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Depaetment of Food Science

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Summary

The aim of the study was to develop a whey protein base beverage for a specific target group, Baby boomers. The Baby boomers are the generation born between 1946-1964. Consumer research shows that this group takes a keen interest in their health and have the ambition to stay healthy. However, at the same time age related conditions, like stiff joints but also cancer, starts to appear. Therefore a product based on whey protein, with health benefits suitable for this target group was developed. The product was developed in cooperation with Arla Foods; the product development process was hence according to their routines. Background information about the needs of Baby boomers, requirements of the product, process and ingredients was gathered through literature research and interviews with employees at Arla Foods Three powders with different whey protein content were tested in a raspberry flavoured beverage Vitamin D and calcium was included in the recipe to add health benefits. Samples were produced in lab scale, but also in a pilot plant. Some problems with the process occurred in the first pilot plant trial and several changes had to be made in the second trial. A trained sensory panel then evaluated the samples, and nutritional values were calculated. The sensory evaluation showed all the three samples had off flavours, and one sample also separated when raspberry puree was added. The nutritional value was calculated based on the recipes. The values differed between the samples, with better results for the whey protein powders with higher protein content. More work has to be done to improve the nutritional values, but most of all the sensory properties of the product.

Key words: whey protein, beverage, Baby boomers

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1 Introduction

1.1 Background

In order to conduct successful product development the first step is to identify the intended consumer and investigate its needs, thereafter design a product based on those needs. The more defined the consumer, the easier it is to target a product regarding packaging, formulation and marketing. In this study the target group is Baby boomers. Baby boomers are the generation born after World War II, between 1946-1964. During these years many children were born compared to the generation before and the generation after. For example, in US the average in the peak year 1957, the average per mother was 3,8 children, compared to 1994 when the average was 1,9 children (Swinyard & Rinne, 1994). Apart from being a large group another factor that is special for Baby boomer is that they are the generation between two worlds, the early modernity and the late modernity (mid 20th century and onwards). The first one is characterised by routine and security, and the later one by flexibility, change and uncertainties. Another characteristic for late modernity is individualisation and globalisation. This generation has been through major social changes, which will impact their health later in life (Buckley, 2008). They are now starting to retire, but many of them are still working and have busy lives. Hence within this group there are several different needs to be identified and dealt with. One need that has been identified by Arla Foods is the ability to stay active despite the physical deterioration that in most cases comes with age (pers.com. Tornell, 2013). For this purpose a whey based drink with added benefits was developed. In US, Baby boomers use a lot of fortified foods since they want to be able to manage their health through food and hence make their choices based on what health benefits a product can bring (Chappa, Chao, & Edelstein, 2004). This is also valid for the markets this product is aimed for (pers. com. Tornell, 2013). The reason for choosing whey proteins were that this ingredient has shown several

health benefits (Madureira, Pereira, Gomes, Pintado, & Xavier Malcata, 2007). Some Baby boomers also do not want to consume too many dairy products since they want to avoid saturated fat, but they still want the benefits of dairy like for example proteins and calcium (pers. com. Tornell, 2013). This project was performed in cooperation with the dairy company Arla Foods; therefore it should also contain some kind of dairy product.

Whey was used for its health benefits already in Ancient Greece. During the middle age it was used not only for health but also as an aphrodisiac and for skin care (Madureira et al., 2007). However, it is not until recent decades that whey proteins have been commercialised big scale (Huffman & Ferreira, 2009). Whey proteins are now ingredients with documented nutritional and functional benefits and are used for several types of products such as sports bars/drinks, infant formulas and dairy food. The different functional properties, for example water binding, foaming and emulsification make whey proteins useful for different food applications (Evans, Zulewska, Newbold, Drake, & Barbano, 2009).

1.2 Objectives and delineation

1.2.1 Primary objectives

The primary objective of this project was to make a prototype of a beverage based on whey protein with added benefits such as minerals, vitamins and/or probiotics, which will be suitable for, and attractive to, the target group Baby boomers. In order to achieve this goal, several questions had to be addressed.

To increase the likelihood of finding the right formulation, different whey protein powders, with different protein content, were compared. The hypothesis was that the powders will give different sensory properties to the product, but also that it will affect the nutritional value for the product.

1.2.2 Secondary objectives

1. Investigate the target group and define the needs in order to decide on what added benefits the product should have. For example if it should be energising, calming, enhance recovery after sports etcetera.

2. Decide whether the product should have a health claim. EFSA has recently sharpened the regulations around health claims, so this had to be considered.
3. The challenges with whey protein had to be identified and addressed, for example there is a potential risk of off flavours and also impact the consistency of the product (Evans et al., 2009).
4. When the added benefits had been decided, ingredients, which deliver these benefits, had to be found, and their documented effects they have to be investigated.
5. When there was fairly clear picture of what the product should contain, the procedure for product development had to be established. This includes for example defining a recipe, decide which ingredients to be used and not least decide on how the product should be evaluated, in which way it can be determined whether the making of prototypes was successful or not.

1.3 Delineations

This project will only deal with the development of a whey protein based beverage at the first phases of the product development phases. No full-scale trial will be performed. It is also focused on product development, not how the consumer insight behind the product was gained, the packaging or the marketing of the product. The product is going to be produced by Arla Foods and therefore the equipment the company has access to and the supplier they use will be another limitation within this project. The product will be designed based on the requirements from Arla Foods. A trained expert panel, and not a consumer panel, will evaluate the product. Performing a proper consumer test is resource demanding in terms of time and money and therefore out of scope in this study.

2 Theoretical Background

2.1 Baby boomers

2.1.1 The consumer insight

Prior to this project, Arla Foods performed a market survey in order to identify opportunities for new products aimed at this target group. First of all, Baby boomers are not a homogenous group; they have different attitudes to for example life, health and dairy. They have different needs on different occasions. The attitudes and needs can also be observed in other age groups, like for example worries about health and looks. Hence a product designed for Baby boomers does not have to appeal to this target group exclusively. Age is relative and this group does not see themselves as old. For most of them, life is good, and many spend much time doing things they enjoy. However, in this stage of life, fragility starts to come into focus. It could be disease or more simple conditions like stiff joints in the morning. In any case, many of the Baby boomers have realised that life is precious and living life to the full has become more important over the years. They have desire to keep up with the pace they used to have. Weight and bone health has been identified as key issues, especially for women. Research also shows that some consumers do take action and consume foods with added benefits such as probiotic yoghurt drinks and food enriched with Calcium and Omega's, as well as regular exercise. Cholesterol is another issue where functional ingredients are used to help manage health (pers.com. Tornell, 2013). Other research confirms the picture of Baby boomers as being active and not just identifying themselves as caregivers. They struggle to balance work, family and other social commitments (Pruchno, 2012).

For this group of consumers, dairy plays an important role in their diet. They have a positive relationship with dairy and it is seen as natural and "good for you". However, there are also some negative perceptions around high fat and cholesterol content. The research was conducted on several markets, and the conclusion is that attitudes and behaviour were very similar across those markets. For example all consumers valued health as a way of living life to the full and for food and dairy, all markets tended to have more traditional diets. A requirement for the product is that it should fit with their lifestyle since getting them to change is much harder. The market survey performed by Arla Foods also revealed that the consumers see dairy as important for health and wellbeing, especially in regard to calcium and bone health. The target group is also aware of that dairy contains important vitamins and minerals for health. The three most important aspects of food are taste, health and convenience, in the mentioned order. It should also be remembered that not all in this group have retired. Many of the Baby boomers are still working, and have a busy life with activities such as looking after grandchildren. The Baby boomers have worked for a long time and many of them feel that they have earned the right to treat themselves. They also want to stay healthy to be able to do the things they love and they want to both feel good but also look good. Natural food is important, and also food that not cause high cholesterol and obesity. The strongest occasion for dairy is at breakfast at home. Other occasions are the afternoon snack to keep them going or for indulgence (pers.com. Tornell, 2013).

2.1.2 Health issues for Baby boomers

The product should in some way boost wellness and/or health. Research shows that there are several issues that influence the life quality of this group. Obesity is a global problem that affects all age groups. The large increase in living standard the Baby boomers has experienced has lead to many positive outcomes, but also negative ones such as obesity (Buckley, 2008). In US for example, the Baby boomers grew up at the same time as the fast food was launched and they adapted to a more sedentary life style. The Baby boomers are more likely to smoke, be overweight and have a sedentary lifestyle compared to the previous generation. At the same time, they are more likely to take an active role in their wellness (Chappa et al., 2004). However, other authors claim that Baby boomers are healthier then their parents' generation and have longer life expectancies (Pruchno, 2012). There are also health problems that are inevitable with age; many will develop conditions such as hypertension, arthritis, cancer and heart diseases (Pruchno, 2012). Other

physical changes are loss of muscles mass and the slowing down of the metabolic rate. Many older people also experience the effect of osteoporosis and osteoarthritis, as though a healthy diet and regular exercise can slow down many age-related changes (Collins, 2004). Women also lose bone mass during menopause (Madureira et al., 2007).

2.2 Product development issues

A food product with added benefits such as protein and vitamins requires special care in the product development phase. Unlike pharmaceutical or supplements, the sensory properties of the product are important since the consumer use it not only for the health benefits but also to enjoy the flavour. The added compounds, for example vitamins and proteins, need to be homogenously dispersed in the product. The product also has to be stabilised since added vitamins are often inclined to oxidation and other degradative reactions. Many bioactive substances need to be protected from light and oxygen since these parameters can cause unwanted reactions (Rittmanic, 2013). The solubility is another issue for fluids and varies depending on the food matrices. However, there are different encapsulation techniques to solve this issue. Structuring the food matrix in a suitable way will be important to secure the availability of the bioactive compounds and the stability of the product (Kaufmann & Palzer, 2011). Hence, packaging, storage environment and transportation of the product are important factors to consider already in the product development phase. Other steps are of course to decide on the nutritional value of the product, whether it should be possible to make any claims or not, and all other ingredients that should be included (Rittmanic, 2013) .

This product will contain proteins. Added protein will improve the general nutritional profile of the product. However, adding protein will most likely increase the viscosity of the product (Kaufmann & Palzer, 2011). For whey proteins, sugar has an impact on the denaturation of the proteins and therefore impacts the viscosity of the product (pers. com. Kot, 2013; Rittmanic, 2013). For example lactose can inhibit denaturation (Ramos et al., 2012). Some sugar will hence be needed to get the desired taste of the product, but it will also play an important role in getting the desired viscosity.

2.2.1 Product development at Arla Foods

In this project, the first steps of the product development process in Arla Foods will be covered. Those will be the following:

Before doing full-scale trials, there are often test runs performed on a larger pilot plant. Those are located at several of the dairies. This way it is possible to do a trial in a more realistic way, without having to do full scale trials (pers. com. Kot, 2013).

2.3 Ingredients

Whey protein will be an important ingredient in this product. Other ingredients will be some kind of sweetener, flavouring and vitamins/minerals. All these can interact and will have an impact on the properties of the final products.

2.3.1 Whey protein

Whey is obtained during cheese making when cheese curd is separated from milk. It can also be obtained by direct acidification of milk, when a curd is formed. In cheese making, 10 kilos of milk ends up in 1 kg of cheese and 9 kg of whey. The liquid whey contains lactose, minerals, whey proteins, fat and by products of cheese. The protein content in whey is around 0,7% and consists of β-lactoglobulin, α -lactalbumin, bovine serum albumin (BSA), immunoglobulins, glycomacropeptide (GMP) and several other minor proteins (Huffman & Ferreira, 2009). Today the utilisation in Europe is around 90% and is important for the feasibility of the dairy industries. Recent technological developments have made it possible to further fractionate whey ingredients, and being able to create products with a higher value. It is the proteins in the whey that defines the functional properties of the whey ingredient in a food product. Whey is usually dried to extend shelf life and reduce the cost for transportation. The protein content in whey ingredients vary from 12,5% to 90% (Huffman & Ferreira, 2009).

Whey protein concentrate

Whey protein concentrate (WPC) is usually produced by ultrafiltration where lactose and minerals are removed and different rations of protein can be obtained. For example WPC35 (35% protein content) is used in bakery mixes, dietetic mixes and confections, while WPC50, WPC65 and WPC80 (50 respectively 65 and % protein content) can be used as protein supplements in nutritional products like

drinks, bars and soups. Whey protein Isolate (WPI) contains a minimum of 90% protein and is therefore more expensive. Due to the price it is mostly used in premium products such as sports and nutritional products, e.g. beverages and bars (Huffman & Ferreira, 2009).

Functional properties

For making a ready to drink product the solubility of whey the protein is one of the key parameters. Whey proteins have a very good solubility over a wide range of pH, making it suitable for foods, compared to for example soy protein isolates, which have a poor solubility at low pH, making it less suitable for foods with low pH. Heat treatment can influence the denaturation of whey proteins and hence good control of the process is important. Other factors that influence denaturation are pH, total solids and ionic strength and concentration of sugars (Rittmanic, 2013). One advantage of using whey protein in drinks is the low viscosity in water, allowing use of high protein concentration, without having to use large quantities of liquid (Huffman & Ferreira, 2009).

Nutritional properties

From a nutritional standpoint, milk protein is good source of high quality protein. Whey proteins are suitable in sports drink because they contain amino acids that assist both as an energy source, protein source and for muscle building. The lactose content of whey can be a problem for the lactose intolerant consumers, however development in whey processing has made it possible to produce ingredients with less than 1-2% lactose, suitable for low lactose or lactose free products (Huffman & Ferreira, 2009).

Health benefits

There are several potential health benefits with whey protein. Some components can give protection for some types of cancers. Peptides can protect from hypertension and have anti-inflammatory properties. Further on there is anti-thrombotic activity, reduction in cholesterol level, opioid-like activity, prebiotic effects and anti-oxidative effects (Huffman & Ferreira, 2009). Madureira et al. (2007) found in their literature review several biological functions for whey proteins. Whole whey protein can prevent some types of cancer, like breast and intestinal cancer. By increasing the glutathione level, tumour cells can get more vulnerable and it can also be used for treatment of HIV patients. Whole whey proteins also have antimicrobial activities and can increase satiety response. β-Lactoglobulin is a

transporter for retinol, palmitate, fatty acids, vitamin D and cholesterol. α-Lactalbumin can also be used for prevention of cancer. It is involved in the lactose synthesis and can be used for treatment of chronic stress induced diseases. Bovine serum albumin has anti-mutagenic functions and can prevent cancer. Whey proteins also contribute to build muscles and decrease the tendency for bone breaking. There is also research showing that whey proteins can help in bone formation and activate bone cells. Bovine lactoferrin also plays an important part in the stimulation of the immune system, and has been shown to have power against a wide range of microorganisms (Madureira et al., 2007).

Whey proteins will be used in this product because they can have several advantages in a product for the target group. In general, protein are one of the most satiating of the macronutrients and to increase the protein content in the diet can support weight control (Kaufmann & Palzer, 2011). Solah et al. (2010) presents in their study that besides the protein content, the viscosity of the beverages also influenced satiety. They found that high viscosity and low protein was more sating than low viscosity and high protein, showing that viscosity can affect satiety. The study also showed however that low viscosity and high protein was more sating than low viscosity and low protein, indicating that protein do affect satiety. To make products that increase satiety can be one way to fight obesity (Solah et al., 2010).

Claims

Despite the research on the health benefits of whey proteins, it is not possible to make any claims for whey proteins in particular, only for proteins in general. It is for example allowed to say “Protein contributes to a growth in muscle mass” and “Protein contributes to the maintenance of normal bones” (www, European Commission, 1, 2013)

2.3.2 Sweetener

To obtain a good taste the product must contain some kind of sweetener. There are several options to choose from for this kind of product. The choices include for example sucrose, fructose and high fructose syrup. These are natural but also with high calorie content. There are other low calorie options like sugar alcohols or artificial high-intensity sweeteners like sucralose and acesulfam. Another group is the natural high-intensity sweeteners (Rittmanic, 2013). Stevia is one example from this group, and is already used in products by Arla Foods (pers. com Kot, 2013).

However sweeteners from this group e.g. rebaudioside A can have off flavours like bitter chemical like. Another option could be tagatose, which has fewer calories than sucrose, but a similar taste profile (Fujimaru, Park & Lim, 2012). For tagatose it would also be possible to make health claims about tooth health and lower blood sugar rise (www, European Commission, 1, 2013). The choice of sweeteners is important not only because of the taste, but it can have an impact on both consistency and protein stability of the product. Combination of two sweeteners can be an option to get the best overall flavour impact. The base flavour of the product also has to be considered as it will impact the sweetness profile (Rittmanic, 2013).

Sucrose is considered to give the best sweetness (pers. com. Andersson) and it is also the sweet taste consumers prefer, and they do not want to compromise on taste (DuBois & Prakash, 2012). The disadvantage is the high calorie content with no beneficial attributes, e.g. vitamins or fibre. Sucrose raises blood sugars fast, and there are studies that show that this can increase the risk for cardiovascular disease, especially for overweight women. The Swedish National food agency points out that scientific evidence of this hypothesis is weak and that long-term studies are lacking (www, Livsmedelsverket, 1, 2013). Sugar in beverages can also increase the risk of overweight since a fluid product does not provide the same satiety, but still have high calorie content. The general advice from the authorities is to limit the intake of sugar (www, Livsmedelsverket, 2, 2013).

2.3.3 Flavouring

Some kind of fruit juice or berry puree will be used as flavouring. Whey proteins are compatible with most flavouring. However the pH might have to be adjusted with some kind of acid to avoid that proteins buffer the juice acids, which can change the properties of the product (Rittmanic, 2013). The flavouring also has to appeal to the intended target group. The Baby boomers are rather traditional in their taste, so new exotic flavours or innovative combinations may not be a good choice. A more classic flavour like raspberry or strawberry is probably a better option (pers. com Tornell, 3013).

2.3.4 Vitamin and Minerals

If vitamins are included, they have to fit in with the product. No vitamins are totally stable in food and they may be affected by different factors such as heat, mois-

ture, oxygen, pH and light. The deterioration of the vitamins is due both to other ingredients, process and storage. In the product development process it has to be considered that the shelf life of the product will be determined by the least stable component. Statements regarding vitamin content come under the force of law. Hence, the vitamin content has to be tested to ensure that the stated content is valid throughout shelf life (Ottaway, 2002). Water-soluble vitamins are in general stable in a low pH beverage. However they can have impact on colour and flavour, especially if the beverage is packed in a transparent bottle (Rittmanic, 2013).

Minerals such as calcium could also be added as a health benefit However they can affect the clarity and stability of the beverage (Rittmanic, 2013). The most interesting minerals from a nutrition aspect are calcium, iron, zinc, iodine and selenium. Calcium, phosphate and magnesium act as structural components in bones and teeth. They also play an important part in body fluids regarding pH, nerve impulses and muscle contractions, for example. In the body, some of the minerals are easily absorbed, while others, like calcium and magnesium are harder for the body to take up. A few, e. g. iron, are very poorly absorbed, (Reilly, 2002).

2.3.5 Stabilisers

Other ingredients that might be necessary for this type of beverage is stabilisers such as pectin, which can help to stabilize the protein through heat treatment and shelf life if pH is in the range of 3,5- 4,6. A lower pH does not necessarily need a stabiliser (Rittmanic, 2013). For example calcium often requires some kind of stabiliser, for example carrageenan, to maintain evenly dispersed in the product. Otherwise it has a tendency to settle (pers. com. Kot, 2013).

2.3.6 Preservatives

Preservatives can inhibit the growth of microorganisms such as yeast, mold and bacteria, which can spoil the product. Examples of preservatives that can be used are sorbates and benzoates (Rittmanic, 2013). However, Arla Foods strive to have as natural products as possible with few additives. These kinds of preservatives are amongst the substances that should be avoided in the product (pers. com. Kot, 2013).

2.4 To claim or not to claim

The objectives with the health claims set up by The European Union (EU) is to guide the consumer in making informed choices when it comes to food. Therefore the claims on the labelling must be accurate and based on science. The regulation has been valid for the whole of Europe since 2006 and includes both nutritional claims, such as "low fat" as well as health claims, for example "reducing blood cholesterol" (www, European Commission, 2, 2013). It is also important for Arla Foods not to mislead their consumers (pers. com. Arkbågen, 2013). For each claim there are also conditions of use, one example could be that is has to be certain amount of the substance in the product to be able to say something about it. (www, European Commission, 1, 2013). Claims can be both authorised and non-authorised, but only authorised claims should be used (pers. com. Arkbåge, 2013). The term "source of X" refers to another part on the health and nutrition regulations where the amount of an ingredient is stated in order to be able to claim "low in…" or "rich in…." or "source of ….". In this case, whey protein will be an important part of the product. There are no authorized health claims available for whey proteins, however it could be possible to claim "source of milk protein" if it contains at least 12 % of the energy value comes from protein, and "high protein if the energy value is at least 20% (www, European Commission, 3, 2013). There are also claims available for protein in general (www, European Commission, 4, 2013).

3 Method

For the background information needed, a literature study was performed and relevant people were interviewed. This includes foremost employees at Arla Foods within the areas of concept development, product development and nutrition. Literature and interviews was also used to develop recipe for the product. The recipes were based on the requirements of the product from Arla Foods. The actual prototypes were made at both lab scale in small batches and at a pilot plant in slightly larger batches. Due to time limitations full-scale tests were not possible. The product were evaluated by a modified quantitative descriptive analysis, QDA, profile by a trained sensory panel. However in a real product development case, a consumer panel would have evaluated both the product and the concept (pers.com. Tornell, 2013).

3.1 Product development

The product development process followed the procedure used by Arla Foods and included the following steps;

1. Decide on a *target brief*. The target brief contained the desired properties for the product, e.g. in this case protein content and added benefits.
2. Lab scale samples were made and evaluated. Samples were mixed by hand and no heat treatment was involved. All ingredients were weighted in a glass beaker and then stirred with a metal spoon until all powder was dissolved. The water was cold tap water. The raspberry puree was made of frozen raspberries that had been boiled for two minutes and then put through a strainer to remove the seeds. The amount produced was one kilogram per sample. The samples were evaluated by personal assessment.

There are rarely any more advanced analyses in this stage, e.g. chemical, microbiological or sensory.

3. Pilot plant samples. In the pilot plant at the Arla Foods innovation centre in Stockholm, it is possible to make small batches, Between 15-20 kilograms, of each sample were produced. The process is more or less the same as at a dairy and it was therefore possible to see what happened to different ingredients when they went through the heating process. Samples from the pilot plant were evaluated in a more serious way, in this case by sensory analysis with a trained external panel. During the product development process there are usually several pilot plant trials before the desired product is achieved.

Suggestions for improvement were made for further development of the product (pers.com. Kot, 2013).

3.2 Sensory profile

Since it was not possible to make a real consumer test, a selected and trained sensory panel is evaluated the samples. The panel used for this task was Arla Foods external expert sensory panel, which consists of 14 assessors, whereof 12 participated in the evaluation. The majority of the assessors have worked in the sensory panel for several years and are familiar with different dairy products. The samples were evaluated in a sensory profile, similar to QDA, qualitative descriptive analysis (Lawless & Heymann, 2010). The panel developed the attribute list together with the panel leader, but some attributes were also added to cover important aspects for the product. The samples were then evaluated on a liner scale from 0-10 using FIZZ software (Version 2.47, Biosystèmes, Courternon, France) and statistics were calculated in the same program. The panel was trained with appropriate samples before the sessions, but the actual assessment was performed individually, and in replicates in order to check the consistency of the evaluation of each panellist, but also the whole panel (Lawless & Heymann, 2010).

3.3 Nutritional value

The nutritional value of the samples was calculated based on the information from the manufacturer and literature. No chemical analyses of the samples were made to confirm the figures. Hence, there were only theoretical values.

4 Results

4.1 Requirements for the product –Target brief

The product should encourage activity and help the consumer to keep/get a healthy body, healthy mind and give energy to do the things in life they desire. It should be consumed at breakfast or as a snack during the day. Therefore it should be portion-sized packages. It is also desirable that the portion is not too big, therefore it was decided that for this trial, one portion is 200 grams (pers.com. Tornell, 2013).

4.1.1 Protein content

The protein content is aimed at 5%. This figure is chosen because it is slightly higher than milk, which has 3,4% protein (www, Arla Foods, 1, 2013) and about the same level as protein enhanced beverages already at the market, but slightly less than pure sports/recovery drinks (e.g. www, Arla Foods, 2, 2013; www, Gainomax, 2013 and www, Valio, 2013). At 5%, it should also be possible to get a good consistency of the product while a higher level could make it more difficult to get a desirable viscosity, as there is a risk that it will get too thick (pers. com Kot, 2013).

4.1.2 Flavour

A good flavour is important for this product and raspberry puree has been chosen. It is a rather traditional flavour, but it will be suitable for the target group and it is also a rather strong flavour, which can help masking any off flavour from the other ingredients. In the lab scale samples only puree will be used, however in pilot plant production it is likely that flavouring, has to be added to enhance the flavour since the process will affect the product much more than lab scale, which will have a negative impact on the flavour (pers. com Andersson, 2013).

4.1.3 Sweetener

Sucrose will be used as a sweetener in the first trials. Since it is important to get as low calorie content as possible, using low caloric sweeteners could be a possibility. To start off, the sugar content will be around 6,5 %. After the sensory evaluation of the samples, the possibilities of lowering sugar content will be evaluated. The nutritional value of the product also has to be considered since low energy content is desirable.

4.1.4 Vitamins and minerals

Considering the needs of the target group it has been decided to add vitamin D and calcium. These ingredients will address the needs of bone health since vitamin D is involved in the regulation of the calcium content in the bones and teeth (www, Livsmedelsverket 2, 2013; Reilly, 2002) and calcium also is vital for the formation of bones (www, Livsmedelsverket, 3, 2013; Reilly, 2002). A combination of vitamin D and calcium has also shown to be beneficial since they seem to have synergetic effects (Moyad, 2003). Calcium will also be less absorbed if vitamin D levels are low (Reilly, 2002) Apart from bone health, these nutrients can have other positive effects on the health of the Baby boomers. For example calcium can stimulate weight loss and vitamin D can reduce the risk of some cancer types (Moyad, 2003). Calcium plays an important role to prevent osteoporosis, loss of bone tissue, which often affects women over 50 years (Reilly, 2002).

Vitamin D, which is a fat-soluble vitamin, is the only vitamin that can be produced by the body (Ottaway, 2002). Even so, the vitamin D level is in general low amongst the population in the Nordic countries (pers. com. Arkbåge, 2013; Ovesen, Andersen & Jakobsen, 2003). There are two kinds of vitamin D, D_2 and D_3. Both are derived from ultra-violet irradiation. For D_2 it is irradiation of ergosterol, which is found in fungi and some plants, and for D_3 it is 7-dehydrocholesterol in the skin of animals and humans. The vitamin D naturally occurring in food of animal origin seems to be relatively stable to heat processes. Both forms of the vitamin manufactured for commercial use are more instable. They are sensitive to light and acid. Some forms of vitamin D2 are also sensitive to oxygen (Ottaway, 2002). The vitamin D used by Arla Foods in their fortified products is D_3 (pers. com. Kot, 2013).

It is also possible to make claims for vitamin D, for e.g. “Vitamin D contributes to normal absorption/utilisation of calcium and phosphorus”. However, there is an

accompanying condition of use, which is "The claim may be used only for food which is at least source of vitamin D" (www, European Comission, 2, 2013). For example calcium, to be able to label a beverage as "source of (vitamin/mineral)", one portion must contain at least 7,5% of recommended daily intake (RDI), while "rich in (vitamin/mineral)" requires 15% of RDI. These figures are for beverage, while for solid food the figure is 15% for "source of" and 30 % for " rich in" (pers.com Arkbåge 2013).

To reach 15% of daily intake, i.e. 3,5-5 mcg, of vitamin D (www, Livsmedelsverket, 2013), in one portion of 200 gram, the amount to be added to the 1000 grams lab scale samples is very small, 3.0×10^{-6} grams. It is possible to make a dilution and add the vitamin. However, the experience in Arla Foods is that vitamin D is stable when added to a beverage and does not impact the sensory properties of the product. Hence, this is normally not added in lab scale or first pilot plant trials (pers. com., Kot, 2013). This vitamin will therefore only be added in theory. Calcium on the other hand can have an impact on the product and will therefore be added in the pilot plant trial. The recommended daily intake is 800 mg for women over 20 years old (www, Livsmedelsverket, 1, 2013). A calcium fortification powder containing 24 % calcium will be used. This powder is used in other fortified products by Arla Foods (pers. com. Kot, 2013).

4.2 First lab scale trials

In the first lab scale trials, three different whey protein powders, powder A, B and C, with different protein content were tested.

Table 1. Nutritional values of the whey protein powders (%) according to manufacturer

	Powder A	**Powder B**	**Powder C**
Protein	75-79	64-68	29,5-32
Lactose	7-10	20	54
Fat	5	8	4
Ash	7	4	-

Added sucrose was 6,5 % and raspberry puree was 20%. Water and whey protein powder content was adjusted to get a protein content of 5%, see table 2. Since the

powders could vary in protein content, the % in the final product is calculated on the lowest figure stated in table 1.

Table 2. Recipe in weight %, lab scale samples

	Powder A	Powder B	Powder C
Whey protein powder	6,7	6,5	15
Sugar	6,5	6,5	6,5
Raspberry Puree	20	20	20
Water	66,8	67	58,5
Total	100	100	100

4.2.1 Evaluation of lab scale samples

Since this was the first lab scale test, only the author and an experienced product developer evaluated the samples. The conclusions are summarised in table 2. Based on experience it was suspected that the samples might get thicker during storage (pers. com. Kot, 2013); they were therefore tasted again three days later.

Table 3. Evaluation of first lab scale trials

	2013-03-22	2013-03-25
Powder A	Very powdery mouth feeling, the darkest colour, no off flavours, thin	Most separated, but flavour the same, thin
Powder B	Smooth, no powdery mouth feeling but a whey-like off flavour, thin	Separated, same off flavour, thin
Powder C	Smooth, but salty off flavour, thin	Least separated, same off flavour, thin

4.2.2 Conclusions and next step

It was concluded that none of the samples was good enough, but further work needed to be done before the samples could be tested on the panel. Since the powders used are made for commercial production it was suspected that they would behave differently in a real process, for example longer mixing time and heat treatment can have an effect on the consistency of the product (pers. com. Kot, 2013). It was therefore decided to make a pilot plant trial. The pilot plant has the

same processes as a real dairy, but with the possibility to make small-scale test runs. Further on, the following questions will be discussed in order to improve the likelihood of getting acceptable samples.

- Investigate whether there are any other flavourings that we could use to hide off flavours –Yes, raspberry flavourings can be added to enhance the flavour and hide the off flavours (pers. com. Andersson, 2013)
- Investigate the possibilities to have higher fruit content – No, the product will be too expensive to produce, however it would probably work (pers. com., Andersson, 2013)
- Investigate whether it is possible to lower the protein content, less powder will hopefully give less powder feeling/off flavours –No, the product should have a higher protein content than milk (pers. com., Tornell, 2013).

4.3 Pilot plant trial 1

The recipe for the pilot plant is the same as for the lab scale trials, but with the addition of calcium and flavouring. The seeds in the raspberry puree were not removed this time because it was simply not enough time to do this for the large amount of puree needed for the trial. Since the samples will get off flavours, flavourings might be needed to get an acceptable flavour, see table 4. The plan for the first pilot plant trial is presented in figure 1. Whey protein powder, sugar and raspberry puree were mixed with water for one hour (2), this to allow the powder to fully dissolve in the water and avoid a powdery consistency (pers.com., Andersson, 2013). After the mixing the product should have been homogenised (3). Homogenisation in this case will benefit the product by giving it a better stability and fully disperse the ingredients e.g. the calcium, in the product (Chandan, 2009) and pasteurised (4) at 127° C. The heat treatment is necessary to kill pathogenic organism, and therefore prolong the shelf life of the product. The heat also cause denaturation of the whey proteins (Chandan, 2009). The product should then have been cooled to 5°C before packing. After packaging, the samples were to be stored in 8°C instantly. However, two things went wrong and the samples could not be produced.

1. The protein denaturised and formed big soft lumps. This was probably due to a high temperature during heat treatment, in combination with the low pH in the raspberry puree. As long as the samples were mixed cool, there was no sign of denaturation.

2. The raspberry seeds in the puree were too big for the process equipment, clogging the system and making it impossible to process the product.

Therefore, the following changes of the process were made for the next pilot plant trial.

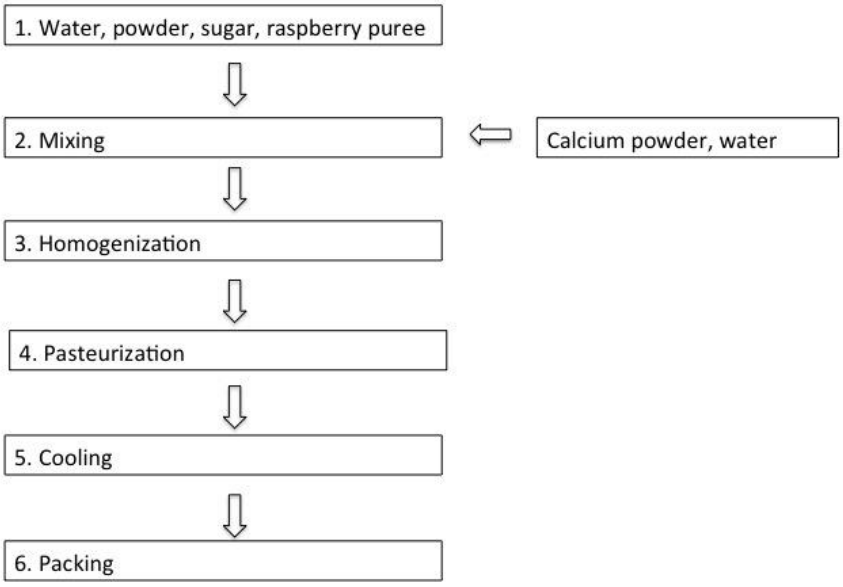
- The temperature during pasteurisation will be lowered. This will give a shorter shelf life, but for this trial, only a short shelf life is necessary. If the product is to be produced in large scale, the process has to be adjusted so a higher heat treatment is possible.
- The raspberry puree will be added after homogenisation and heat treatment. The product will then have a very short shelf life, due to the risks of contamination when the samples are mixed by hand. It will still be possible to analyse the product since samples can be prepared one day prior to the analysis.

Table 4 Recipe pilot plant samples (%)

	Sample A	**Sample B**	**Sample C**
Whey protein powder A	6,70	0,00	0,00
Whey protein powder B	0,00	7,50	0,00
Whey protein powder C	0,00	0,00	15,00
Water	66,69	65,89	58,39
Calcium powder	0,11	0,11	0,11
Sugar	6,50	6,50	6,50
Raspberry puree*	20,00	20,00	20,00
Flaovuring*	0,06	0,06	0,06

*added after processing in pilot plant trial 2

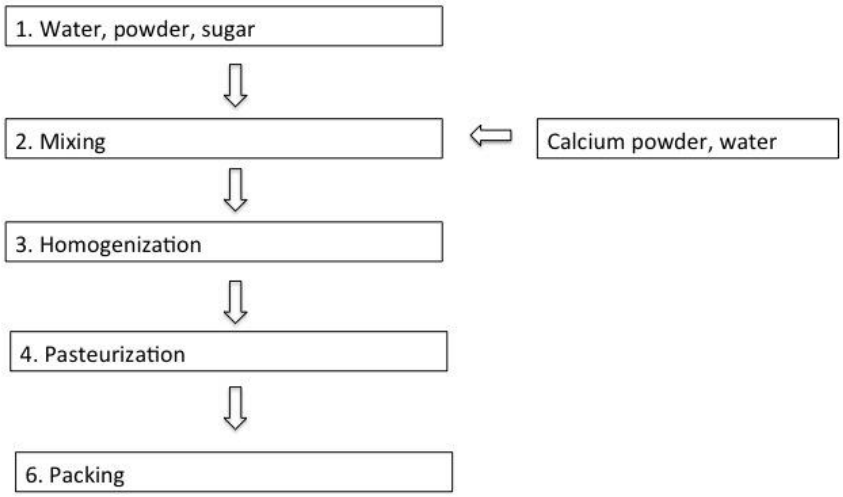
Figure 1. Flow chart for first pilot plant trial



4.4 Pilot plant trial 2

The flowchart for the second trial can be seen in figure 2. In this trial, only whey protein powder, sugar, calcium powder and water were mixed (1). The temperature during pasteurisation was lowered to 85 ° C. (3). The cooling step before packaging was also left out since it was assumed not to have any benefits for the process or the product.

Figure 2. Flow chart for second pilot plant trial



4.4.1 Preparation of samples

Frozen raspberries were thawed and the boiled for two minutes. They were then mixed and put through a strainer to get a puree without seeds. The puree was blended with the whey protein base and finally the flavouring was added. Due to this handling the samples had a short shelf life and therefore the samples was prepared one day prior to the analysis. However, one of the samples, whey protein powder A, separated when mixed with raspberry puree.

4.5 Evaluation of the samples

4.5.1 Sensory evaluation

Due to the problems with the pilot plant trials it was only possible to have one training session. However, most of the panel members have several years of experience in evaluating similar products. During the training session the panel tested samples B and C they agreed on where to put each attribute on the linear 0-10 scale. The attributes were chosen based on the most important sensory aspects of the product, and also the sensory panels comments during training, see table 5.

Table 5. Sensory attributes and explanation

Attribute	**Explanation**
Pink colour	Colour intensity and hue, from bright pink to brown-pink
Sweetness	Intensity of sweet taste
Raspberry	Intensity of raspberry flavour
Off flavour	Intensity of any off flavour, and description of it
Thickness	How thick the sample is in the mouth
Powdery	The presence of small particles in mouth

The samples were evaluated in two replicates. Since sample A separated when mixed with raspberry puree, this sample was excluded from the test. However, this sample had a good taste, but was powdery in the lab scale test, see table 3, so it was decided to test it in another type sensory profile. Only the bases, no raspberry puree or flavouring was added, when the samples were compared for the attributes powder and off flavour. In this test, only one replicate was assessed.

Results of sensory evaluation

The results for the samples are presented in table 6. The calculations are made using FIZZ software. Analyse of variance (ANOVA) was used to calculate judge effect, product effect and interactions. Significance level was set to P< 0,05%.

Table 6. Mean values (MV) and standard deviation (SD) for the sensory analysis, all attributes for sample B (B) and sample C (C). Mean values followed by different letters are significantly different.

	Colour*		Thickness*		Sweet*		Raspberry*		Off flavour*		Powdery	
	MV	SD	MV	SD	MV	SD	MV	SD	MV	SD	MV	SD
B	4,84b	0,26	3,82b	0,39	3,98b	0,31	4,69a	0,54	2,90b	1,27	1,32	0,79
C	6,04a	0,56	4,88a	0,24	5,00a	0,36	3,75b	0,74	4,24a	0,53	1,18	0,88

The results showed significant differences between the samples. Sample C was slightly darker in colour, thicker, sweeter, had less raspberry flavour, but more off flavour. The panel was asked to comment on the off flavours. Sample B got several comments about meat broth, metallic and bitter and sample C about salt, metallic and meat broth.

Table 7. Mean values and standard deviation for the base for sample A, sample B and sample C. Mean values followed by different letters are significantly different

	Powdery*		**Off flavour**	
	MV	**SD**	**MV**	**SD**
A	0,75 b	0,72	3,36	1,26
B	0,98 b	0,88	4,03	1,45
C	1,36a	1,36	3,94	0,76

In the evaluation of the bases there were only significant differences between the samples for powdery mouth feel, were sample C was more powdery that sample A and B. Also in this test the samples got comments about off flavour. Sample B and C got similar comments as in the previous profile; sample A also got comments about meat broth, but not as many as the other samples. There was however no significant difference with respect to this attribute.

4.5.2 pH of the samples

Since the pH value is an important factor for this kind of products (Rittmanic, 2013) pH was measured on the finished product, after the raspberry puree and flavouring was added. The pH value was measured with Thermo Orion model 370PerpHect LogR meter (Thermo Fisher Scientific).

Table 8. pH value of samples and raspberry puree

Sample	**pH**
A	4,89
B	4,64
C	5,20
Raspberry	3,33

The results presented in table 8 shows that the sample C has the highest pH value, followed by sample A and finally B. The separation of sample A is hence not only due to the pH value, as sample B had a lower value, but did not separate. It is not only heat or pH, but heat in combination with pH and the isoelectric point (pI), that impact the whey proteins ability to denaturise and form a gel. The pI differs between different types of whey protein, for example the pI for β-lactoglobulin is pH 5.2 and for immunoglobulins between 4,6-6,0 (Sullivan et al., 2008). When pH is close to the pI, the net charge of the molecule is close to zero. This can cause heat-denatured whey proteins to aggregate, hence the denaturation is faster when

pH is close to pI (Ramos et al., 2012). The presence of salts can influence the aggregation of the proteins (Sullivan et al., 2008), likewise, calcium can also contribute to gel formation (Ramos et al., 2012). The ratio of the different proteins in whey can vary, and that gives the functional properties of they whey protein powder (Huffman & Ferreira, 2009).

4.5.3 Nutritional value of the samples

One important aspect of this product is the nutritional value. It has to be appealing for the intended target group, Baby boomers. The calculations are made on the recipes for the pilot plant trials, but with added vitamin D. For the raspberry puree, values for frozen raspberries from the Swedish National Food Agency web site were used (www, Livsmedelsverket, 4, 2013). The results, see table 9, show that the main difference is in carbohydrates, where sample C has twice as much as sample A and almost twice as much as sample B. Sample B and C has also slightly more fat compared to sample A. Health claims that can be made, as previously stated, are about the vitamin D and calcium content.

Table 9.Nutritional value of the samples, one portion (200 grams)

	Sample A		**Sample B**		**Sample C**	
	%	**Per portion**	**%**	**Per portion**	**%**	**Per portion**
Protein	5,2	10,4 g	5	10 g	4,7	9,4 g
Carbohydrates	7,4	14,8	8,4	16,8 g	15	30 g
-added sugar	6,5	13 g	6,5	13 g	6,5	13 g
-lactose	0,6	0,12 g	1,5	3	8,1	16,2 g
Fat	0,4	0,8 g	0,6	1,2	0,6	1,2 g
Calcium	-	120mg	-	120 mg	-	120 mg
Vitamin D	-	5 mcg	-	5 mcg	-	5 mcg

The distribution of the energy value differs between the samples. In table 10, E%, which is the percentage of the total energy content, show that sample A and B are similar. In sample C less energy comes from protein and more from carbohydrates. Sample A has the highest amount from protein and the lowest from carbohydrates. The energy from fat is similar in all samples. It will also be possible to make claims about protein since the content in all samples are over 20E%, see table 10. The energy content, kcal, is similar in sample A and B, but higher in sample C

Table 10. Energy content, kcal per portion (200 grams)

	Sample A		**Sample B**		**Sample C**	
	Kcal	E%	Kcal	E%	Kcal	E%
Protein	40	37	40	34	40	23
Carbohydrates	59	55	67	57	120	70
Fat	7	6	11	9	11	6
Total energy	**106**		**118**		**191**	

5 Discussion

The objective of this study was to make a prototype of a protein beverage aimed at a specific target group, Baby boomers. The three most important aspects of food for this group are taste, health and convenience (Pers. com Tornell, 2013). Hence, the sensory properties of the product are important, but the aim was also to address the other two aspects. Therefore, apart from whey protein, something that would be beneficial from a health perspective would be added. The portion size of 200 grams was assessed to be a convenient size for a afternoon snack (pers. com., Tornell 2013) In the test, three different whey protein powders with different protein content were evaluated. The hypothesis that the samples would differ in both sensory and nutritional properties could be confirmed. There were clear differences between the whey protein powders, both from a sensory and a nutritional point of view, and some results were more promising than others. The challenge with off flavours and consistency that can occur with whey proteins (Evans et al., 2009) was not solved. After all trials were finished it was clear that there are several problems to be addressed before there is a product ready for launch.

5.1 Process, pilot plant trials

The main problem with the process was the seeds in the raspberries since they clogged the process equipment. In further work raspberry puree has to be added from the start in order to go through the pasteurisation process. A puree without seeds should be used for easier process, but also because seeds are probably not desirable in a beverage. Another problem was the temperature of the heat treatment. The lower temperature in the second trial is probably one reason why the whey proteins did not denaturate into lumps. However, to get a long enough shelf

life the temperature probably has to be higher so the process parameters were not optimal. The instability of sample A, which separated when raspberry puree was added, could be due to the process and probably in combination with other factors such as pH and pI. Since the denaturation is faster when pH is close to pI, the composition of whey proteins for sample A is likely to have a pI close to the pH of that sample. There are however several other factors besides the process that impact the denaturation of whey proteins, like calcium, salts and sugars (Ramos et al., 2012; Sullivan et al., 2008). For example sample C had more lactose in it than any other sample, which can have inhibited the denaturation. (Ramos et al., 2012).

The process can also have an impact on the vitamin D and the calcium. The levels must be measured after the proper process has been decided in order to adjust the added levels. If for example some of the vitamin D disappears during heat treatment it might not be enough left in the product to be able to make claims.

5.2 Sensory evaluation

A trained sensory panel evaluated the most important aspect, taste. The main result from the sensory analysis is that despite the addition of flavouring, all samples do have quite a lot of off flavours. It is possible that off flavour increase over time, and these samples were only evaluated once, when they were only two days old. Besides the off flavour, both samples were rather thick. Since research has shown (Solah et al., 2010) that a certain viscosity do enhance satiety, this could be a feature, however only a consumer tests can verify which thickness is desired. Sample C was thicker but also had a brown-pinker colour, which is probably less desirable than the brighter pink colour in sample B. Sample C had a higher amount of whey protein powder, which might be the reason for the thicker consistency. The higher sweetness, lower raspberry flavour and higher off flavour in sample C indicates that sample B is a better recipe to continue to work with. The high sweetness in sample C could on the other hand be a possibility the lower the sucrose content, which would be positive for the product. The second sensory test, see table 7, showed that sample A, which had a very powdery consistency in the lab scale trial, see table 3, is the least powdery. This indicates that heat treatment processing of the whey protein powders is important for the final result. There was no significant difference in off flavour in the second sensory test, but sample A has the lowest mean value. Both sample A and B has very low mean values for powdery, so this should not be a problem in the final product. These results show that if it is possi-

ble to find a solution for the separation of the sample, whey protein powder A is the most promising from a sensory perspective.

5.3 Nutritional value

To be able to make health claims can hopefully be a positive attribute when marketing the product. The nutritional vale showed that sample C had much more carbohydrates than sample A and B, due to the higher lactose content in the whey protein powder used in sample C. This also had the effect that more of the energy value, E%, came from carbohydrates and less from protein compared to sample A and B. Since this product is supposed to be a protein drink, the ratio between protein and carbohydrates is more favorable in sample A and B. The total energy content, measured in kcal, see table 10, is almost twice as high in sample C compared to sample A and B, which is also negative. The energy content should be kept as low as possible since obesity is a problem within the target group (Buckley, 2008). From a nutritional point of view, whey protein powder C is the least suitable for this type of product. Sample A and B are very similar, but with a small favor for sample A since it ha slightly lower energy content, and slightly better ratio between protein and carbohydrates, see table 10.

In the literature, several advantages with calcium, vitamin D and whey proteins have been found, but it is not possible to make claims for all of these. However, claims can be made available in the future and many consumers, especially those concerned about their health, will probably know the benefits of e.g. whey protein, without any claims (pers. com, Tornell, 2013). Benefits of the ingredients found in research fits very well with the needs for the target groups, for example increase satiety, which can help prevent obesity. Whey proteins also contribute to build muscles and lower the tendency for breaking bones (Madureira et al., 2007). The addition of calcium and vitamin D also enhance the prevention of osteoporosis. These nutrients also respond to other health need of the Baby boomers, such as it might stimulating weight loss and reduce the risk of some types of cancer (Moyad, 2003).

5.4 Improvements – further research

Looking at all three samples, it is clear that the taste, but also consistency and stability have to be improved. One way to go would be to test other types of whey proteins. The results clearly show that the process has a big impact on the final product. Therefore, improvements of the process will also be necessary since heat influence the denaturation of the proteins which impacts the final product consistency. Heat treatment is also important for the shelf life of the product, and a balance must be found where an acceptable shelf life is obtained, as well as a good consistency and stability of the product. The type of whey protein should also be considered since the properties, e.g. isoelectric point have an impact on how they behave in acidic beverage and during heat treatment.

Another solution to get less off flavour and a thinner consistency could be to have a slightly bigger portion size, e.g. 250 grams, the whey proteins will then be more diluted, and possibly have less impact on viscosity and off flavour. On the other hand the aim is a small portion snack (pers. com Tornell, 2013), and increasing the volume with 25% might result in a too big portion.

From a nutritional point of view, the biggest improvement would be to replace some, or all sucrose with a low calorie sweetener that would lower the energy content. This would be beneficial for the product since sucrose can increase the risk for obesity and other diseases (www, Livsmedelsverket, 2, 2013), which will then work against the positive effect of the whey proteins. For this product tagatose could be an alternative since the taste profile is similar to sucrose (Fujimaru et al. 2012) and it is also possible to make claims about tagatose (www, European Commission, 2, 2013).

6 Conclusion

The project was successful in the sense prototypes of a whey protein beverage were produced. It was also possible to see differences between the three different whey protein powders that were used. Both from a sensory and a nutritional aspect, sample A and B were better than sample C. However the sensory test shows that all samples have off flavours, therefore in further studies, other types of whey protein powders should be tested. The sample with the least desirable sensory properties was also the sample with the least describe nutritional properties and can hence be excluded from further studies. Vitamin D and calcium were added to give the product extra health benefits that would correspond to the needs of the target group. To replace sucrose with low calorie sweeteners would be the biggest health improvement of the product.

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Popular Scientific Summary

A beverage for Baby Boomers based on Whey protein

In product development, it is very important to find out what consumer want and/or need before deciding on which product to develop. In this study, the aim was to develop a whey protein base beverage for a specific target group, Baby boomers. The Baby boomers are the generation born between 1946-1964. Consumer research shows that this group takes a keen interest in their health and have the ambition to stay healthy. However, at the same time age related conditions, like stiff joints but also cancer, starts to appear. Therefore a product based on whey protein, with health benefits suitable for this target group was developed. The product was developed in cooperation with Arla Foods; the product development process was therefore adjusted to suit their routines. The background information about the needs of Baby boomers, requirements of the product, process and ingredients was gathered through literature research and interviews with employees at Arla Foods. Since it was decided that the product should be based on whey protein powder, three powders, A, B and C, with different whey protein content were tested. The reason for this is that the different powders can give the product different qualities. The beverage was flavoured with raspberry flavoured. Vitamin D and calcium was included in the recipe to add health benefits, which had been found to be suitable for Baby Boomers. Samples were first produced in lab scale, but also in a pilot plant, since this process is like in a real dairy, but in much smaller scale. Some problems with the process occurred in the first pilot plant trial and no samples could be produced. Therefore several changes had to be made in the second trial. A trained sensory panel then evaluated the samples, and nutritional values were calculated. The project was successful in the sense prototypes of a whey protein beverage were produced. It was also possible to see differences between the three different whey protein powders that were used. Both from a sensory and a nutritional aspect, sample A and B were better than sample C. However the sensory test shows that all samples have off flavours, therefore in further studies, other types of whey protein powders should be tested. The sample with the least desirable sensory properties was also the sample with the least desirable nutritional properties and can therefore be excluded from further studies. Other ways to improve the product is to replace sucrose with low calorie sweeteners, which

would be the biggest health improvement of the product. In order to produce the product, the process also has to improve to get a more stable product.