Title of Assignment:

Playing with Pectins and a Minimum Content of Sugar

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Module Name:

Molecular Gastronomy 1 (TFCS4025)

Course:

Culinary Science (DT405/ 4)

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Abstract:

This study involved making gels with pectin using a minimum concentration of sugar. Two pectin types were identified in this study. These include high-methoxyl pectins, which are the conventional pectin used and require sugar concentrations of 65% or higher to form gels, and low-methoxyl pectins which do not require sugar but do need calcium to enable gel formation. Therefore, low-methoxyl pectins were selected for use in this study as they can form gels with little or no sugar. The pectin was used in the creation of a dish, which would utilise the pectin's properties such as gelling, thickening and stabilising. A "cheesecake" was decided as the dish where pectin would be used to thicken the filling and would also be used to prepare a jelly with a minimum content of sugar – in order to accomplish the main objective of the study. In the trials, the tests for creating gels using pectin for the filling and jelly were successful – where the "cheesecake" filling was stiffened using pectin but maintained a soft texture due to the low concentration of pectin used. A solid jelly was also formed in the trials using pectin with no addition of sugar, which showed that a gel could be formed using low-methoxyl pectin without any sugar as long as calcium was present.

However in the final trial where the full dish was to be presented, the pectin seemed to fail at developing a gel – as shown by a very soft and loose "cheesecake" filling and the jelly remaining in liquid form. A number of reasons could explain this failure, including errors regarding the pectin or human errors occurring throughout the study. Errors with pectin may involve overheating which would destroy the pectin and prevent gel formation, excess calcium which would decrease gel strength, insufficient acid concentrations which would hinder gel formation and inadequate blending which would lead to not enough pectin being available for gel formation. Some human errors would include weighing of ingredients which would result in too little pectin or excess in other ingredients which would lead to not enough gel formation taking place to thicken or stiffen the mixture. Errors in calculations may have also occurred which would lead to too little concentrations of pectin being used which would result in insufficient gel formation taking place. Errors in recording changes of recipes may have also taken place which would result in the recipe not working as the amounts of some ingredients used in the final trial would either not be enough or in excess which would lead to poor gel formation occurring.

However regardless of the outcome in the final trial, the earlier trials had shown positive results in the gelling of pectin with the "cheesecake" filling being thickened by pectin and a jelly formed with no added sugar. The creation of the jelly using no added sugar showed that the main objective of the study had been achieved as a pectin gel was formed with a minimum content of sugar – with the minimum content of sugar possibly being 0% as long as other properties of the pectin are met, such as calcium content.

Background:

Molecular Gastronomy is defined as a branch of physical chemistry that looks at the results of culinary transformation. It does not focus on the activity of cooking but instead explores the effects of cooking when observing novel phenomena and mechanisms (This (2014)). It is concerned with the culinary transformations and sensory phenomena associated with eating (This (2006)), which involves the physical and chemical transformations that occur in cooking (Britannica.com). The term was first established by Hervé This and Nicholas Kurti in 1998 as they were interested in the phenomena that occur during culinary processes. The concept seeks to generate new knowledge on the basis of chemistry and physics behind culinary processes – such as why a soufflé swells and why mayonnaise becomes firm (Britannica.com). It identifies methods for creating the best flavour and texture, comparing recipes with old proverbs and "old wives tales". It involves the deconstruction of recipes, with various changes and transformations being carried out to the cooking method – such as the physical state of the food, the equipment and also the ingredients used. This provides an insight into the chemical and physical nature of cooking as well as gaining an understanding of what foods and techniques can be used to improve upon traditional methods (Edelstein (2014)).

Molecular Gastronomy uses centrifuges, syringes, freeze-driers, blast chillers and carbon dioxide dispensers along with other pieces of equipment to create a unique cuisine that can engage with and confuse the senses. Ingredients used include alginates, xanthan gum, soy lecithin, agar-agar, liquid nitrogen and calcium salts. Liquid nitrogen can be used for instantly freezing an ingredient or to make something shatter whilst soy lecithin is used for foaming and also for emulsifying. Other ingredients are used for producing gels, foams and spheres – where spheres can be made from any liquid and resemble the texture and appearance of caviar (Edelstein (2014)). These ingredients and pieces of equipment contribute to developing new cooking methods which may produce improved results in flavour and texture. This in turn will help achieve the ultimate goal of Molecular Gastronomy by combining the scientific understandings and knowledge of physical properties in the exploration of food (Sanchez (2016)).

Note-By-Note is a concept first imagined by Hervé This in 1994. It is a method that involves using chemical compounds to produce a food item. These chemical compounds could be sourced naturally or synthetically, but the molecules are the same regardless of the source and each source type has the same effects on sensory receptors (This (2014)). The idea of Note-By-Note is to use these chemical compounds instead of plant or animal tissue in the making of a dish that has the same consistency, odour, taste, colour and trigeminal sensation as the plant or animal tissue (This (2015)). The plant and animal tissue ingredients are deconstructed into their individual constituents – such as lipids and amino acids - to identify the chemical make-up of a dish (Chandran (2018)). Iqemusu.com

(2017) gives cherry as an example of a food that can be deconstructed into various categories which highlight the pure compounds associated with it. The consistency of the cherry is given by pectin and cellulose, which form the pulp by binding and trapping water with a system of networks. Colour is brought by a mixture of colour compounds such as beta-carotene and anthocyanins. Hundreds of odorant compounds contribute towards the smell of the cherry, which also take part in the cherry's taste. Other compounds include oil - which is a mixture of triglycerides, as well as starches – which is usually made up of two polysaccharides called amylase and amylopectin. Maize starch is a starch close to being a pure compound, as it is made up of 85% amylopectin (This (2015)). Once these raw compounds are identified, they can be used to reconstruct the essence of traditional dishes (Chandran (2018)). The concept can also be used to produce new foods rather than recreating existing dishes. Since ingredients in a dish contain a wide variety of compounds, there are an infinite number of chemical combinations that can be used to invent new dishes. It is thought that Note-by-Note cooking can be used to feed more people, prevent food spoilage, save energy and also to help improve global food security (Chandran (2018)).

Pectin is a polysaccharide that is found in plants – acting as a structural component in the plants' cell walls and is extracted from the skin and core of fruits (Ozilgen (2019)). Pectin is typically extracted from fruits such as apples and citrus fruits (Kamozawa, Talbot (2008) and is available in a powder or liquid form, or can be mixed with other gelling agents (Molecularrecipes.com). Kamozawa and Talbot (2008) state that pectin is an indigestible soluble fibre that can create colloidal systems – and subsequently a gel – when combined with water. It is used for a variety of purposes; including gelling, thickening and stabilising foods – in particular jams, jellies and some fruit juices (Ozilgen (2019)). They also play a role in the physical and sensorial properties, such as texture and ripeness, of fresh fruit and vegetables and can be used in nutrition, medicine, pharmaceutical and cosmetic products (Williams; Phillips (2000)).

According to Williams and Phillips (2000), pectin is made up of partially methyl-esterified galacturonic acid residues which are present in relatively large proportions in the plant tissue. These esterified pectins contain methyl groups, consisting of groups of one carbon atom and three hydrogen atoms, which modify the gelling properties of the pectin (This (2014)). Pectin is present in two forms: High-Methoxyl (HM) pectin and Low-Methoxyl (LM) pectin (Kamozawa; Talbot (2008)). This (2014) states that the degree of esterification relates to the number of carboxylic acid groups in the pectin chain esterified by methanol per one hundred galacturonic units. A High Methyl-Ester pectin has a degree of esterification of 50% and above whereas Low Methyl-Ester pectin is only 25 to 45%.

There are several factors that affect gel formation of pectin, such as heat, acidity and sugar. Heat is required for gelling to take place as it disrupts the linkages between pectin molecules and make it water soluble. Acid can contribute to gel formation at certain concentrations as it hydrolyses

pectin and forms new cross-linkages (Ozilgen (2019)). The amount of acid needed varies depending on the types of pectin used. HM pectin is very sensitive to acidity whereas LM pectin is not (Molecularrecipes.com (2019)). Ozilgen (2019) states that too little acid will result in no gel forming but too much acid will cause the gel to lose liquid. Often, acid present in the fruit is sufficient for gel formation although more may be required for low-acid fruits. Sugar binds to excess water which prevents forming a runny product and can also bind to pectin (Ozilgen (2019)). The amount of sugar used also affect gel formation as HM pectins requires sugar for gelling with concentrations of 65% or more needed for a gel to form. LM pectin gels can be produced with little or no sugar, as long as calcium is present (Williams; Phillips (2000)). The calcium is used with LM pectins as it helps to bind pectin molecules together and create a firmer gel (This (2014)).

LM pectins are used for producing low-sugar jams as they do not require high levels of sugar to gel (Molecularrecipes.com (2019)) – which is the ideal pectin type for this study in trying to produce pectin gels with a minimum sugar content. In producing gels from LM pectin, the pectin can be dispersed in cold water but can only be hydrated in a hot liquid. 80ºC is required for hydration to be completed and if hydration is not carried out, then gel formation cannot occur. A calcium-rich medium is also required for LM pectin to gel but does not require sugar. Different concentrations of pectin can also produce various consistencies in the liquid. Less than 1% concentration will give a syrup-like consistency, whilst a 1% concentration can produce a soft custard/ jelly texture as gel formation can begin at this concentration. A 2% concentration will produce a jelly (Alicia Foundation (2015)). When producing a gel from standard LM pectin, a pH range of 2.8 to 6.5 is required with 30 to 50mg of calcium per gram of pectin needed for gelling to occur (Modernistpantry.com (2019)). It is also recommended to use 150g of liquid when producing gels to achieve sufficient homogenisation (Alicia Foundation (2015)). Lumping may occur in producing gels from pectin which may be difficult to dissolve as the pectin forms a gel around the clumps. This can be prevented by using a hand blender when combining the pectin with the rest of the ingredients (Kamozawa; Talbot (2008)). The strength of the pectin gel can be increased with increasing levels of calcium used. However, if maximum saturation of calcium is achieved and too much calcium is added, the strength of the gel will begin to decline (Kamozawa; Talbot (2008)). The end result of producing a pectin gel is a brittle gel that has a similar mouthfeel to gelatine – but with a more sticky texture. The gel has a clear appearance and also has great flavour release (Molecularrecipes.com (2019)).

Therefore in producing gels using pectin and with a minimum amount of sugar, Low-Methoxyl pectins must be used with a concentration range of 1% to 2% to achieve adequate gelling. 30 to 50mg of calcium is also needed for gelling to occur but sugar is not a requirement. These ranges will be tested to determine the optimum concentrations for gelling of pectin.

Overall Aim:

The aim of this assignment is to investigate the gelling of pectins using varying amounts of sugar in an attempt to create a gel using the minimum quantity of sugar.

In seeking to fulfil this aim, several objectives were set:

- Identify pectins that would be suitable for testing in attempting to create a pectin gel with low sugar concentrations
- Create a series of gels using the pectins identified to test for the pectin with optimal gelling
- Test various pectin concentrations to determine the optimum concentration of pectin to achieve the desired consistency to use in the dish
- Use a range of sugar concentrations to develop a gel using the optimal pectin to determine the lowest concentration of sugar that can be used
- Use the results of these tests to develop a dish that utilises the gelling properties of pectin with the desired texture, shape and consistency

Final Materials and Methods:

Cheesecake Note-By-Note

Ingredients:

Base: Fruity Butter Sand;

- 2.50g icing sugar
- 5.00g clarified butter
- 10.00g maltodextrin
- 3-4 drops "Mallard Ferriére*"* yellow food colouring
    - Water, Tartrazine, Chloride, Sodium Sulphate, Sodium Benzoate
- 4-5 drops "Iqemusu" *Frum* (Rhum, Tropical Fruit, Ripe Fruit Evocation) Flavouring
    - Propylene Glycol, Pure Aromatic Note

Filling: Banana-Flavoured Yoghurt Mousse;

- 3.95g "Louis Francois Pectine NH Nappage*"* pectin

    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 31.0g caster sugar
- 45g milk
    - 38.57g water
    - 6.43g “Millac Value” Skimmed Milk Powder
        - Lactose, Whey Powder, Coconut Oil, Palm Oil, Dried Glucose Syrup, Milk Protein, Sugar, Potassium Phosphate (E340b), Mono- and Diglycerides of Fatty Acids (E471), Vitamin D
- 113.4g Greek Yoghurt
    - 85.05g water
    - 28.35g “Texturas Yopol” Yoghurt Powder
        - Hydrogenated Plant Fat, Modified Starch, Sugar, Milk Proteins, Powdered Skimmed Milk, Citric Acid (E330), Aromas
- 70g egg white
    - 60.00g water
    - 10.00g “Louis Francois Blanc Gallia” egg white powder
        - Powdered Hen’s Egg Albumin, Xanthan Gum (E415), Citric Acid (E330), Triethyl Citrate (E1505)
- 2-3 drops “Mallard Ferriere Bleu Ciel*”* blue food colouring
    - Water, Brilliant Blue, Sodium Sulphate, Sodium Benzoate
- 4-5 drops “Iqemusu” *Baliqin* (Banana, Candy, Sweetness Evocation) Flavouring
    - Propylene Glycol, Pure Aromatic Note

Recipe adapted from http://lostrecipesfound.com/very-airy-vintage-no-bake-cheesecake/ (2016)

<u>Jelly: Cherry-Flavoured Jelly</u>

- 4.29g “Louis Francois Pectine NH Nappage*”* pectin
    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 0.1g “Texturas Gluco*”* calcium
    - Calcium Lactate (E327), Calcium Gluconate (E578)
- 200g water
- 7.5g “PureSweet”erythritol
- 2-3 drops drops “Mallard Ferriere Bleu Ciel*”* blue food colouring

    - Water, Brilliant Blue, Sodium Sulphate, Sodium Benzoate
- 4-5 drops “Iqemusu” *Amerise* (Almond, Cherry, Pistachio Evocation) Flavouring
    - Propylene Glycol, Pure Artomatic Note

Equipment:

- Bowls
- Spoons
- Weighing scales
    - “ACCUWEIGHT 255 Digital Pocket Jewellery Scale” (amazon.co.uk)
        - Model Number: Accuweight255EU-BK

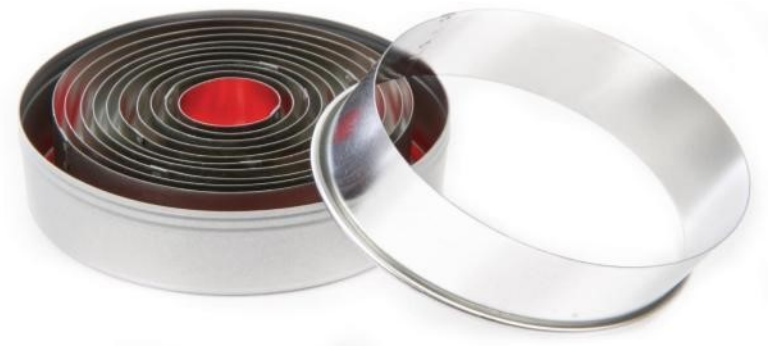
- Food processor
    - “Robot Coupe Food Processor” (hughjordan.com)
        - Model Number: R301Ultra

- Whisk
- Sieve
- Jugs
- Saucepans

- Stove
- Stand Mixer
    - “KitchenAid Heavy Duty Stand Mixer” (kitchenaid.co.uk)
        - Model Number: 5KPM50
        - 
- Whisk attachment
- Spatula
- Hand Blender
    - “BRAUN MultiQuick 5 Hand Blender - White” (currys.ie)
        - Model Number: MQ5000

- Silicone Moulds
    - “Pavoni Formaflex Silicone Petit Four Mould 15 Cup” - 325mm width x 176 depth (www.buzzcateringsupplies.com)

- Fridge
- Blast Chiller
- Freezer
- Knives
- Ring Mould
    - "Vogue Round Plain Pastry Cutter" – 23mm diameter (www.nisbets.ie)



Methods:

<u>Base:</u>

- Add icing sugar and clarified butter to a food processor and blend. Add colouring and flavouring and blend until incorporated. Add maltodextrin and mix again until fine powder forms. Reserve until ready to use.
    - (Alternatively, whisk clarified butter and icing sugar until combined. Add colouring and flavouring and mix until incorporated. Add maltodextrin and whisk until combined)

<u>Filling:</u>

- Whisk water and milk powder until powder is dispersed. Heat the milk until combined, then reserve.
- Whisk water and yoghurt powder until combined. Reserve
- Place water and egg white powder into a bowl of a stand mixer with a whisk attachment. Whisk until combined. Continue whisking until stiff peaks form. Remove and reserve.
- Add sugar and pectin to reconstituted milk. Blend using a hand blender. Heat in saucepan until combined. Remove from heat and cool
- Once cool, add to reconstituted yoghurt and whisk to combine.
- Fold in reconstituted and whipped egg whites until combined
- Add flavouring and colouring. Combine
- Pour mixture into moulds. Leave in fridge to set
- Place in freezer to firm before removing from moulds

Jelly:

- Add pectin and calcium to water in a jug. Blend until dispersed.
- Add colouring and flavouring then blend again.
- Pour into a saucepan and bring to boil. Remove from heat and pour into moulds. Leave to set in fridge.
- Place in freezer to firm slightly before removing.
- Cut jelly into desired shapes before serving

Once each component of the dish is prepared, plate up the dish for service. Carry out a sensory analysis of each component of the dish to determine the effect of gelling by pectin on mouthfeel, texture and consistency.

Results:

Figure 1: Pectin gel for Jelly set in moulds

Figure 2: "Cheesecake" Filling set in moulds

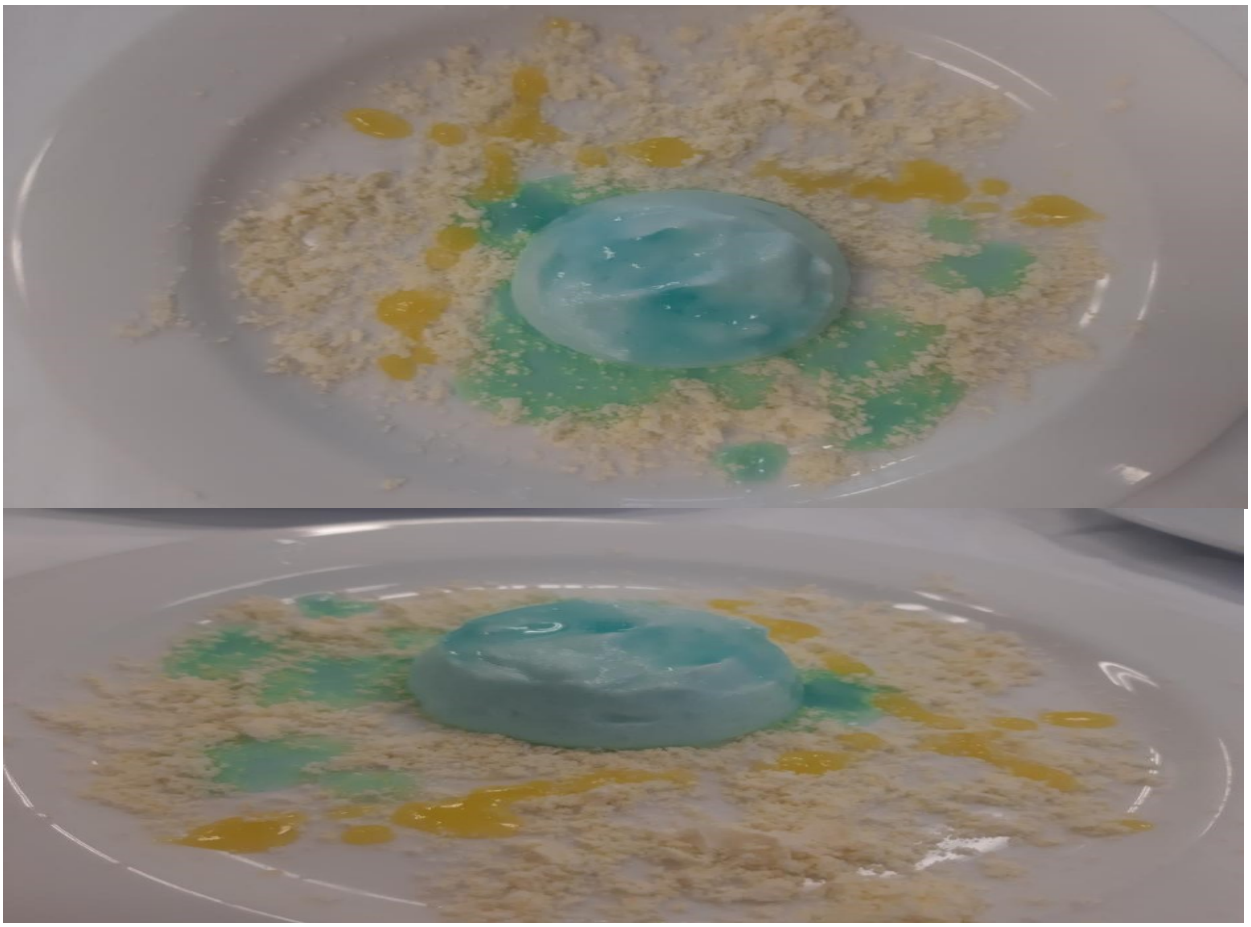


Figure 3: Finished "Cheesecake" dish with base, filling and jelly

Base

Appearance	Flavour	Texture	Aroma	Consistency	Mouthfeel
Light-Yellow (48%)	Buttery (51%)	Soft (39%)	Nothing (71%)	Light (52%)	Soft (44%)
Crumbly (33%)	Bland (36%)	Airy (35%)	Fruity (9%)	Airy (29%)	Light (40%)
Powdery (15%)	Sweet (9%)	Light (21%)	Buttery (8%)	Fluffy (17%)	Powdery (10%)
Other (4%)	Other (4%)	Other (5%)	Other (12%)	Other (2%)	Other (6%)

Figure 4: Top Three Descriptive Terms Associated with “Cheesecake” Base for Each Sensory Category

Filling

Appearance	Flavour	Texture	Aroma	Consistency	Mouthfeel
Moist (36%)	Fruity (51%)	Soft (31%)	Fruity (41%)	Soft (46%)	Sticky (33%)
Colourful (28%)	Sweet (30%)	Light (22%)	Sweet (36%)	Sticky (28%)	Smooth (30%)
Bright (25%)	Tangy (5%)	Sticky (21%)	Sour (5%)	Light (20%)	Soft (28%)
Other (11%)	Other (14%)	Other (26%)	Other (18%)	Other (6%)	Other (9%)

Figure 5: Top Three Descriptive Terms Associated with "Cheesecake" Filling for Each Sensory Category

Jelly

Appearance	Flavour	Texture	Aroma	Consistency	Mouthfeel
Liquid (36%)	Sweet (30%)	Syrupy (42%)	Nothing (38%)	Light (35%)	Syrupy (32%)
Shiny (20%)	Nothing (29%)	Light (29%)	Fruity (21%)	Syrupy (30%)	Smooth (29%)
Bright (19%)	Fruity (20%)	Sticky (20%)	Sweet (20%)	Smooth (19%)	Slimy (10%)
Other (25%)	Other (21%)	Other (9%)	Other (21%)	Other (16%)	Other (29%)

Figure 6: Top Three Descriptive Terms Associated with "Cheesecake" Jelly for Each Sensory Category

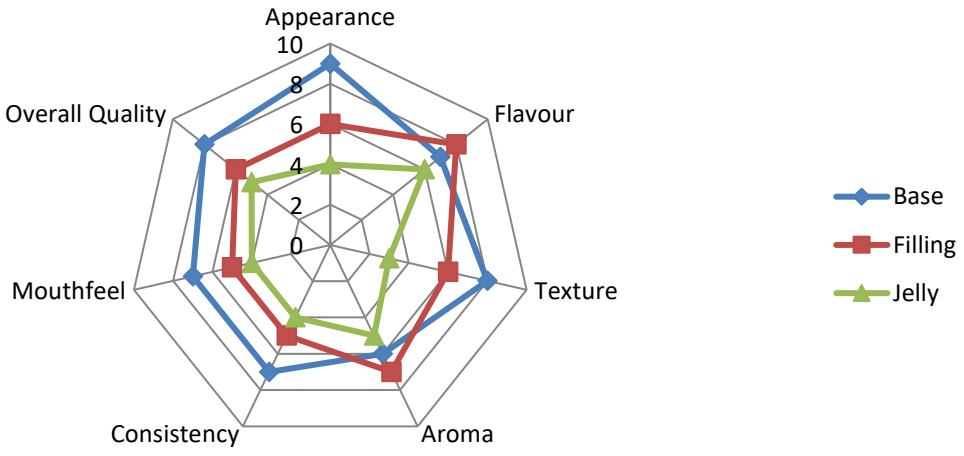


Figure 7: Results of Sensory Analysis of Base, Filling, and Jelly for "Cheesecake"

Discussion:

In the preparation of the "Cheesecake" filling and jelly, the amounts of pectin used were based on the recommended concentrations given by the Alicia Foundation (2015); where a 1% concentration would produce a soft structure similar to custard whilst a 2% concentration would produce a solid jelly. Therefore, a 1.5% concentration was used for the "Cheesecake" filling as this would provide a texture that is slightly stiffer than custard but not as firm as jelly. A 2% concentration of pectin was used for the jelly as was suggested by the aforementioned recommendations. The pectin used for each item was that of "Louis Francois Pectine NH Nappage*"* pectin. Chlebana (2018) states that NH pectin is a subcategory under LM pectin and therefore, is suitable for use in low-sugar recipes. When used in the "Cheesecake" filling, this pectin was combined with reconstituted milk and yoghurt powders. These powders, being dairy products, assist in gelling by pectin as dairy contains calcium ions which are required by the LM pectin to create gels (Early (1998)). With regards to the jelly, the pectin gel was produced using only water and calcium alongside colours and flavour compounds. The main objective of this study was to attempt to create a gel with pectin using the minimum concentration of sugar. Since LM pectin does not require sugar to gel (BeMiller (2019)), an attempt was made to prepare a pectin gel with no sugar added and have a sugar concentration of 0%. Erythritol was used to replace sugar as a sweetener, as erythritol is a sugar alcohol that is low in carbohydrates (Ketchum (2017)). However, the pectin used consisted of a blend of ingredients which included dextrose alongside the pectin. Dextrose is a simple sugar (Fletcher (2018)) and therefore would cause the sugar concentration to increase. The concentration of dextrose was not included on the pectin's packaging which resulted in the actual sugar concentration of the gel being unknown.

On completion of the dish, sensory analyses were carried out to determine the characteristics of each component of the dish – including the "cheesecake" base, filling and jelly. The sensory characteristics included appearance, flavour, texture, aroma, consistency and mouthfeel with the top three most common terms used recorded. With regards to the "cheesecake" base the majority of respondents stated that there was a light-yellow appearance, a buttery flavour, a soft texture, no distinct aroma, a light and airy consistency and soft mouthfeel – which were the desired characteristics in the preparation of the base. Fruity flavour compounds were added to enhance the flavour whilst yellow food colouring was used to make a more pronounced yellow colour – similar to butter in order to pair with the buttery flavour.

The filling was found to have a moist appearance, a fruity flavour, soft texture, a fruity aroma, soft consistency and a smooth mouthfeel. It was prepared as a yoghurt mousse using reconstituted egg

white powder mixed with reconstituted yoghurt powder and met some of the intended characteristics, such as flavour and appearance. Banana flavours were used alongside blue food colouring to make a product with a sweet and fruity taste but with a contradicting colour to confuse the senses. The texture was soft, light, sticky and smooth but did not have the desired level of stiffness that should have been achieved by the pectin, which suggests gel formation had either been insufficient or absent.

Finally the jelly was found to be liquid in appearance, sweet in flavour, had a syrupy texture, no aroma, a light consistency and a syrupy mouthfeel. It had met the desired characteristics in terms of flavour and sweetness but failed to meet the intended texture, consistency and mouthfeel as the jelly was liquid on serving. This suggests that gel formation did not take place.

Gel formation by pectin was required in order to achieve the desired consistency, mouthfeel and texture of the dish as well as the appearance as the pectin gel will assist in shaping the dish. However, the pectin failed to gel in the final trial despite being successful in previous weeks (see logbook). There may be a number of reasons as to why this had occurred, such as properties of the pectin and also standard human error. With regards to the pectin's properties, Ozilgen (2019) states that pectin can be destroyed as a result of prolonged cooking or cooking with too much heat which would result in decreased gel strength. In the "cheesecake" filling, the pectin was combined with reconstituted milk powder and brought to the boil to ensure hydration had occurred – as was recommended by the Alicia Foundation (2015). As a result, it is possible that excess cooking had taken place and damaged the pectin which resulted in inadequate gelling. This may have also occurred in the making of the jelly as the pectin was boiled with water. Acid concentrations may have also influenced the gelling of pectin, as the pH of the filling and jelly may not have been at adequate levels for gelling. The NH pectin used consisted of amidated pectin, which works best at a pH range of 3.2 to 3.6 (Modernistpantry.com (2019)). With regards to the filling, the only acidic ingredient present was yoghurt powder which may assist in dropping the pH of the filling. However, yoghurt tends to have a pH range of 4.0 to 4.6 (Masulli (2016)) which does not meet the ideal range given above and therefore, may have resulted in the poor gel development. The jelly had no acidic ingredients present which may explain the lack of gel formation, as too little acid – or no acid in this case - would result in gelling failing to occur (Ozilgen (2019)). However, gelling had been achieved in previous trials which suggest that acid concentrations may not have been at fault for the lack of gel formation. There may have also been an issue with blending of pectin with other ingredients that resulted in insufficient gel formation. Kamozawa and Talbot (2008) state that the pectin must be blended sufficiently to ensure that lumping does not occur with gels forming over pectin clumps which in turn do not dissolve. This would result in insufficient pectin being present for gelling and therefore, a failure of gel formation to occur. Although a hand blender had been used to combine the pectin with other ingredients, it may have been done inadequately and resulted in poor gel formation. This would also explain the failure in the final trial but success in earlier weeks as blending methods may have been

different. Calcium concentrations may also have affected the gel formation as too much calcium added would lead to maximum saturation and would in turn lead to a decline in gel strength (Kamozawa; Talbot (2008)). Amidated LM pectin requires only 10 to 30mg of pectin per gram of pectin (Modernistpantry.com (2019)). The filling already contains calcium from dairy products (Early (1998)) such as the milk and yoghurt powders with the pectin also containing some calcium already in the form of tricalcium phosphate. The jelly included 0.1g of calcium alongside the tricalcium phosphate present in the pectin blend. Therefore, it is possible that too much calcium was used for the filling and jelly and resulted in a decline of gel strength. However, this issue did not arise in previous trials as shown by the success in gel formation.

Human errors may have also occurred throughout the trials, which would have resulted in the failure of pectin to form gels. Such human errors may have included errors in calculations, weighing or recording. The filling and jelly used concentrations of 1.5% and 2.0% respectively, although the calculations to work out the amounts for these concentrations may have been incorrect which could have resulted in insufficient amounts of pectin used. Errors may have occurred in the weighing of ingredients which would have resulted in not enough pectin being used. Other errors that may have occurred include making changes to improve recipes that might not have been recorded. Therefore in the final trial, the amounts of pectin used may have been insufficient or excess amounts of other ingredients could have been used which would require more pectin to gel.

However regardless of the outcome in the final trial, pectin had been successful in producing gels in earlier weeks. A 1.5% concentration of pectin had been able to produce the desired texture and consistency of the “cheesecake” filling with a slightly stiffened texture but without the firmness of jelly – which shows that pectin can be used to produce a variety of textures. A jelly had also been prepared using a 2% concentration of pectin using no added sugar – meeting the objective of the study in preparing a pectin gel with a minimum content of sugar.

Conclusion:

In the preparation of a dish that utilises the gelling properties of pectin, a “cheesecake” filling had been successfully thickened using a 1.5% concentration of pectin to provide a texture firmer than custard but not as stiff as jelly. A jelly had also been prepared using a 2% concentration of pectin with a smooth and soft texture which was also solid and firm. The jelly had been prepared using low-methoxyl pectin, which is capable of producing gels with little or no sugar as long as calcium is present. As a result of this property, the jelly was successfully prepared in earlier trials using no added sugar with the addition of calcium to enable gel formation. This had shown that pectin gels can be prepared using little or no added sugar as long as the pectin used is a low-methoxyl pectin which only

requires calcium in order to gel. The pectin can also be used to produce a range of textures and appearances. The jelly had shown to have a firm and solid appearance, but had a soft, chewy and smooth mouthfeel. The "cheesecake" filling, on the other hand, had a spongy, slightly firm appearance but in fact had a very soft, smooth and creamy mouthfeel as the different concentrations of pectin used was able to provide various textures to the dish.

Although the final trial did not seem to be successful with regards to gel formation of pectin, the earlier trials had shown the properties of pectin and the range of its potential uses in the kitchen in providing dishes and foods with different textures and shapes.

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Log Books:

Week One:

Aim and Objectives:

The aim of this trial is to identify the optimum pectin type and concentration to use for gelling

The objectives set for this aim include:

- Identifying a range of potential pectin types to use
- Testing each pectin type to determine which pectin produces optimum results
- Testing each pectin to determine which concentration works best
- Determining which pectin type produces optimum results at given concentrations

Materials and Methods:

Ingredients:

Recipe 1;

- 3.05g (1.5%) "Louis Francois Pectine NH Nappage*"* pectin
    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 200g water
- 0.1g "Texturas Gluco"calcium
    - Calcium Lactate (E327), Calcium Gluconate (E578)

Recipe 2;

- 3.05g (1.5%) "Sosa Fruit Pectin NH" pectin
    - Thickener: amidated pectin (E440ii), stabiliser: disodium diphosphate, (E450i), dextrose, acid: tricalcium phosphate (E341iii)
- 200g water
- 0.1g "Texturas Gluco" calcium
    - Calcium Lactate (E327), Calcium Gluconate (E578)

Recipe 3;

- 3.05g (1.5%) "Sosa Pectina Low Sugar" pectin
    - Thickener: pectin (E440), stabiliser: calcium sulphate (E516)
- 200g water
- 0.1g "Texturas Gluco" calcium

- Calcium Lactate (E327), Calcium Gluconate (E578)

Equipment:

- Jug
- Weighing Scales
- Bowls
- Hand Blender
- Spoons
- Pot
- Stove
- Whisk
- Trays
- Fridge
- Blast chiller

Methods:

- Weigh out pectin, calcium and water
- Place calcium, water and pectin into a jug
- Blend using a hand blender until combined
- Place mixture into pot
- Heat mixture, bringing to a boil
- Allow to cool slightly
- Pour into trays
- Leave trays in blast chiller or fridge to cool and set
- Observe each pectin mixture, testing for gel development
- Record results

Results:

Pectin Type	Gel Formation (Yes/ No)
Nappage/ Amidated (1.5% concentration)	Yes
Low Sugar (1.5% concentration)	No
Fruit (1.5% concentration)	No

Figure 8: Table showing gel formation of different pectin types used at concentrations of 1.5%

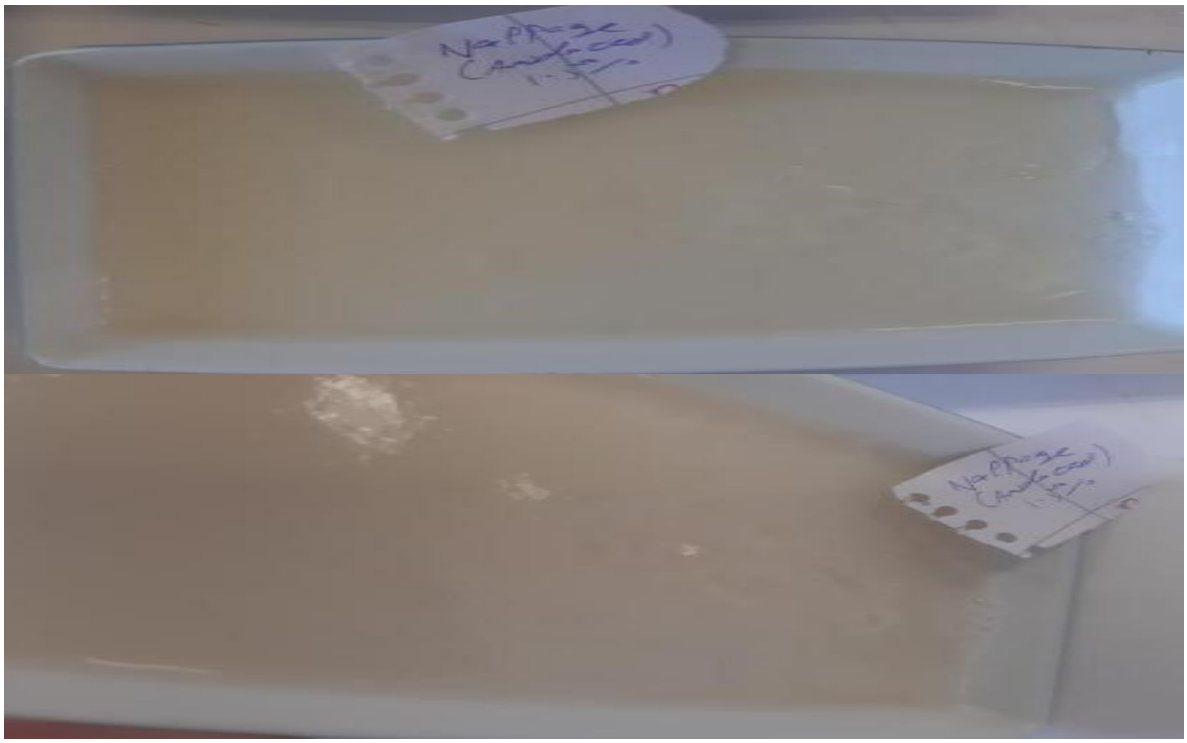

Figure 9: Nappage Pectin (1.5%) showing gelling taking place

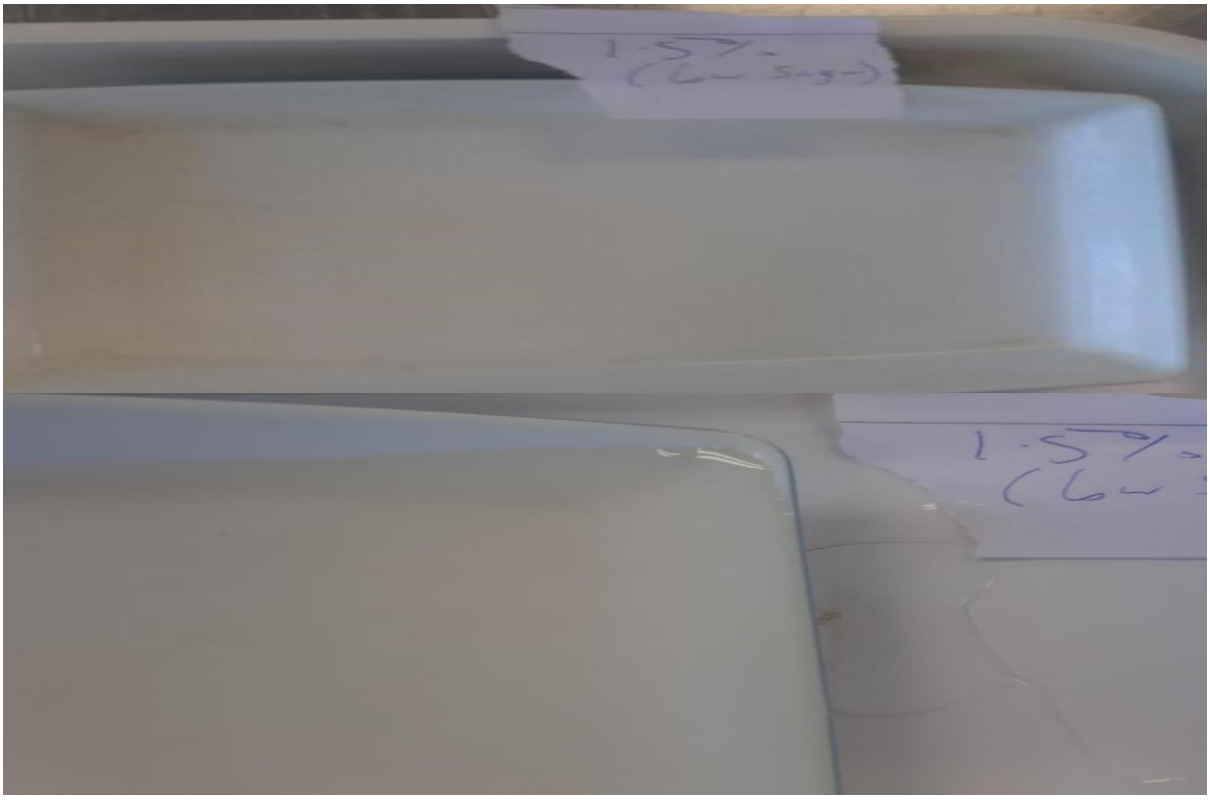

Figure 10: Low Sugar Pectin (1.5%) showing no gelling taking place

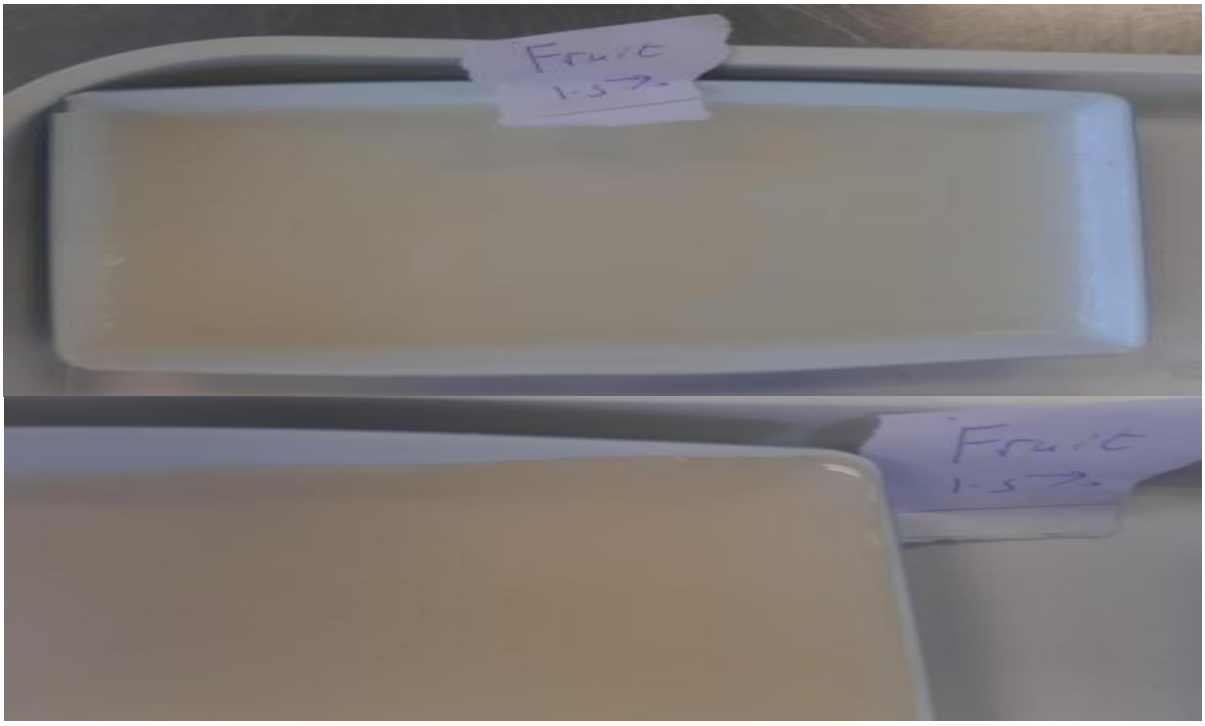

Figure 11: Fruit Pectin (1.5%) showing no gelling taking place

Conclusion:

From the testing of different pectin types, it was found that the Nappage pectin, under the name "Louis Francois Pectine NH Nappage*",* had been the optimum type of low-sugar pectin tested. This pectin was successful in creating a gel at a concentration of 1.5% with only water and calcium as added ingredients. The fruit pectin and even the low-sugar pectin had failed to form a gel. Therefore, the Nappage pectin will be the ideal pectin to use in future weeks in creating low- and no-sugar gels.

Recommendation:

It was noted that each pectin type available was in fact a blend of pectin with other ingredients such as dextrose, sugar, stabilisers and acids which would assist in gelling. It would be ideal to use purer forms of pectin with no added ingredients, if possible, in order to gain a better understanding into the action of pectin and to ensure that each factor, such as acidity, sugar content and calcium content are controlled.

Week Two:

Aim and Objectives:

The aim of this trial is to develop a “cheesecake” filling using varying amounts of pectin to achieve optimum gelling for texture, shape and mouthfeel

The objectives set to achieve this aim include:

- Developing a “cheesecake” filling recipe to which pectin will be combined
- Using various concentrations of pectin to determine the optimum concentration for gelling
- Use various flavours and colour combinations to develop a unique “cheesecake” filling with interesting colour and flavour combinations
- Use various concentrations of flavour compounds to determine the optimum concentration of flavour to be used
- Carry out a sensory analysis to determine the optimum pectin concentration, colour, and flavour concentrations of the filling

Materials and Methods:

Ingredients:

Recipe 1;

- 3.95g (1.5% concentration) “Louis Francois Pectine NH Nappage” pectin
    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 31.0g caster sugar
- 45g milk
    - 38.57g water
    - 6.43g “Millac Value” Skimmed Milk Powder
        - Lactose, Whey Powder, Coconut Oil, Palm Oil, Dried Glucose Syrup, Milk Protein, Sugar, Potassium Phosphate (E340b), Mono- and Diglycerides of Fatty Acids (E471), Vitamin D
- 113.4g Greek Yoghurt
    - 85.05g water
    - 28.35g “Texturas Yopol” Yoghurt Powder
        - Hydrogenated Plant Fat, Modified Starch, Sugar, Milk Proteins, Powdered Skimmed Milk, Citric Acid (E330), Aromas
- 70g egg white
    - 60.00g water
    - 10.00g “Louis Francois Blanc Gallia” egg white powder

        - Powdered Hen's Egg Albumin, Xanthan Gum (E415), Citric Acid (E330), Triethyl Citrate (E1505)
- 3-4 drops "Mallard Ferriére*"* yellow food colouring
    - Water, Tartrazine, Chloride, Sodium Sulphate, Sodium Benzoate
- 2-3 drops "Iqemusu" *Baliqin* (Banana, Candy, Sweetness Evocation) Flavouring
    - Propylene Glycol, Pure Aromatic Note

Recipe 2;

- 3.28g (1.25% concentration) "Louis Francois Pectine NH Nappage*"* pectin
    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 31.0g caster sugar
- 45.0g milk
    - 38.57g water
    - 6.43g "Millac Value" Skimmed Milk Powder
        - Lactose, Whey Powder, Coconut Oil, Palm Oil, Dried Glucose Syrup, Milk Protein, Sugar, Potassium Phosphate (E340b), Mono- and Diglycerides of Fatty Acids (E471), Vitamin D
- 113.4g Greek Yoghurt
    - 85.05g water
    - 28.35g "Texturas Yopol" Yoghurt Powder
        - Hydrogenated Plant Fat, Modified Starch, Sugar, Milk Proteins, Powdered Skimmed Milk, Citric Acid (E330), Aromas
- 70g egg white
    - 60.00g water
    - 10.00g "Louis Francois Blanc Gallia" egg white powder
        - Powdered Hen's Egg Albumin, Xanthan Gum (E415), Citric Acid (E330), Triethyl Citrate (E1505)
- 2-3 drops "Mallard Ferriere Bleu Ciel*"* blue food colouring
    - Water, Brilliant Blue, Sodium Sulphate, Sodium Benzoate
- 4-5 drops "Iqemusu" *Baliqin* (Banana, Candy, Sweetness Evocation) Flavouring
    - Propylene Glycol, Pure Aromatic Note

Recipe adapted from http://lostrecipesfound.com/very-airy-vintage-no-bake-cheesecake/ (2016)

<u>Equipment:</u>

- Bowls
- Spoons
- Weighing scales
- Jugs
- Whisk
- Stand Mixer
- Whisk attachment
- Silicone moulds

Methods:

- Whisk water and milk powder until powder is dispersed. Heat the milk until combined, then reserve.
- Whisk water and yoghurt powder until combined. Reserve
- Place water and egg white powder into a bowl of a stand mixer with a whisk attachment. Whisk until combined. Continue whisking until stiff peaks form. Remove and reserve.
- Add sugar and pectin to reconstituted milk. Blend using a hand blender. Heat in saucepan until combined. Remove from heat and cool
- Once cool, add to reconstituted yoghurt and whisk to combine.
- Fold in reconstituted and whipped egg whites until combined
- Add flavouring and colouring. Combine
- Pour mixture into moulds. Leave in fridge to set
- Place in freezer to firm before removing from moulds

Results:

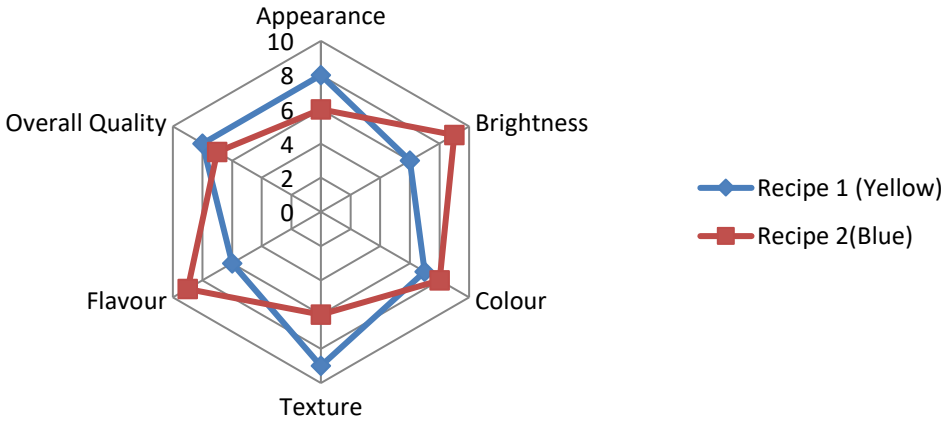

Figure 12: Spider Graph Detailing Results from Sensory Analysis

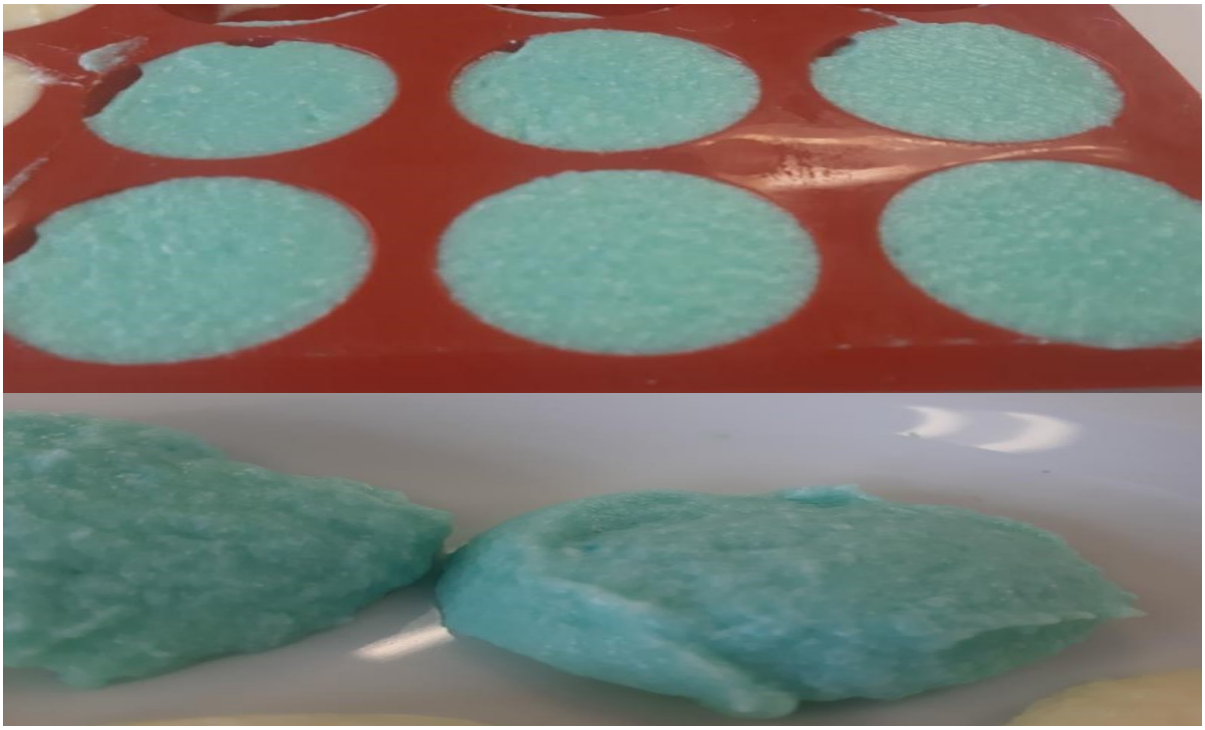

Figure 13: Nappage Pectin (1.25%) showing slight gel formation

Figure 14: Nappage Pectin (1.5%) showing good gel formation

Conclusion:

From the sensory analysis, it was found that a pectin concentration of 1.5% was the preferred concentration for gel formation as it provided the optimum texture and appearance for the filling. A flavour concentration of 4-5 drops was also the preferred amount with a blue colouring also being the most liked. As a result, characteristics from each recipe will be taken and used to produce a "cheesecake" filling that will include all of the characteristics enjoyed by respondents in order to achieve a dish with optimum sensory traits.

Recommendation:

In removing the "cheesecake" filling from the moulds, it may be helpful to keep in a freezer for some time after leaving to set to cause the filling to firm slightly. This will allow for easier removal from the moulds and in turn, give a better appearance to the fillings as they may become damaged if removed incorrectly or without care.

Week Three:

Aim and Objectives:

The aim of this trial is to develop a jelly with optimum flavour and colour. Also to develop a "butter sand" with desired colours and flavours

This aim will be achieved by several objectives which include:

- Creating a recipe for "butter sand" with varying amounts of colouring agents and flavour compounds
- Creating a recipe for "jelly" with different colours and varying amounts of flavour compounds
- Carrying out a sensory analysis to determine the optimum colours, colour quantities, and flavour compound quantities
- Use the information to develop a "butter sand" and " jelly" with the optimum colour, colour concentration and flavour concentration

Materials and Methods:

Ingredients:

Butter Sand;

Recipe 1;

- 2.50g icing sugar

- 5.00g clarified butter
- 10.00g maltodextrin
- 1-2 drops “Mallard Ferriére*”* yellow food colouring
    - Water, Tartrazine, Chloride, Sodium Sulphate, Sodium Benzoate
- 2-3 drops “Iqemusu” *Frum* (Rhum, Tropical Fruit, Ripe Fruit Evocation) Flavouring
    - Propylene Glycol, Pure Aromatic Note

Recipe 2;

- 2.50g icing sugar
- 5.00g clarified butter
- 10.00g maltodextrin
- 3-4 drops “Mallard Ferriére*”* yellow food colouring
    - Water, Tartrazine, Chloride, Sodium Sulphate, Sodium Benzoate
- 4-5 drops “Iqemusu” *Frum* (Rhum, Tropical Fruit, Ripe Fruit Evocation) Flavouring
    - Propylene Glycol, Pure Aromatic Note

Jelly;

Recipe 1;

- 4.29g (2% concentration) “Louis Francois Pectine NH Nappage*”* pectin
    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 0.1g “Texturas Gluco*”* calcium
    - Calcium Lactate (E327), Calcium Gluconate (E578)
- 200g water
- 10g “PureSweet”erythritol
- 2-3 drops drops “Mallard Ferriere Bleu Ciel*”* blue food colouring
    - Water, Brilliant Blue, Sodium Sulphate, Sodium Benzoate
- 2-3 drops “Iqemusu” *Amerise* (Almond, Cherry, Pistachio Evocation) Flavouring
    - Propylene Glycol, Pure Artomatic Note

Recipe 2;

- 4.29g (2% concentration) “Louis Francois Pectine NH Nappage*”* pectin
    - Amidated Pectin E440ii, Disodium diphosphate E450i, dextrose, tricalcium, phosphate E341iii
- 0.1g “Texturas Gluco*”* calcium
    - Calcium Lactate (E327), Calcium Gluconate (E578)

- 200g water
- 7.5g “PureSweet”erythritol
- 3-4 drops “Mallard Ferriére*”* yellow food colouring
    - Water, Tartrazine, Chloride, Sodium Sulphate, Sodium Benzoate
- 4-5 drops “Iqemusu” *Amerise* (Almond, Cherry, Pistachio Evocation) Flavouring
    - Propylene Glycol, Pure Artomatic Note

Equipment:

- Bowls
- Spoons
- Weighing scales
- Sieve
- Food processor
- Jugs
- Hand Blender
- Pot
- Stove
- Moulds
- Blast chiller
- Fridge

Methods:

Butter Sand:

- Add icing sugar and clarified butter to a food processor and blend.
- Add colouring and flavouring and blend until incorporated.
- Add maltodextrin and mix again until fine powder forms.
- Reserve until ready to use.
- (Alternatively, whisk clarified butter and icing sugar until combined. Add colouring and flavouring and mix until incorporated. Add maltodextrin and whisk until combined)

Jelly:

- Add pectin and calcium to water in a jug. Blend until dispersed.
- Add colouring and flavouring then blend again.
- Pour into a saucepan and bring to boil. Remove from heat and pour into moulds. Leave to set in fridge.
- Place in freezer to firm slightly before removing.
- Cut jelly into desired shapes before serving

Results:

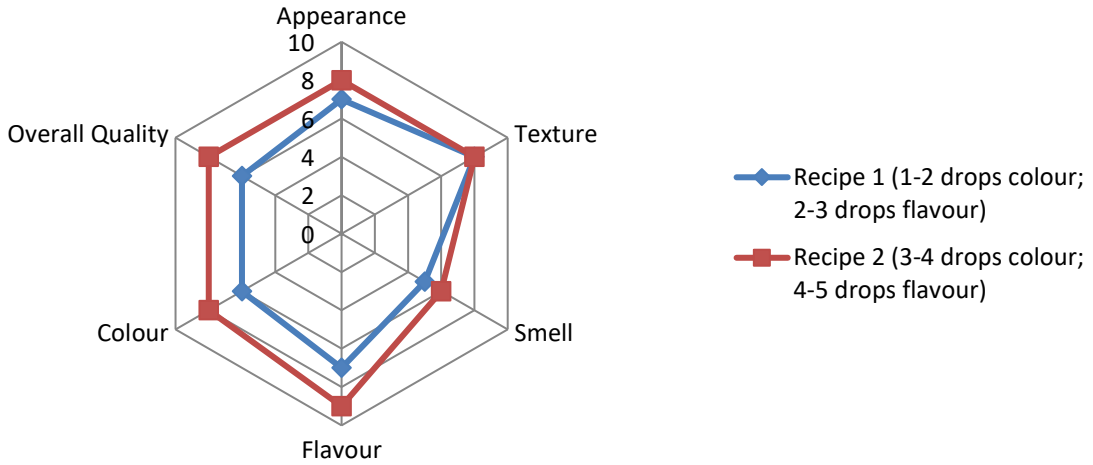

Figure 15: Results of Sensory Analysis for Butter Sand

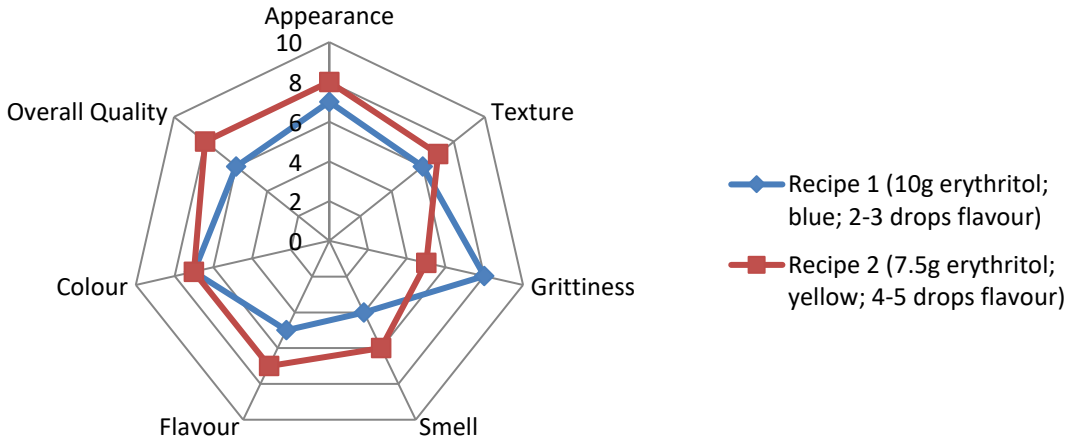

Figure 16: Results of Sensory Analysis for Jelly

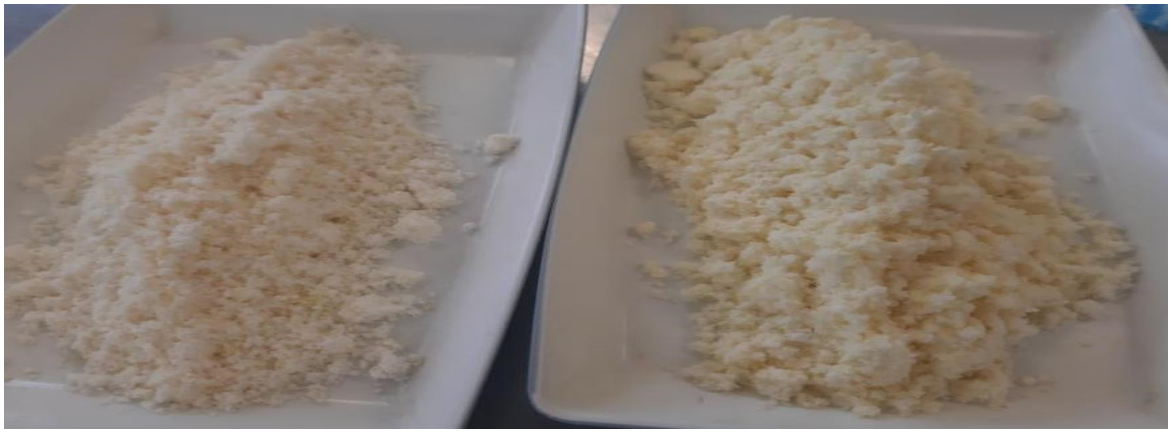

Figure 17: "Butter Sand" showing colour concentration of 1-2 drops (left) and 3-4 drops (right)

Figure 18: Jelly showing that gel formation was successful by pectin

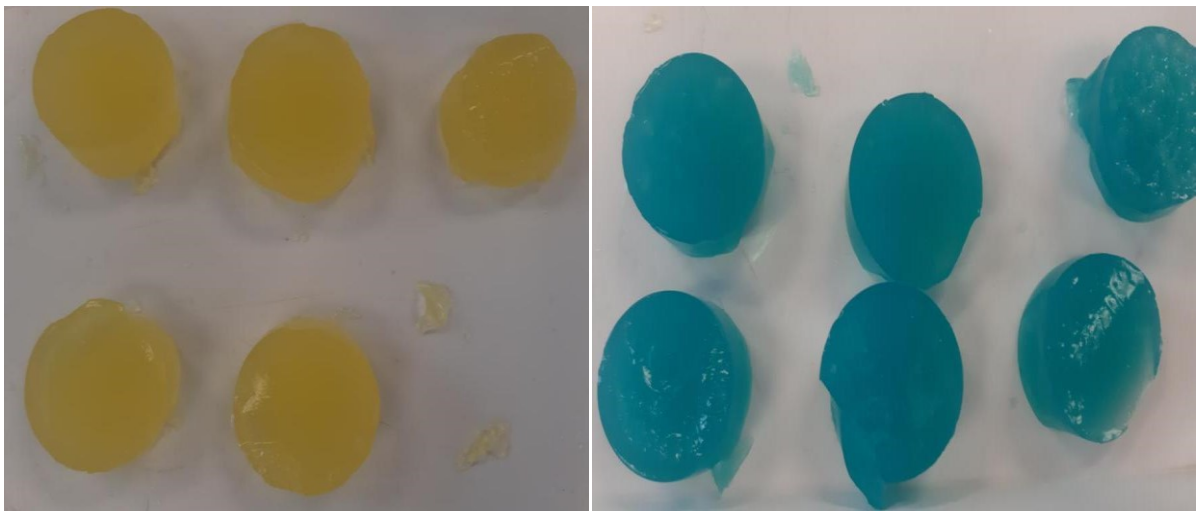

Figure 19: Yellow jelly using 7.5g erythitol and 4-5 drops flavouring (left) and blue jelly with 10g erythritol and 2-3 drops flavouring (right)

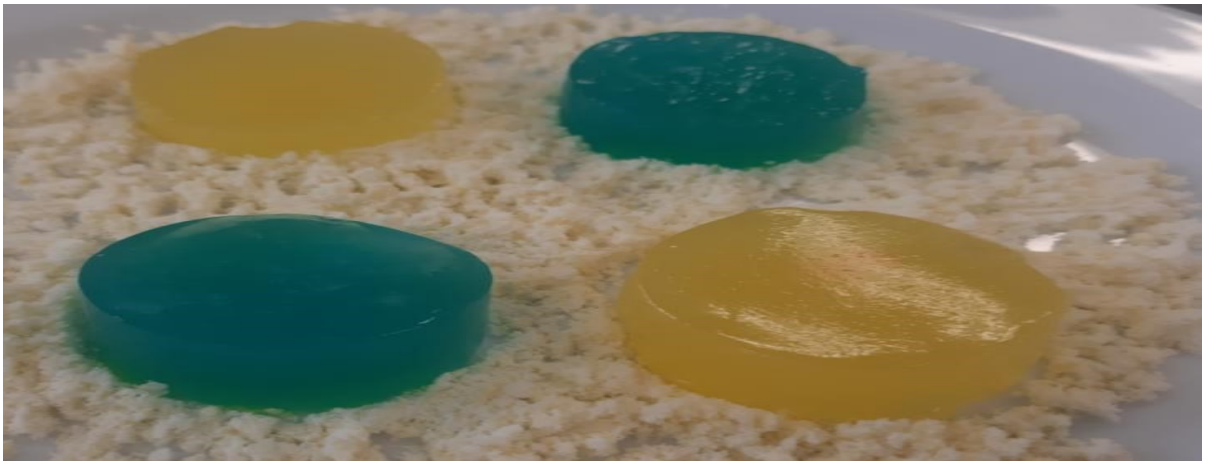

Figure 40: Yellow and blue jellies with butter sand as served, showing gel formation by pectin through solid shapes

Conclusion:

From the sensory analyses that took place, it was found that Recipe 2 of the Butter Sand was the most preferred, offering a stronger flavour and aroma from the extra flavour added along with a brighter and more pronounced colour using more of the colouring agent. Therefore, this recipe will be used in the final trial when presenting the final dish

With regards to the jelly, it was found that Recipe 2 had the most traits that respondents preferred. Recipe 1 featured more erythritol than Recipe 2, resulting in a gritty texture than was disliked by respondents. Recipe 2, on the other hand, was smoother in texture and appearance. Recipe 2 also had better flavours and aromas caused by the increased concentration of flavour compounds. Respondents were tied on the colour, with both the yellow and blue colours being appealing. Therefore, Recipe 2 will be used in the final trial as this was well-received by the respondents.

From the creation of the jellies, a pectin concentration of 2% had been used with no added sugar and some calcium present to aid in gelling. This resulted in a solid pectin gel forming, which had shown that gel formation of pectin with a minimum content of sugar was successful – with the minimum sugar content being 0% of added sugar

Recommendation:

In the making of the Butter Sand, the product needed to be made multiple times as there were some difficulty in adding colour due to the colour causing clumping and appearing as small dots even after passing through a sieve. This gave a grainy appearance which did not look desirable. It may be ideal to add the colouring to the clarified butter and combining these ingredients together before adding any powders so as to ensure full dispersal of colour throughout.