3,697	0,372	4,267	0,225	3,533	0,461	3,920	0,202	3,010	0,750	3,633	0,235	4,113	0,532	3,113	0,964	3,513	0,137
		Kallunda Varvete Evolutionar	3,653	0,516	3,453	0,161	3,447	1,195	3,267	0,330	3,700	0,392	3,200	1,012	3,700	0,072	2,823	0,168	3,603	0,450	3,470	0,238
	b*	Helkorn Vete	13,733	10,600	9,067	1,289	9,777	1,186	5,557	0,624	9,240	1,097	6,527	1,126	9,603	0,679	9,880	2,727	10,813	1,134	9,663	2,236
		ölands Vete	11,617	0,828	9,627	0,552	10,937	0,310	9,780	1,334	11,213	1,219	9,603	2,402	9,990	1,677	10,817	0,713	9,593	2,575	10,727	0,820
		Kallunda Varvete Evolutionar	10,267	1,868	7,643	1,529	9,363	2,727	11,237	1,260	10,370	0,575	9,930	1,516	10,110	0,287	7,993	0,787	10,027	0,595	10,583	0,736

Appendix 5 : Results of the t-test for shortbreads, cookies and pasta

a) By recipes

Cereals		COMPRESSION												EXTENSION								
		Peak load (N)			Deformation peak (mm)			Final load (N)			Adhesive force (N)			Peak load (N)			Deformation peak (mm)			Final load (N)		
		Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona
Normal	Mean value	10,423	14,257	10,360	15,000	15,000	15,000	8,912	12,211	9,349	0,655	0,236	1,908	7,411	8,694	6,727	20,333	21,200	20,800	7,222	8,407	6,493
	Standard deviation	4,444	4,931	3,004	0,000	0,000	0,000	3,125	4,005	2,299	0,265	0,160	1,025	0,430	0,268	0,064	0,709	0,436	0,361	0,413	0,190	0,036
	Significant	a	abdf	abc	a	a	a	ab	abc	abc	a	a	a	a	a	a	a	a	ad	ad	ad	a
Butter +	Mean value	10,298	12,458	6,777	14,967	14,967	14,933	9,140	10,701	6,220	2,306	1,758	1,373	7,491	8,400	5,673	22,333	21,933	21,933	7,381	8,259	5,597
	Standard deviation	2,421	1,035	0,550	0,058	0,058	0,058	2,023	0,976	0,494	0,170	0,708	0,523	0,915	0,734	0,367	0,351	0,777	0,569	0,913	0,729	0,381
	Significant	a	a	a	a	a	a	ab	a	ac	bc	ac	a	ac	ace	b	bc	a	ac	acd	ac	ac
Butter + / sugar -	Mean value	12,558	16,471	11,630	15,000	15,000	15,000	10,595	14,255	10,424	1,889	3,024	1,698	7,117	7,020	3,248	23,000	19,733	18,333	6,969	6,699	3,142
	Standard deviation	4,891	1,394	2,915	0,000	0,000	0,000	3,412	0,834	2,303	0,531	1,525	0,361	0,150	0,225	1,070	0,500	0,577	0,153	0,183	0,261	1,097
	Significant	a	cf	bc	a	a	a	ab	c	ab	be	ac	a	a	bc	c	be	bc	be	d	bce	b
Butter + / flour +	Mean value	18,586	29,701	29,136	15,000	15,000	14,967	15,827	22,590	22,465	0,091	0,006	1,388	11,626	4,868	6,048	23,600	18,200	18,967	11,272	4,565	5,734
	Standard deviation	4,063	15,245	13,304	0,000	0,000	0,058	3,303	9,026	8,264	0,079	0,004	0,859	0,136	1,147	0,189	0,819	0,985	0,404	0,064	1,219	0,153
	Significant	a	ace	ab	a	a	a	b	acd	abc	a	a	a	d	bf	b	bc	bd	bg	e	defg	bc
Sugar + / flour -	Mean value	11,851	5,685	5,897	14,967	14,933	14,900	6,632	4,837	5,039	2,649	1,538	7,897	5,829	5,770	7,084	23,400	20,700	20,800	5,791	5,714	7,023
	Standard deviation	4,144	2,081	2,321	0,058	0,058	0,000	1,646	1,572	1,464	0,249	0,491	7,574	0,259	0,155	0,160	1,652	1,572	1,400	0,258	0,163	0,165
	Significant	a	bde	a	a	a	a	a	bde	c	bd	bc	a	bc	df	e	ace	acd	cdeg	bc	f	d
Big particles	Mean value	15,834	10,885	14,081	15,000	15,000	15,000	12,940	9,388	12,152	1,639	1,291	2,329	10,667	7,812	11,238	23,867	20,933	24,767	10,519	7,705	11,012
	Standard deviation	5,666	3,850	1,603	0,000	0,000	0,000	4,404	3,353	1,361	0,816	0,208	0,221	0,164	0,347	0,504	0,666	0,153	0,981	0,238	0,359	0,548
	Significant	a	adf	b	a	a	a	ab	ace	b	acde	bc	a	e	e	f	cde	ac	f	f	a	e

Cereals		RUPTURE						COLOR								
		Rupture load (N)			Deform rupture (mm)			L*			a*			b*		
		Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutiona
Normal	Mean value	31,445	23,683	18,844	0,900	1,767	1,600	59,207	56,760	61,297	6,570	5,877	5,943	16,280	15,087	17,110
	Standard deviation	3,695	10,177	3,324	0,100	0,306	0,265	1,570	1,113	0,293	0,293	0,536	0,391	0,271	0,817	0,405
	Significant	a	ab	ac	ab	a	a	ab	ab	a	ae	abc	ab	a	a	a
Butter +	Mean value	10,181	7,274	13,194	1,567	1,967	0,900	59,553	58,783	58,333	8,193	5,570	6,443	17,973	15,600	17,153
	Standard deviation	1,345	1,795	1,365	0,379	0,551	0,346	1,348	0,196	0,811	0,587	0,157	0,101	0,404	0,249	0,261
	Significant	b	a	ad	a	ace	ac	a	a	bc	b	ac	a	b	a	a
Butter + / sugar -	Mean value	5,798	2,284	4,008	1,476	2,433	1,467	56,453	57,350	57,663	5,830	5,093	4,943	14,433	15,323	13,487
	Standard deviation	1,203	0,098	0,945	0,569	0,115	0,058	1,051	1,062	0,081	0,234	0,165	0,830	0,287	0,696	1,580
	Significant	c	bc	b	ac	bcg	a	bc	ac	bc	cd	b	ab	ce	a	a
Butter + / flour +	Mean value	6,811	14,296	7,326	0,800	1,000	1,367	58,890	55,737	58,037	5,597	5,967	5,423	14,877	15,127	14,473
	Standard deviation	3,777	4,732	2,151	0,100	0,100	0,451	0,817	1,135	4,025	0,071	0,576	0,462	0,240	0,782	1,474
	Significant	cb	a	be	ad	ef	ac	a	bcd	ac	cd	abd	ab	c	a	a
Sugar + / flour -	Mean value	4,975	10,997	12,751	0,500	1,033	0,633	52,643	55,570	51,537	6,777	5,413	6,900	14,880	15,573	13,370
	Standard deviation	1,383	4,752	2,798	0,346	0,551	0,289	3,476	0,351	5,252	0,140	0,072	1,175	2,046	0,221	2,732
	Significant	cd	ac	cde	bcde	af	bc	acd	bce	ac	e	ab	ab	abcd	a	a
Big particles	Mean value	21,864	10,700	5,134	0,933	2,233	1,333	56,130	58,150	58,297	5,973	5,850	5,483	14,053	17,030	15,160
	Standard deviation	3,245	2,326	1,712	0,321	0,643	0,252	0,301	1,269	2,281	0,276	0,173	0,285	0,222	0,370	1,000
	Significant	e	a	b	ae	afg	a	bd	ade	ac	ad	cd	b	de	b	a

Cereals		COMPRESSION												EXTENSION								
		Peak load (N)			Deformation peak (mm)			Final load (N)			Adhesive force (N)			Peak load (N)			Deformation peak (mm)			Final load (N)		
		Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar
Normal	Mean value	7,367	7,182	5,805	14,967	14,933	14,967	6,300	6,204	5,212	1,983	1,482	1,394	10,259	4,032	6,488	25,933	18,967	21,467	10,175	3,954	6,409
	Standard deviation	2,072	2,329	0,338	0,058	0,058	0,058	1,455	1,796	0,399	0,437	0,615	0,339	0,087	0,437	0,088	0,351	0,058	0,208	0,091	0,434	0,080
	Significant	a	a	a	a	a	a	ab	ab	ab	a	a	ac	ac	a	a	a	a	a	ac	a	a
Sugar +	Mean value	6,577	10,700	5,301	14,967	15,000	15,000	5,756	8,513	4,528	1,578	2,253	3,480	10,263	4,077	6,619	23,867	17,867	21,500	10,156	3,981	6,503
	Standard deviation	1,101	2,409	0,886	0,058	0,000	0,000	0,661	1,106	0,682	0,112	0,432	3,576	0,096	0,664	0,312	0,611	1,595	1,249	0,072	0,663	0,319
	Significant	a	a	a	a	a	a	a	a	a	ab	a	abc	ac	a	a	bc	a	a	ac	a	a
Butter + / sugar +	Mean value	6,155	8,282	7,003	14,900	15,000	14,933	5,513	6,957	6,136	1,586	3,373	1,880	10,930	8,052	7,647	25,233	22,233	19,167	10,838	7,983	7,084
	Standard deviation	1,269	2,290	2,187	0,000	0,000	0,058	1,138	1,580	1,785	0,467	3,949	0,624	0,483	0,137	0,645	0,611	1,007	5,787	0,495	0,107	0,728
	Significant	a	a	a	a	a	a	a	a	ab	ab	a	abc	a	b	ac	abc	bc	a	c	b	ac
Butter + / flour +	Mean value	11,838	24,647	6,964	15,000	14,967	14,967	9,449	18,822	6,130	0,968	1,223	0,530	9,718	7,681	6,438	23,867	19,767	19,300	9,707	7,378	5,994
	Standard deviation	2,833	7,869	2,435	0,000	0,058	0,058	1,868	3,730	1,995	0,344	1,615	0,143	0,328	0,272	0,818	0,850	0,404	1,493	0,441	0,337	0,508
	Significant	a	a	a	a	a	a	bc	b	ab	b	a	b	c	b	ad	be	a	a	a	bd	ad
Butter - / flour -	Mean value	20,151	8,871	8,754	15,000	15,000	14,967	10,240	6,833	6,742	8,084	2,910	3,810	6,566	6,658	5,679	23,167	20,033	21,233	6,518	6,365	5,631
	Standard deviation	11,933	3,282	1,894	0,000	0,000	0,058	5,874	2,329	0,841	3,629	1,614	1,109	0,462	0,315	0,151	1,550	2,977	1,405	0,472	0,145	0,153
	Significant	a	a	a	a	a	a	ac	a	b	ab	a	c	b	c	bd	ace	ac	a	b	c	bcd
Big particles	Mean value	8,759	9,026	5,949	15,000	14,967	14,933	7,317	7,173	5,302	1,215	2,339	1,301	5,545	6,764	8,916	19,033	20,900	21,100	5,583	6,720	8,826
	Standard deviation	4,698	0,806	0,772	0,000	0,058	0,058	3,802	0,676	0,705	0,449	0,163	0,409	0,255	0,173	0,482	0,757	0,737	1,000	0,345	0,156	0,471
	Significant	a	a	a	a	a	a	ac	a	ab	ab	a	ab	d	c	ce	d	ac	a	b	cd	e

Cereals		RUPTURE						COLOR								
		Rupture load (N)			Deform rupture (mm)			L*			a*			b*		
		Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar	Helkorn Vete	Ölands Vete	Kallunda Varvete Evolutionar
Normal	Mean value	6,009	11,788	27,900	2,133	6,167	4,400	62,303	61,037	59,590	5,627	5,750	4,897	16,403	16,850	14,130
	Standard deviation	0,899	2,299	9,118	0,651	0,929	1,249	0,310	0,250	1,149	0,042	0,406	0,256	0,656	0,415	1,250
	Significant	a	ac	a	a	a	a	a	a	abd	a	ab	a	ac	a	abc
Sugar +	Mean value	5,302	13,081	4,432	2,033	4,967	1,633	59,267	59,120	60,673	5,387	5,933	4,407	15,173	16,753	15,863
	Standard deviation	0,077	0,893	0,394	0,058	1,274	0,321	0,715	0,278	1,287	0,385	0,500	0,264	0,365	0,236	0,290
	Significant	a	a	b	a	a	ac	b	bc	ad	ab	ab	ab	ab	ab	ac
Butter + / sugar +	Mean value	4,432	4,453	2,392	0,013	2,067	1,067	56,710	58,523	58,293	5,790	5,470	5,767	13,800	16,033	15,213
	Standard deviation	1,788	0,108	0,088	0,006	0,808	0,115	0,992	1,765	0,330	0,480	0,304	0,268	0,720	1,101	0,203
	Significant	ac	b	cd	b	bc	bc	c	abc	ac	ab	ab	b	b	ab	b
Butter + / flour +	Mean value	4,169	8,444	7,912	1,667	4,533	5,733	60,987	56,907	59,440	5,940	5,517	5,663	15,967	14,400	16,247
	Standard deviation	0,691	1,376	2,552	0,513	1,429	3,612	0,142	1,371	1,840	0,066	0,436	0,169	0,410	1,110	1,080
	Significant	ac	c	abd	a	ac	ac	de	c	acd	b	ab	b	ac	b	abc
Butter - / flour -	Mean value	4,434	2,513	2,359	1,833	1,000	0,800	58,353	56,903	56,887	5,640	5,270	5,090	15,790	15,710	14,400
	Standard deviation	1,259	0,222	0,064	0,289	0,000	0,265	1,242	1,651	1,463	0,161	0,183	0,244	0,973	0,894	0,782
	Significant	ac	de	cd	a	bc	b	bce	bc	bce	ab	a	a	abc	ab	ab
Big particles	Mean value	3,355	3,720	2,865	1,433	2,333	1,600	59,807	60,180	59,563	6,193	5,807	6,010	16,463	16,427	16,237
	Standard deviation	0,770	1,298	0,385	0,289	0,764	0,141	0,967	0,527	0,558	0,336	0,031	0,291	0,235	0,663	0,360
	Significant	bc	be	cd	a	bc	a	be	ab	de	ab	b	b	c	ab	c

		Peak load (N)			Deformation @PEAK (mm)			Final load (N)		
Cereals		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	4,742	7,314	8,808	27,167	25,733	26,967	4,432	6,923	8,347
	Standard	0,737	0,268	0,044	1,904	0,764	0,473	0,723	0,265	0,086
	Significant	a	ad	a	ac	af	ac	a	ad	af
Hight particule	Mean value	10,696	8,043	8,868	29,167	25,733	25,967	10,457	7,604	8,367
	Standard	0,171	0,367	0,534	0,451	0,907	0,208	0,119	0,335	0,492
	Significant	b	acf	b	a	ac	a	b	ac	acf
Salt +	Mean value	10,425	8,660	8,482	29,367	27,533	28,500	10,021	8,293	8,227
	Standard	0,413	0,304	0,496	0,635	1,266	0,624	0,333	0,293	0,526
	Significant	be	bcef	bd	a	ad	be	bd	cb	acf
Salt ++	Mean value	6,752	8,819	10,896	25,633	27,933	31,900	6,401	8,555	10,551
	Standard	0,381	0,117	0,172	1,069	0,551	1,493	0,426	0,094	0,101
	Significant	cf	bcg	c	c	bd	dg	c	b	b
Olive oil+	Mean value	7,262	8,179	6,702	26,567	27,700	27,667	7,020	7,840	6,440
	Standard	0,295	0,060	0,140	1,242	0,265	1,550	0,299	0,086	0,108
	Significant	df	fh	af	cd	bcd	cehi	c	cef	d
Olive oil++	Mean value	11,342	8,808	9,421	33,000	28,200	30,067	11,074	8,580	9,085
	Standard	0,766	0,233	0,426	1,664	1,153	0,289	0,789	0,246	0,415
	Significant	bi	bi	e	be	df	fgh	bfg	b	ac
Salt + / Olive oil +	Mean value	9,458	7,010	9,214	28,633	27,000	29,067	9,318	6,651	8,971
	Standard deviation	0,217	0,052	0,158	1,193	1,127	0,961	0,210	0,090	0,208
	Significant	h	d	ad	ad	ad	bghj	ef	d	ec
Salt ++ / Olive oil ++	Mean value	10,219	7,693	8,240	28,600	22,733	27,667	9,314	7,388	7,947
	Standard	0,142	0,396	0,230	0,700	0,462	1,234	0,154	0,391	0,236
	Significant	ei	adgh	g	ad	f	aeh	dg	ade	f
Salt + / Olive oil ++	Mean value	10,741	8,093	7,887	27,367	27,633	27,433	10,472	7,711	7,664
	Standard	0,410	0,548	0,352	0,513	0,404	0,416	0,458	0,526	0,309
	Significant	be	adeghij	b	cd	bde	cejk	b	abdef	f
Salt ++ / Olive oil +	Mean value	9,261	8,760	6,840	29,300	28,133	26,467	9,043	8,448	6,666
	Standard	0,303	0,209	0,420	0,520	0,115	0,929	0,292	0,277	0,421
	Significant	gh	bcfj	hf	ae	bde	aik	e	bf	d

		Peak load (N)			Deformation @PEAK (mm)			Final load (N)			Adhesive Force (N)		
Cereals		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	17,315	19,441	21,731	15,000	15,000	14,967	14,551	13,886	18,308	1,865	2,120	2,935
	Standard	5,613	1,612	7,516	0,000	0,000	0,058	4,195	3,492	4,966	0,449	0,344	1,284
	Significant	ab	acd	abc	a	a	a	ab	acd	abc	ab	ab	a
Hight particule	Mean value	25,809	48,240	21,210	15,000	15,000	15,000	19,704	30,569	17,839	2,448	2,255	1,805
	Standard	4,495	5,879	4,276	0,000	0,000	0,000	2,003	2,667	3,110	0,019	0,344	0,799
	Significant	a	b	ac	a	a	a	a	b	ac	a	a	a
Salt +	Mean value	22,612	21,303	21,099	15,000	14,967	14,967	18,370	18,286	18,333	2,082	2,355	2,371
	Standard	4,256	2,789	2,102	0,000	0,058	0,000	30,080	2,403	1,268	0,318	0,062	0,079
	Significant	ad	ad	a	a	a	a	ac	c	a	ac	a	a
Salt ++	Mean value	18,467	20,647	20,595	14,967	15,000	15,000	15,342	17,219	17,584	1,601	2,438	2,303
	Standard	2,868	1,234	4,162	0,058	0,000	0,000	2,288	1,199	3,218	0,386	0,043	0,292
	Significant	ac	a	ad	a	a	a	acd	c	ac	ac	a	a
Olive oil+	Mean value	14,535	17,790	15,263	15,000	15,000	15,000	12,838	15,274	13,204	1,464	2,245	2,351
	Standard	0,487	1,361	2,066	0,000	0,000	0,000	0,436	0,924	1,245	0,244	0,531	0,206
	Significant	bcd	ae	cd	a	a	a	bc	ce	c	bc	ac	a
Olive oil++	Mean value	13,461	17,563	16,841	15,000	15,000	14,967	11,934	14,694	14,302	1,097	2,123	1,972
	Standard	0,778	4,122	3,085	0,000	0,000	0,058	0,620	2,131	2,151	0,878	0,294	0,570
	Significant	bcd	ae	ad	a	a	a	bc	ce	ad	ac	a	a
Salt + / Olive oil +	Mean value	14,867	13,935	18,683	15,000	15,000	15,000	12,926	12,284	15,049	1,624	1,675	2,426
	Standard deviation	0,463	3,014	5,402	0,000	0,000	0,000	0,510	2,338	3,032	0,132	0,344	0,137
	Significant	ac	ce	ad	a	a	a	bc	de	ae	bcd	ac	a
Salt ++ / Olive oil ++	Mean value	13,713	17,324	14,624	15,000	14,967	15,000	12,071	14,768	12,819	2,161	2,093	1,782
	Standard	2,816	2,118	2,010	0,000	0,058	0,000	2,475	1,251	1,628	0,157	0,293	0,620
	Significant	bc	de	cd	a	a	a	bc	ce	cde	a	ac	a
Salt + / Olive oil ++	Mean value	14,293	18,664	13,719	15,000	15,000	15,000	11,804	16,564	11,973	2,094	1,269	2,370
	Standard	3,568	3,680	1,052	0,000	0,000	0,000	2,447	3,113	0,813	0,535	0,402	0,179
	Significant	bcd	ae	cd	a	a	a	bd	ce	cde	ac	bc	a
Salt ++ / Olive oil +	Mean value	14,971	20,039	12,263	15,000	15,000	15,000	12,653	17,463	2,054	2,043	2,729	2,100
	Standard	2,256	4,709	2,219	0,000	0,000	0,000	1,192	3,411	1,752	0,292	0,618	0,217
	Significant	bcd	ae	bd	a	a	a	bc	ce	bde	ad	a	a

		Peak load (N)			Deformation @PEAK (mm)			Final load (N)		
Cereals		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	6,104	8,347	9,252	21,333	25,233	26,033	5,111	7,956	8,900
	Standard	0,508	0,310	0,032	0,666	1,069	0,115	0,314	0,438	0,100
	Significant	a	adhi	a	a	ace	ah	a	acd	ad
Hight particule	Mean value	11,172	9,018	7,497	27,900	25,233	22,700	10,699	8,394	6,883
	Standard	0,147	0,503	0,290	0,173	0,757	0,173	0,153	0,469	0,353
	Significant	b	ach	b	b	abe	c	b	ad	bk
Salt +	Mean value	10,582	9,303	8,079	27,567	27,100	24,700	10,165	8,681	7,549
	Standard	0,584	0,459	0,062	0,231	0,529	0,500	0,495	0,409	0,155
	Significant	bdl	ce	bd	b	c	b	bd	a	be
Salt ++	Mean value	8,969	7,749	10,662	25,133	24,533	27,700	8,166	7,101	10,136
	Standard	0,496	0,395	0,246	0,586	0,153	0,173	0,560	0,462	0,206
	Significant	cfm	dfgij	c	c	ae	d	ce	cef	c
Olive oil+	Mean value	7,329	8,053	9,188	24,733	24,633	26,567	7,006	7,696	8,642
	Standard	0,131	0,188	0,383	0,473	0,379	0,208	0,113	0,169	0,334
	Significant	eh	afi	af	c	a	eg	c	de	dgj
Olive oil++	Mean value	10,865	7,053	10,029	28,967	23,500	27,467	10,485	6,701	9,387
	Standard	1,345	0,105	0,193	1,026	0,200	0,153	1,349	0,124	0,179
	Significant	bfijk	bgk	e	b	bfg	d	bdef	bf	f
Salt + / Olive oil +	Mean value	8,360	8,934	8,430	24,533	26,367	25,200	8,046	8,550	7,984
	Standard deviation	0,467	0,246	0,345	0,351	0,751	0,900	0,498	0,310	0,182
	Significant	chi	hel	ad	c	ce	abe	cf	a	hg
Salt ++ / Olive oil ++	Mean value	10,506	6,110	11,256	28,233	22,033	29,967	10,023	5,745	10,833
	Standard	0,120	0,230	0,061	0,379	0,777	1,950	0,200	0,324	0,103
	Significant	dj	j	g	b	df	dfgh	d	g	i
Salt + / Olive oil ++	Mean value	10,106	7,825	7,465	28,467	25,500	24,067	9,643	7,545	7,047
	Standard	0,117	0,408	0,304	1,242	1,015	0,404	0,177	0,346	0,155
	Significant	mlk	ik	b	b	acg	b	d	de	k
Salt ++ / Olive oil +	Mean value	7,685	9,113	9,619	23,388	26,233	26,300	7,277	8,661	9,267
	Standard	0,221	0,308	0,109	0,115	0,802	0,500	0,351	0,366	0,099
	Significant	ghi	cl	hf	c	ac	aeh	c	a	fj

		L*			a*			b*		
Cereals		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	62,213	52,677	54,000	5,303	3,933	3,653	13,733	11,617	10,267
	Standard	0,108	3,414	2,930	0,631	0,287	0,516	10,600	0,828	1,868
	Significant	a	abd	a	a	ab	ab	a	a	abd
Hight particule	Mean value	51,273	52,587	52,890	3,757	3,697	3,453	9,067	9,627	7,643
	Standard	2,526	1,128	5,152	0,046	0,372	0,161	1,289	0,552	1,529
	Significant	bd	a	a	acf	ab	a	bd	bc	ad
Salt +	Mean value	52,817	49,770	52,367	3,670	4,267	3,447	9,777	10,937	9,363
	Standard	1,951	1,244	3,317	0,370	0,225	1,195	1,186	0,310	2,727
	Significant	be	bc	a	bcdf	a	ab	be	a	abd
Salt ++	Mean value	45,290	52,943	57,280	2,593	3,533	3,267	5,557	9,780	11,237
	Standard	1,201	3,001	2,126	0,587	0,461	0,330	0,624	1,334	1,260
	Significant	cf	ace	a	bce	ac	ab	cf	ac	bc
Olive oil+	Mean value	55,087	52,477	54,540	3,507	3,920	3,700	9,240	11,213	10,370
	Standard	3,090	1,760	2,920	0,296	0,202	0,392	1,097	1,219	0,575
	Significant	adeg	ace	a	bg	ac	a	b	ac	acd
Olive oil++	Mean value	51,000	55,457	52,983	2,617	3,010	3,200	6,527	9,603	9,930
	Standard	6,170	0,817	3,541	0,200	0,750	1,012	1,126	2,402	1,516
	Significant	adefg	de	a	ach	ac	ab	df	ac	acd
Salt + / Olive oil +	Mean value	55,663	53,707	52,700	3,380	3,633	3,700	9,603	9,990	10,110
	Standard deviation	2,053	1,524	1,731	0,289	0,235	0,072	0,679	1,677	0,287
	Significant	bg	ae	a	bci	bc	a	b	ac	ac
Salt ++ / Olive oil ++	Mean value	57,377	51,997	54,780	3,393	4,113	2,823	9,880	10,817	7,993
	Standard	5,686	1,704	1,069	0,839	0,532	0,168	2,727	0,713	0,787
	Significant	adefg	ace	a	bch	ac	b	adefg	ac	d
Salt + / Olive oil ++	Mean value	52,557	57,243	52,537	3,923	3,113	3,603	10,813	9,593	10,027
	Standard	1,155	4,619	2,644	0,304	0,964	0,450	1,134	2,575	0,595
	Significant	bg	ace	a	fgi	ac	ab	b	ac	ac
Salt ++ / Olive oil +	Mean value	51,953	54,797	53,613	3,967	3,513	3,470	9,663	10,727	10,583
	Standard	0,950	0,720	0,539	0,859	0,137	0,238	2,236	0,820	0,736
	Significant	bg	ae	a	adegi	ac	a	adefg	ac	ac

b) By cereals

		Cereals	Normal			Butter +			Butter + / sugar -			Butter + / flour +			Sugar + / flour -			Big particles		
			Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant
COMPRESSION	Peak load (N)	Helkorn Vete	10,423	4,444	a	10,298	2,421	ab	12,558	4,891	ab	18,586	4,063	a	11,851	4,144	a	15,834	5,666	a
		Ölands Vete	14,257	4,931	a	12,458	1,035	a	16,471	1,394	a	29,701	15,245	a	5,685	2,081	a	10,885	3,850	a
		Kallunda Varvete Evolutionar	10,360	3,004	a	6,777	0,550	b	11,630	2,915	b	29,136	13,304	a	5,897	2,321	a	14,083	1,603	a
	Deformation peak (mm)	Helkorn Vete	15,000	0,000	a	14,967	0,058	a	15,000	0,000	a	15,000	0,000	a	14,967	0,058	a	15,000	0,000	a
		Ölands Vete	15,000	0,000	a	14,967	0,058	a	15,000	0,000	a	15,000	0,000	a	14,933	0,058	a	15,000	0,000	a
		Kallunda Varvete Evolutionar	15,000	0,000	a	14,933	0,058	a	15,000	0,000	a	14,967	0,058	a	14,900	0,000	a	15,000	0,000	a
	Final load (N)	Helkorn Vete	8,912	3,125	a	9,140	2,023	ab	10,595	3,412	a	15,827	3,303	a	6,632	1,646	a	12,940	4,404	a
		Ölands Vete	12,211	4,005	a	10,701	0,976	a	14,255	0,834	a	22,590	9,026	a	4,837	1,572	a	9,388	3,353	a
		Kallunda Varvete Evolutionar	9,349	2,299	a	6,220	0,494	b	10,424	2,303	a	22,465	8,264	a	5,039	1,464	a	12,152	1,361	a
	Adhesive force (N)	Helkorn Vete	0,655	0,265	a	2,306	0,170	a	1,889	0,531	a	0,091	0,079	a	2,649	0,249	a	1,639	0,816	ab
		Ölands Vete	0,236	0,160	a	1,758	0,708	a	3,024	1,525	a	0,006	0,004	a	1,538	0,491	b	1,291	0,208	a
		Kallunda Varvete Evolutionar	1,908	1,025	a	1,373	0,523	a	1,698	0,361	a	1,388	0,859	a	7,897	7,574	b	2,329	0,221	b
EXTENSION	Peak load (N)	Helkorn Vete	7,411	0,430	a	7,491	0,915	ab	7,117	0,150	a	11,626	0,136	a	5,829	0,259	a	10,667	0,164	a
		Ölands Vete	8,694	0,268	b	8,400	0,734	a	7,020	0,225	a	4,868	1,147	b	5,770	0,155	a	7,812	0,347	b
		Kallunda Varvete Evolutionar	6,727	0,064	a	5,673	0,367	b	3,248	1,070	b	6,048	0,189	b	7,084	0,160	b	11,238	0,504	c
	Deformation peak (mm)	Helkorn Vete	20,333	0,709	a	22,333	0,351	a	23,000	0,500	a	23,600	0,819	a	23,400	1,652	a	23,867	0,666	a
		Ölands Vete	21,200	0,436	a	21,933	0,777	a	19,733	0,577	b	18,200	0,985	b	20,700	1,572	a	20,933	0,153	b
		Kallunda Varvete Evolutionar	20,800	0,361	a	21,933	0,569	a	18,333	0,153	c	18,967	0,404	b	20,800	1,400	a	24,767	0,981	a
	Final load (N)	Helkorn Vete	7,222	0,413	a	7,381	0,913	ab	6,969	0,183	a	11,272	0,064	a	5,791	0,258	a	10,519	0,238	a
		Ölands Vete	8,407	0,190	b	8,259	0,729	a	6,699	0,261	a	4,565	1,219	b	5,714	0,163	a	7,705	0,359	b
		Kallunda Varvete Evolutionar	6,493	0,036	a	5,597	0,381	b	3,142	1,097	b	5,734	0,153	b	7,023	0,165	b	11,012	0,548	c
RUPTURE	Rupture load (N)	Helkorn Vete	31,445	3,695	a	10,181	1,345	ab	5,798	1,203	a	6,811	3,777	a	4,975	1,383	a	21,864	3,245	a
		Ölands Vete	23,683	10,177	ab	7,274	1,795	a	2,284	0,098	b	14,296	4,732	a	10,997	4,752	ab	10,700	2,326	b
		Kallunda Varvete Evolutionar	18,844	3,324	b	13,194	1,365	b	4,008	0,945	a	7,326	2,151	a	12,751	2,798	b	5,134	1,712	c
	Deform rupture (mm)	Helkorn Vete	0,900	0,100	a	1,567	0,379	a	1,476	0,569	ab	0,800	0,100	a	0,500	0,346	a	0,933	0,321	a
		Ölands Vete	1,767	0,306	b	1,967	0,551	a	2,433	0,115	a	1,000	0,100	a	1,033	0,551	a	2,233	0,643	a
		Kallunda Varvete Evolutionar	1,600	0,265	b	0,900	0,346	a	1,467	0,058	b	1,367	0,451	a	0,633	0,289	a	1,333	0,252	a
COLOR	L*	Helkorn Vete	59,207	1,570	ab	59,553	1,348	a	56,453	1,051	a	58,890	0,817	a	52,643	3,476	a	56,130	0,301	a
		Ölands Vete	56,760	1,113	a	58,783	0,196	a	57,350	1,062	a	55,737	1,135	b	55,570	0,351	a	58,150	1,269	a
		Kallunda Varvete Evolutionar	61,297	0,293	b	58,333	0,811	a	57,663	0,081	a	58,037	4,025	ab	51,537	5,252	a	58,297	2,281	a
	a*	Helkorn Vete	6,570	0,293	ab	8,193	0,587	a	5,830	0,234	a	5,597	0,071	a	6,777	0,140	b	5,973	0,276	a
		Ölands Vete	5,877	0,536	a	5,570	0,157	b	5,093	0,165	b	5,967	0,576	a	5,413	0,072	ab	5,850	0,173	a
		Kallunda Varvete Evolutionar	5,943	0,391	b	6,443	0,101	c	4,943	0,830	ab	5,423	0,462	a	6,900	1,175		5,483	0,285	a
	b*	Helkorn Vete	16,280	0,271	a	17,973	0,404	a	14,433	0,287	a	14,877	0,240	a	14,880	2,046	a	14,053	0,222	a
		Ölands Vete	15,087	0,817	ab	15,600	0,249	b	15,323	0,696	a	15,127	0,782	a	15,573	0,221	a	17,030	0,370	b
		Kallunda Varvete Evolutionar	17,110	0,405	b	17,153	0,261	a	13,487	1,580	a	14,473	1,474	a	13,370	2,732	a	15,160	1,000	ab

		Cereals	Normal			Sugar +			Butter + / sugar +			Butter + / flour +			Butter - / flour -			Big particles		
			Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant	Mean value	Standard deviation	Significant
COMPRESSION	Peak load (N)	Helkorn Vete	7,367	2,072	a	6,577	1,101	ab	6,155	1,269	a	11,838	2,833	a	20,151	11,933	a	8,759	4,698	ab
		Ölands Vete	7,182	2,329	a	10,700	2,409	a	8,282	2,290	a	24,647	7,869	a	8,871	3,282	a	9,026	0,806	a
		Kallunda Varvete Evolutionar	5,805	0,338	a	5,301	0,886	b	7,003	2,187	a	6,964	2,435	a	8,754	1,894	a	5,949	0,772	b
	Deformation peak (mm)	Helkorn Vete	14,967	0,058	a	14,967	0,058	a	14,900	0,000	a	15,000	0,000	a	15,000	0,000	a	15,000	0,000	a
		Ölands Vete	14,933	0,058	a	15,000	0,000	a	15,000	0,000	a	14,967	0,058	a	15,000	0,000	a	14,967	0,058	a
		Kallunda Varvete Evolutionar	14,967	0,058	a	15,000	0,000	a	14,933	0,058	a	14,967	0,058	a	14,967	0,058	a	14,933	0,058	a
	Final load (N)	Helkorn Vete	6,300	1,455	a	5,756	0,661	a	5,513	1,138	a	9,449	1,868	a	10,240	5,874	a	7,317	3,802	ab
		Ölands Vete	6,204	1,796	a	8,513	1,106	b	6,957	1,580	a	18,822	3,730	b	6,833	2,329	a	7,173	0,676	a
		Kallunda Varvete Evolutionar	5,212	0,399	a	4,528	0,682	a	6,136	1,785	a	6,130	1,995	a	6,742	0,841	a	5,302	0,705	b
	Adhesive force (N)	Helkorn Vete	1,983	0,437	a	1,578	0,112	a	1,586	0,467	a	0,968	0,344	a	8,084	3,629	a	1,215	0,449	a
		Ölands Vete	1,482	0,615	a	2,253	0,432	a	3,373	3,949	a	1,223	1,615	a	2,910	1,614	a	2,339	0,163	b
		Kallunda Varvete Evolutionar	1,394	0,339	a	3,480	3,576	a	1,880	0,624	a	0,530	0,143	a	3,810	1,109	a	1,301	0,409	a
EXTENSION	Peak load (N)	Helkorn Vete	10,259	0,087	a	10,263	0,096	a	10,930	0,483	a	9,718	0,328	a	6,566	0,462	ab	5,545	0,255	a
		Ölands Vete	4,032	0,437	b	4,077	0,664	b	8,052	0,137	b	7,681	0,272	b	6,658	0,315	a	6,764	0,173	b
		Kallunda Varvete Evolutionar	6,488	0,088	c	6,619	0,312	c	7,647	0,645	b	6,438	0,818	b	5,679	0,151	b	8,916	0,482	c
	Deformation peak (mm)	Helkorn Vete	25,933	0,351	a	23,867	0,611	a	25,233	0,611	a	23,867	0,850	a	23,167	1,550	a	19,033	0,757	a
		Ölands Vete	18,967	0,058	b	17,867	1,595	b	22,233	1,007	b	19,767	0,404	b	20,033	2,977	a	20,900	0,737	a
		Kallunda Varvete Evolutionar	21,467	0,208	c	21,500	1,249	c	19,167	5,787	ab	19,300	1,493	b	21,233	1,405	a	21,100	1,000	a
	Final load (N)	Helkorn Vete	10,175	0,091	a	10,156	0,072	a	10,838	0,495	a	9,707	0,441	a	6,518	0,472	ab	5,583	0,345	a
		Ölands Vete	3,954	0,434	b	3,981	0,663	b	7,983	0,107	b	7,378	0,337	b	6,365	0,145	a	6,720	0,156	b
		Kallunda Varvete Evolutionar	6,409	0,080	c	6,503	0,319	c	7,084	0,728	b	5,994	0,508	c	5,631	0,153	b	8,826	0,471	c
RUPTURE	Rupture load (N)	Helkorn Vete	6,009	0,899	a	5,302	0,077	a	4,432	1,788	ab	4,169	0,691	a	4,434	1,259	a	3,355	0,770	a
		Ölands Vete	11,788	2,299	b	13,081	0,893	b	4,453	0,108	a	8,444	1,376	b	2,513	0,222	a	3,720	1,298	a
		Kallunda Varvete Evolutionar	27,900	9,118	ab	4,432	0,394	a	2,392	0,088	b	7,912	2,552	ab	2,359	0,064	a	2,865	0,385	a
	Deform rupture (mm)	Helkorn Vete	2,133	0,651	a	2,033	0,058	ab	0,013	0,006	a	1,667	0,513	a	1,833	0,289	a	1,433	0,289	a
		Ölands Vete	6,167	0,929	b	4,967	1,274	a	2,067	0,808	b	4,533	1,429	a	1,000	0,000	b	2,333	0,764	a
		Kallunda Varvete Evolutionar	4,400	1,249	ab	1,633	0,321	b	1,067	0,115	b	5,733	3,612	a	0,800	0,265	b	1,600	0,141	a
COLOR	L*	Helkorn Vete	62,303	0,310	a	59,267	0,715	a	56,710	0,992	a	60,987	0,142	a	58,353	1,242	a	59,807	0,967	a
		Ölands Vete	61,037	0,250	b	59,120	0,278	a	58,523	1,765	a	56,907	1,371	b	56,903	1,651	a	60,180	0,527	a
		Kallunda Varvete Evolutionar	59,590	1,149	b	60,673	1,287	a	58,293	0,330	a	59,440	1,840	b	56,887	1,463	a	59,563	0,558	a
	a*	Helkorn Vete	5,627	0,042	a	5,387	0,385	a	5,790	0,480	a	5,940	0,066	a	5,640	0,161	a	6,193	0,336	a
		Ölands Vete	5,750	0,406	a	5,933	0,500	a	5,470	0,304	a	5,517	0,436	a	5,270	0,183	ab	5,807	0,031	a
		Kallunda Varvete Evolutionar	4,897	0,256	b	4,407	0,264	a	5,767	0,268	a	5,663	0,169	a	5,090	0,244	b	6,010	0,291	a
	b*	Helkorn Vete	16,403	0,656	a	15,173	0,365	a	13,800	0,720	a	15,967	0,410	a	15,790	0,973	a	16,463	0,235	a
		Ölands Vete	16,850	0,415	a	16,753	0,236	b	16,033	1,101	a	14,400	1,110	a	15,710	0,894	a	16,427	0,663	a
		Kallunda Varvete Evolutionar	14,130	1,250	a	15,863	0,290	a	15,213	0,203	a	16,247	1,080	a	14,400	0,782	a	16,237	0,360	a

Cereals		EXTENSION (dough) Peak load (N)			Deformation @PEAK (mm)			Final load (N)		
		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	4,742	7,314	8,808	27,167	25,733	26,967	4,432	6,923	8,347
	Standard deviation	0,737	0,268	0,044	1,904	0,764	0,473	0,723	0,265	0,086
	Significant	a	b	c	a	a	a	a	b	c
Hight particule	Mean value	10,696	8,043	8,868	29,167	25,733	25,967	10,457	7,604	8,367
	Standard deviation	0,171	0,367	0,534	0,451	0,907	0,208	0,119	0,335	0,492
	Significant	a	b	b	a	b	b	a	b	b
Salt +	Mean value	10,425	8,660	8,482	29,367	27,533	28,500	10,021	8,293	8,227
	Standard deviation	0,413	0,304	0,496	0,635	1,266	0,624	0,333	0,293	0,526
	Significant	a	b	b	a	a	a	a	b	b
Salt ++	Mean value	6,752	8,819	10,896	25,633	27,933	31,900	6,401	8,555	10,551
	Standard deviation	0,381	0,117	0,172	1,069	0,551	1,493	0,426	0,094	0,101
	Significant	a	b	c	a	b	c	a	b	c
Olive oil+	Mean value	7,262	8,179	6,702	26,567	27,700	27,667	7,020	7,840	6,440
	Standard deviation	0,295	0,060	0,140	1,242	0,265	1,550	0,299	0,086	0,108
	Significant	a	b	a	a	a	a	a	b	a
Olive oil++	Mean value	11,342	8,808	9,421	33,000	28,200	30,067	11,074	8,580	9,085
	Standard deviation	0,766	0,233	0,426	1,664	1,153	0,289	0,789	0,246	0,415
	Significant	a	b	b	a	b	ab	a	b	b
Salt + / Olive oil +	Mean value	9,458	7,010	9,214	28,633	27,000	29,067	9,318	6,651	8,971
	Standard deviation	0,217	0,052	0,158	1,193	1,127	0,961	0,210	0,090	0,208
	Significant	a	b	a	a	a	a	a	b	a
Salt ++ / Olive oil ++	Mean value	10,219	7,693	8,240	28,600	22,733	27,667	9,914	7,388	7,947
	Standard deviation	0,142	0,396	0,230	0,700	0,462	1,234	0,154	0,391	0,236
	Significant	a	b	b	a	b	a	a	b	b
Salt + / Olive oil ++	Mean value	10,741	8,093	7,887	27,367	27,633	27,433	10,472	7,711	7,664
	Standard deviation	0,410	0,548	0,352	0,513	0,404	0,416	0,458	0,526	0,309
	Significant	a	b	b	a	a	a	a	b	b
Salt ++ / Olive oil +	Mean value	9,261	8,760	6,840	29,300	28,133	26,467	9,043	8,448	6,666
	Standard deviation	0,303	0,209	0,420	0,520	0,115	0,929	0,292	0,277	0,421
	Significant	a	a	b	a	ac	c	a	a	b

Cereals		COMPRESSION (dough) Peak load (N)			Deformation @PEAK (mm)			Final load (N)			Adhesive Force (N)		
		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	17,315	19,441	21,731	15,000	15,000	14,967	14,551	13,886	18,308	1,865	2,120	2,935
	Standard deviation	5,613	1,612	7,516	0,000	0,000	0,058	4,195	3,492	4,966	0,449	0,344	1,284
	Significant	a	a	a	a	a	a	a	a	a	a	a	a
Hight particule	Mean value	25,809	48,240	21,210	15,000	15,000	15,000	19,704	30,569	17,839	2,448	2,255	1,805
	Standard deviation	4,495	5,879	4,276	0,000	0,000	0,000	2,003	2,667	3,110	0,019	0,344	0,799
	Significant	a	b	c	a	a	a	a	b	c	a	a	a
Salt +	Mean value	22,612	21,303	21,099	15,000	14,967	14,967	18,370	18,286	18,333	2,082	2,355	2,371
	Standard deviation	4,256	2,789	2,102	0,000	0,058	0,000	30,080	2,403	1,268	0,318	0,062	0,079
	Significant	a	a	a	a	a	a	a	a	a	a	a	a
Salt ++	Mean value	18,467	20,647	20,595	14,967	15,000	15,000	15,342	17,219	17,584	1,601	2,438	2,303
	Standard deviation	2,868	1,234	4,162	0,058	0,000	0,000	2,288	1,199	3,218	0,386	0,043	0,292
	Significant	a	a	a	a	a	a	a	a	a	a	a	a
Olive oil+	Mean value	14,535	17,790	15,263	15,000	15,000	15,000	12,838	15,274	13,204	1,464	2,245	2,351
	Standard deviation	0,487	1,361	2,066	0,000	0,000	0,000	0,436	0,924	1,245	0,244	0,531	0,206
	Significant	a	b	ab	a	a	a	a	b	ab	a	ab	b
Olive oil++	Mean value	13,461	17,563	16,841	15,000	15,000	14,967	11,934	14,694	14,302	1,097	2,123	1,972
	Standard deviation	0,778	4,122	3,085	0,000	0,000	0,058	0,620	2,131	2,151	0,878	0,294	0,570
	Significant	a	a	a	a	a	a	a	a	a	a	ab	b
Salt + / Olive oil +	Mean value	14,867	13,935	18,683	15,000	15,000	15,000	12,926	12,284	15,049	1,624	1,675	2,426
	Standard deviation	0,463	3,014	5,402	0,000	0,000	0,000	0,510	2,338	3,032	0,132	0,344	0,137
	Significant	a	a	a	a	a	a	a	a	a	a	a	b
Salt ++ / Olive oil ++	Mean value	13,713	17,324	14,624	15,000	14,967	15,000	12,071	14,768	12,819	2,161	2,093	1,782
	Standard deviation	2,816	2,118	2,010	0,000	0,058	0,000	2,475	1,251	1,628	0,157	0,293	0,620
	Significant	a	a	a	a	a	a	a	a	a	a	a	a
Salt + / Olive oil ++	Mean value	14,293	18,664	13,719	15,000	15,000	15,000	11,804	16,564	11,973	2,094	1,269	2,370
	Standard deviation	3,568	3,680	1,052	0,000	0,000	0,000	2,447	3,113	0,813	0,535	0,402	0,179
	Significant	a	a	a	a	a	a	a	a	a	ab	a	b
Salt ++ / Olive oil +	Mean value	14,971	20,039	12,263	15,000	15,000	15,000	12,653	17,463	2,054	2,043	2,729	2,100
	Standard deviation	2,256	4,709	2,219	0,000	0,000	0,000	1,192	3,411	1,752	0,292	0,618	0,217
	Significant	a	a	a	a	a	a	a	a	a	a	a	a

Cereals		EXTENSION (pasta) Peak load (N)			Deformation @PEAK (mm)			Final load (N)		
		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	6,104	8,347	9,252	21,333	25,233	26,033	5,111	7,956	8,900
	Standard deviation	0,508	0,310	0,032	0,666	1,069	0,115	0,314	0,438	0,100
	Significant	a	b	c	a	b	b	a	b	b
Hight particule	Mean value	11,172	9,018	7,497	27,900	25,233	22,700	10,699	8,394	6,883
	Standard deviation	0,147	0,503	0,290	0,173	0,757	0,173	0,153	0,469	0,353
	Significant	a	b	c	a	b	c	a	b	c
Salt +	Mean value	10,582	9,303	8,079	27,567	27,100	24,700	10,165	8,681	7,549
	Standard deviation	0,584	0,459	0,062	0,231	0,529	0,500	0,495	0,409	0,155
	Significant	a	b	c	a	a	b	a	b	c
Salt ++	Mean value	8,969	7,749	10,662	25,133	24,533	27,700	8,166	7,101	10,136
	Standard deviation	0,496	0,395	0,246	0,586	0,153	0,173	0,560	0,462	0,206
	Significant	a	b	c	a	a	b	a	a	b
Olive oil+	Mean value	7,329	8,053	9,188	24,733	24,633	26,567	7,006	7,696	8,642
	Standard deviation	0,131	0,188	0,383	0,473	0,379	0,208	0,113	0,169	0,334
	Significant	a	b	c	a	a	b	a	b	c
Olive oil++	Mean value	10,865	7,053	10,029	28,967	23,500	27,467	10,485	6,701	9,387
	Standard deviation	1,345	0,105	0,193	1,026	0,200	0,153	1,349	0,124	0,179
	Significant	a	b	a	a	b	a	a	b	a
Salt + / Olive oil +	Mean value	8,360	8,934	8,430	24,533	26,367	25,200	8,046	8,550	7,984
	Standard deviation	0,467	0,246	0,345	0,351	0,751	0,900	0,498	0,310	0,182
	Significant	a	a	a	a	b	ab	a	a	a
Salt ++ / Olive oil ++	Mean value	10,506	6,110	11,256	28,233	22,033	29,967	10,023	5,745	10,833
	Standard deviation	0,120	0,230	0,061	0,379	0,777	1,950	0,200	0,324	0,103
	Significant	a	b	c	a	b	a	a	b	c
Salt + / Olive oil ++	Mean value	10,106	7,825	7,465	28,467	25,500	24,067	9,643	7,545	7,047
	Standard deviation	0,117	0,408	0,304	1,242	1,015	0,404	0,177	0,346	0,155
	Significant	a	b	b	a	b	b	a	b	b
Salt ++ / Olive oil +	Mean value	7,685	9,113	9,619	23,388	26,233	26,300	7,277	8,661	9,267
	Standard deviation	0,221	0,308	0,109	0,115	0,802	0,500	0,351	0,366	0,099
	Significant	a	b	b	a	b	b	a	b	b

Cereals		COLOR L*			a*			b*		
		Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona	Helkorn Vete	ölands Vete	Kallunda Varvete Evolutiona
Normal Recipe	Mean value	62,213	52,677	54,000	5,303	3,933	3,653	13,733	11,617	10,267
	Standard deviation	0,108	3,414	2,930	0,631	0,287	0,516	10,600	0,828	1,868
	Significant	a	b	b	a	b	b	a	a	a
Hight particule	Mean value	51,273	52,587	52,890	3,757	3,697	3,453	9,067	9,627	7,643
	Standard deviation	2,526	1,128	5,152	0,046	0,372	0,161	1,289	0,552	1,529
	Significant	a	a	a	a	a	a	a	a	a
Salt +	Mean value	52,817	49,770	52,367	3,670	4,267	3,447	9,777	10,937	9,363
	Standard deviation	1,951	1,244	3,317	0,370	0,225	1,195	1,186	0,310	2,727
	Significant	a	a	a	a	a	a	a	a	a
Salt ++	Mean value	45,290	52,943	57,280	2,593	3,533	3,267	5,557	9,780	11,237
	Standard deviation	1,201	3,001	2,126	0,587	0,461	0,330	0,624	1,334	1,260
	Significant	a	b	b	a	a	a	a	b	b
Olive oil+	Mean value	55,087	52,477	54,540	3,507	3,920	3,700	9,240	11,213	10,370
	Standard deviation	3,090	1,760	2,920	0,296	0,202	0,392	1,097	1,219	0,575
	Significant	a	a	a	a	a	a	a	a	a
Olive oil++	Mean value	51,000	55,457	52,983	2,617	3,010	3,200	6,527	9,603	9,930
	Standard deviation	6,170	0,817	3,541	0,200	0,750	1,012	1,126	2,402	1,516
	Significant	a	a	a	a	a	a	a	ab	b
Salt + / Olive oil +	Mean value	55,663	53,707	52,700	3,380	3,633	3,700	9,603	9,990	10,110
	Standard deviation	2,053	1,524	1,731	0,289	0,235	0,072	0,679	1,677	0,287
	Significant	a	a	a	a	a	a	a	a	a
Salt ++ / Olive oil ++	Mean value	57,377	51,997	54,780	3,393	4,113	2,823	9,880	10,817	7,993
	Standard deviation	5,686	1,704	1,069	0,839	0,532	0,168	2,727	0,713	0,787
	Significant	a	a	a	ab	a	b	ab	a	b
Salt + / Olive oil ++	Mean value	52,557	57,243	52,537	3,923	3,113	3,603	10,813	9,593	10,027
	Standard deviation	1,155	4,619	2,644	0,304	0,964	0,450	1,134	2,575	0,595
	Significant	a	a	a	a	a	a	a	a	a
Salt ++ / Olive oil +	Mean value	51,953	54,797	53,613	3,967	3,513	3,470	9,663	10,727	10,583
	Standard deviation	0,950	0,720	0,539	0,859	0,137	0,238	2,236	0,820	0,736
	Significant	a	b	ab	a	a	a	a	a	a