Molecular Gastronomy

‘Playing with Pectin’s at a minimum content of sugar’

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Idea: Seaside dish.

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CHAPTER 1

INTRODUCTION

Introduction:

Molecular Gastronomy

Molecular gastronomy was first developed in 1988 and has since grown and developed in research institutes, universities, companies and kitchens worldwide. It is described as the scientific discipline that explores the phenomena that occurs amidst culinary transformations. Molecular gastronomy arrived in Ireland later than in some other countries around the world; currently developing into a greater mature discipline. Carrageenan (or carraigín in Gaelic) grows in Ireland and this was the first documented extraction from *Chondrus crispus* (seaweed also known as Irish moss) was demonstrated, it is ironic that this ingredient of molecular cuisine has not been used more frequently in its culinary form. Currently Carrageenan is creating a lot of interest and fortification in several of its applications through timid steps that are taken out of molecular gastronomy (Valverde, Burke and Traynor, 2011). The main aim of molecular gastronomy is the determination of chemical and physical techniques involved in the preparation and processing (including cooking) of food, and lastly the discovery of new mechanisms and applications (Burke, This, Kelly, 2016).

Note by Note Cooking

Ann application of Molecular Gastronomy is Note by Note cooking. It was initially developed in 1994 by French Physical Chemist and Molecular Gastronomy Co-founder, Hervé This. Traditional foods are not utilised in this application to formulate dishes. Alternatively, pure compounds or mixtures of pure compounds are used. This application holds the potential for the creation of new foods which is enormous. Hervé This estimates through mathematical calculation that 1,000 to the power of 10 (or 1030) new recipes can possibly be created through the use of Note by Note cooking. The chef can design various parts of the dish, the odours, colours, tastes, temperatures, trigeminal stimulation, consistency and nutritional aspects.

Gels

According to Hervé This, a gel is a ‘‘liquid immobilized by molecules that are linked together to form a network. A cooked egg white, for example is a chemical gel, for the network formed by the proteins is permanent. By contrast, jams and preserves form a physical – that is, reversible gel’’ (This, 2012). Each hydrocolloid reacts differently when introduced to water, resulting in either gelling or thickening. Depending on the environment pectins will gel into a solid, jelly-like form with weak fluidity that can maintain solidity with some

flexibility. Gelation is the process in which a fluid becomes gel when fibres are formed. When utilising hydrocolloids, the formed fibres trap the food hydrocolloids and water inside the solution to create resistance, hence the gel. The hydrocolloid category used for gelling can result in hot or cold gels that will not lose their shape when added to hot or cold liquids. Gels are commonly described as brittle, elastic, soft or hard. (Sanchez, 2016)

Pectin (E440)

Globally, pectin is used in the food industry as a hydrocolloid gelling agent. It is commonly commercially derived from fruit waste; which includes apple and citrus peel. The term "pectin" generically depicts a family of structural polysaccharides which occur as elements of the primary cell wall of plant cells and intercellular areas of higher plants where they operate as a hydrating cementing material of the cellulosic network. The main component of pectin is a central, linear backbone chain composed of α-D-galacturonic acid units linked by (1 → 4) glycosidic bonds. This linear (or 'smooth') structure is delayed by highly branched regions ('hairy' zones). Relying on the botanic origin and the extraction procedure that is utilised, the carboxylic groups are imcompletely esterified with methanol, and in particular pectins the hydroxyl groups are partially acetylated. Neutral sugars, such as rhamnose, arabinose, galactose, xylose and glucose are also usually exist in a 5–10% capacity of the galacturonic acid weight. The neutral debris consists of the highly branched side chains (arabinan and galactan), a small part of the central chain (rhamnose) or result as contaminating polysaccharides (glucans and xyloglucans). Depending on the degree of esterification, a gel can be produced by pectin networks both in an acid medium and under high sugar concentrations (high DE pectins, more than 50%) or by interaction with divalent cations, particularly Ca^{2+} (low DE pectins, less than 50%). The macromolecules that are present in this gel are cross-linked by divalent calcium ions. In both cases, gelation and gel properties depend upon many factors, including temperature, pH, DE, sugar content, calcium content and pectin content (Cárdenas, Goycoolea and Rinaudo, 2008). There are many different forms of pectin that can be used for different gelation outcomes of a product. As high methoxyl pectin requires a minimum concentration of 55% of sugar in the form of sucrose to form a gel and low methoxyl pectin requiring 30% of sugar in solution to gel (Imeson, 2009). High methoxyl forms of pectins gel in acidic conditions with the presence of sugar, which is evident in Figure 2 below, consequently low methoxyl pectins forms can form a gel in a

broader range if pH with lower concentrations of sugar (Sanchez, 2016). Low methoxyl pectin generally gels in the presence of divalent cations such as Ca^{2+}. The required pH value is in the range of 2 to 6 and sugar is not necessary for gel formation as an increase in ionic strength determines the lower concentration of Ca^{2+} (Gawkowska, Cybulska and Zdunek, 2018). This is evident in the 'egg box' model below in Figure 1 below , where the polysaccharides are linking in a linear chain in the presence of calcium ions which produces calcium bridges in the process of gelation:

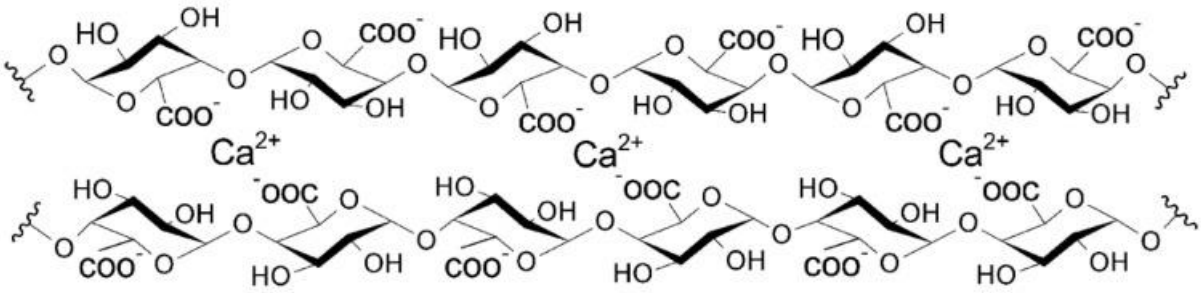


Figure 1: Scheme of "egg-box" model (Gawkowska, Cybulska and Zdunek, 2018).

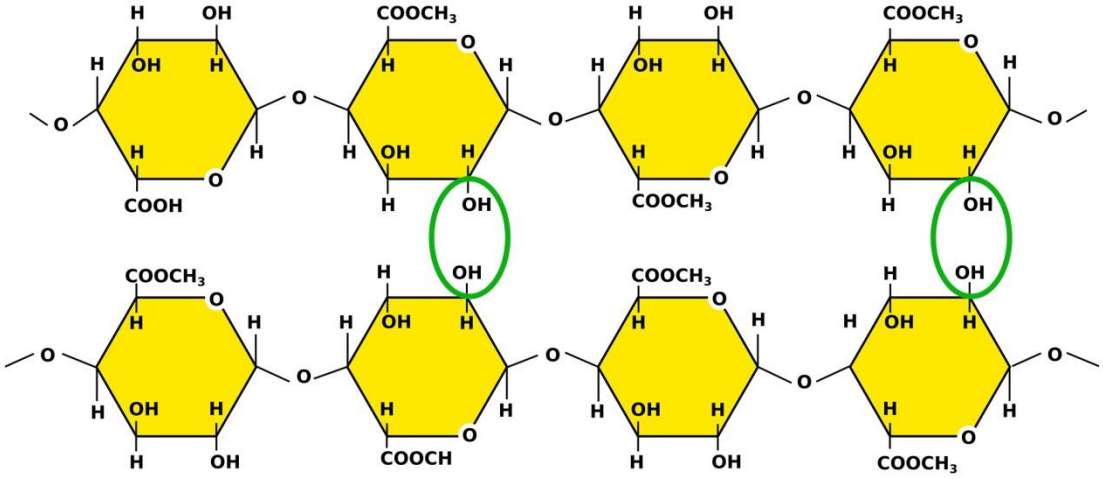


Figure 2: HM Pectin Gelation (Silvateam, 2020).

Aim of the project:

The aim of this project is to experiment with various pectins in order to formulate a product which gels at the lowest sugar content possible, utilising Note by Note cooking. The end goal

of the dish is produce an elastic sweet gel without the use of sugar or potentially low sugar content, and to be creative to develop an aesthetically pleasing dish.

CHAPTER 2

MATERIALS & METHODS

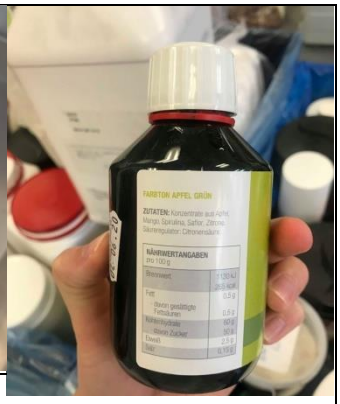
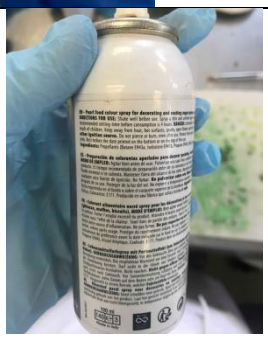
Week 4: 6/12/19

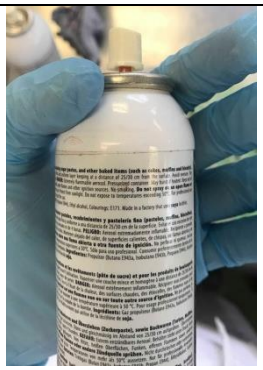
Final Formulation of the Dish
Materials

Table 1: Ingredients and Suppliers

Ingredient	Supplier & Information
Iota Carrageenan	
Kappa Carrageenan	

Stevia	
Red Food Colouring	
Yellow Food Colouring	 

Green Food Colouring	 
Blue Food Colouring	 
Edible Silver Lustre Spray	 

Edible Gold Lustre Spray	 
Low Sugar Pectin	 
Peach & Coconut Flavouring	 

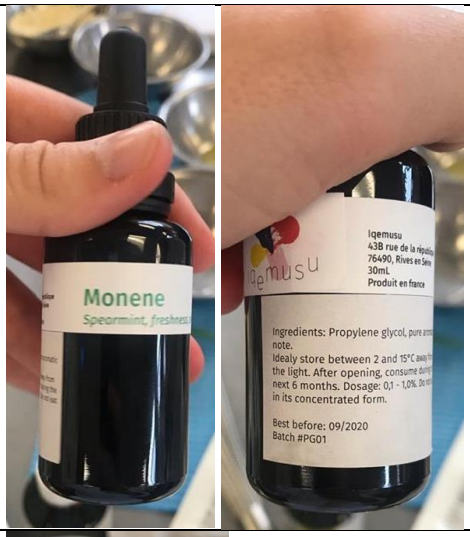
Spearmint Flavouring	
Tropical Flavouring	
Maltodextrin	

Table 2: Concentrations of ingredients for final formulation of the product

Trial 4.1- Lobsters	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	0.075%
Water – 95.325g	94.825%
Red food colouring- 0.1g	0.1%
Peach and Coconut Flavour - 0.5g	0.5%

Trial 4.2- Seaweed	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	0.075%
Water – 95.325g	94.825%
Red food colouring- 0.1g	0.1%
Spearmint Flavour- 0.5g	0.5%

Trial 4.3- Ocean	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	0.075%
Water – 95.325g	94.825%
Green food colouring- 0.1g	0.1%
Rhum & Tropical Fruit Flavour -0.5g	0.5%

Trial 4.4- Sand	
Ingredient	**Concentration**
Maltodextrin 9g	90%
Yellow Food Colouring 1g	10%

Trial 4.5- Pebbles	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	0.075%
Water – 95.325g	94.925%
Rhum & Tropical Fruit Flavour -0.5g	0.5%

Method:

*As per previous cooking method

Modifications include;

The preparation of the pebbles included;

1. Using a syringe to drop, droplets onto the dish.
2. Using silver and gold sprays to resemble that of different coloured rocks.

Equipment: *refer to table 4 in Week 1 log book

CHAPTER 3

RESULTS

Week 1:

Results:

Figure 3: Trial 1+2 Results

Figure 2: Trial 3 Results

Week 2:

Result:

Figure 4: Week 2 Result

Week 3:

Result:

Figure 5: Week 3 Result

Week 4: Final Dish

Result:

Figure 6 : Final Dish

Sensory Evaluation Results:

Week 3

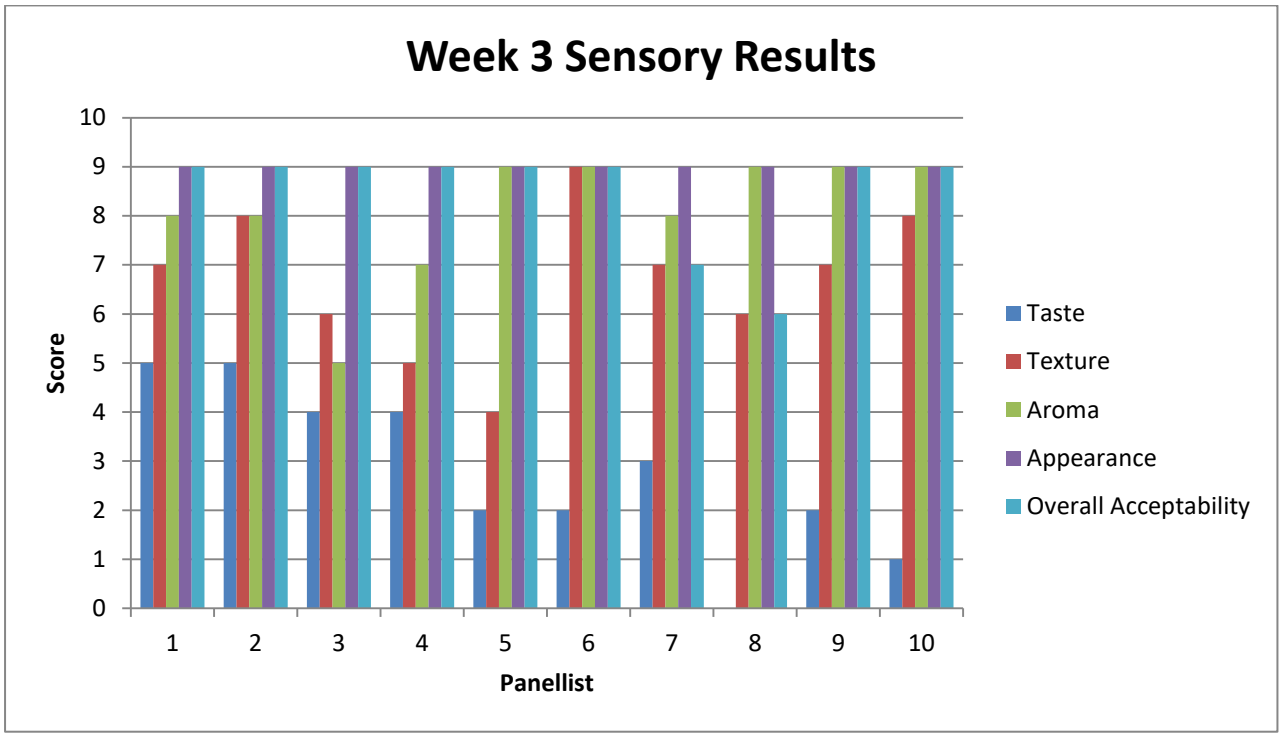


Figure 7: Week 3 Sensory Evaluation Results

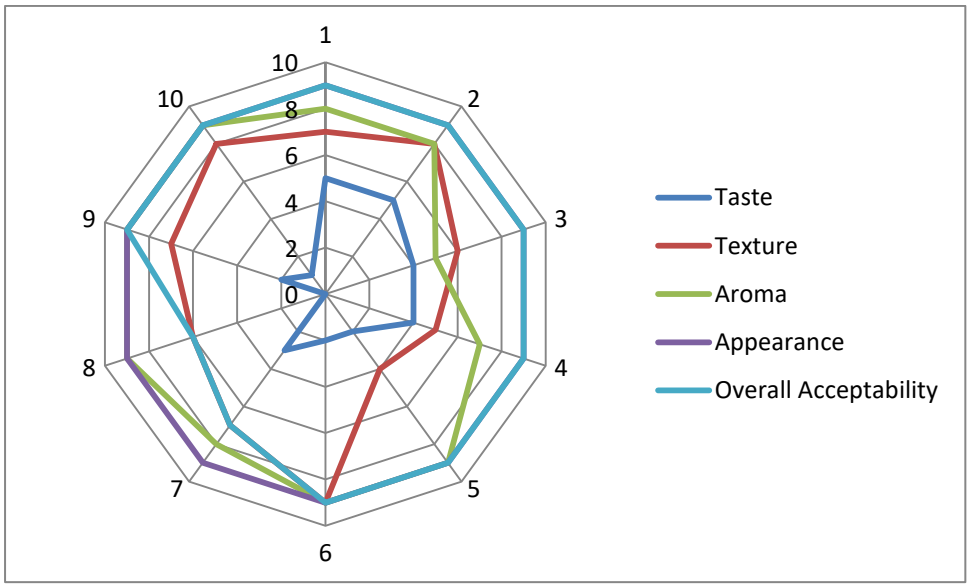


Figure 8: Spider plot of Week 3 Results

Week 4

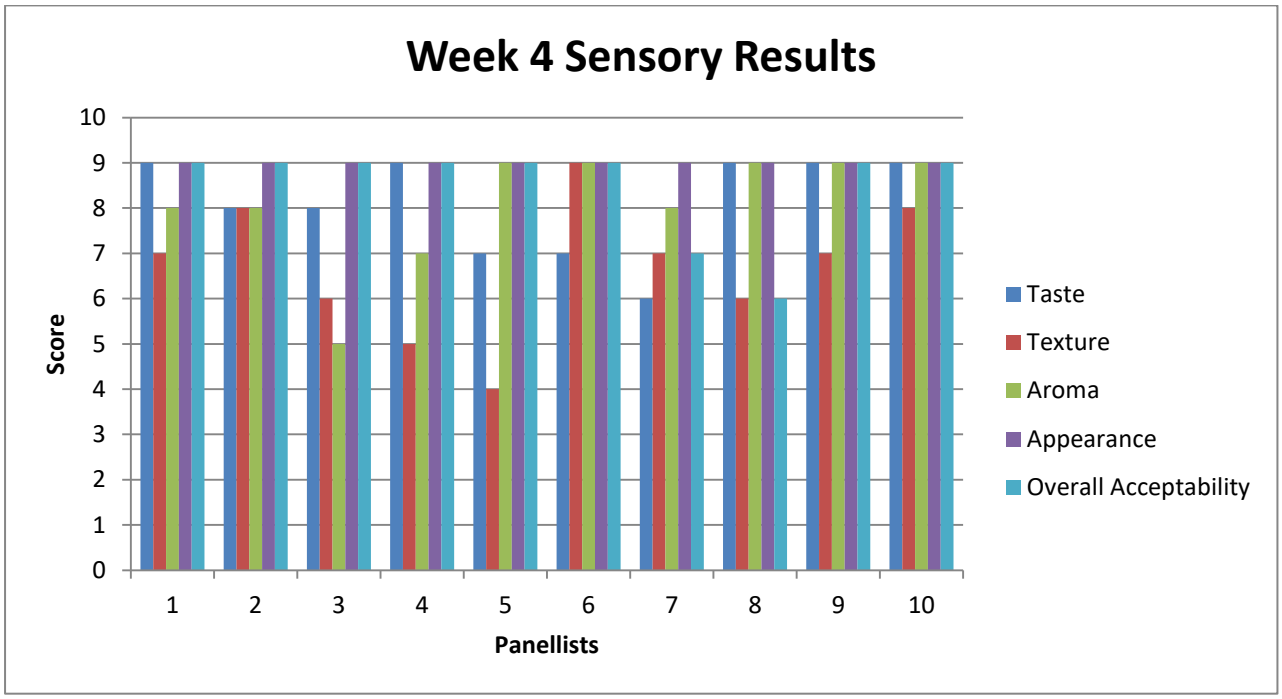


Figure 9: Week 4 Sensory Evaluation Results

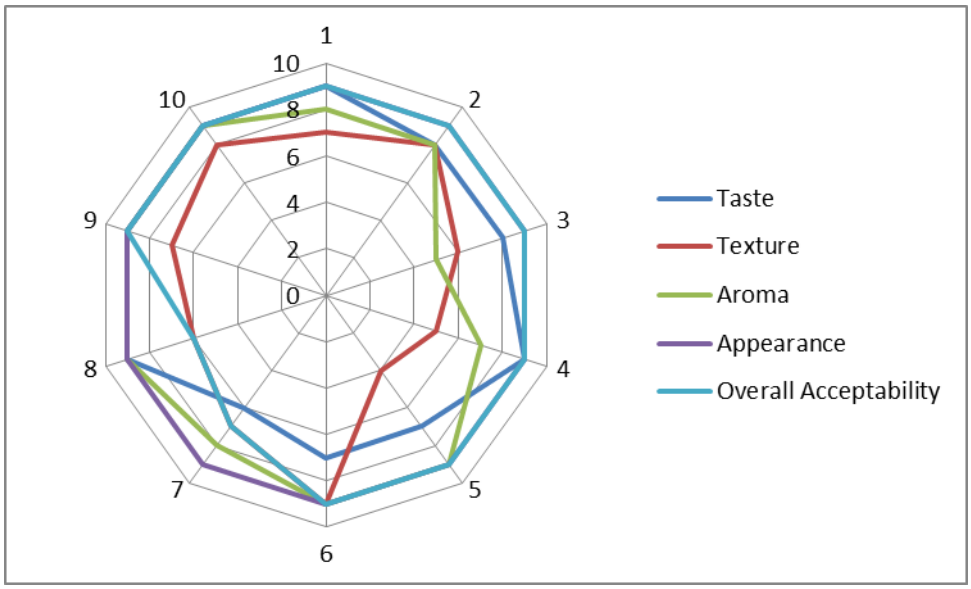


Figure 10: Spider pot for Week 4 Sensory Results

CHAPTER 4

DISCUSSION

Week 1 Results:

In Week 1, the utilisation of different sugar contents (1, 2 & 3%) had no real impact on the sweetness of the dish due to it being a relatively low level. However, the most favourable Trial was the 3% sugar concentration. In regards to the gelling agent Agar, this resulted in a brittle gel, however due to its high gelling capability in Week 1 results, it was then utilised in Week 2. Syneresis occurred after ten minutes of rest, which is undesired for this project. Syneresis is condensation from a gelled item of a phenomenom (Sanchez, 2016). The cause of this could have been due to the amount of agar in a contained liquid solution being too much or too little. Agar is used in combination with low sugar pectin to ensure a gel is produced. Low methoxyl does not gel under a concentration of 33% sugar, however together with Agar-Agar a gel was accomplished. The Spiced Apple Flavouring and Lemon Flavouring was not a desired taste for the product. The Colourings used in each trial produced vibrant colours which was highly favoured in this trial.

Week 2 Results:

From Week 1, trial 3 ingredients were carried on into Week 2 trials. In Week 2, an idea to create a jelly that resembled a cake occurred. The idea of this trial was to use the yellow food colouring to illustrate the sponge part of the cake and the red to resemble the jam filling of the cake. This method worked, however the texture of the jelly was not desired as it was brittle and not very elastic which is a desired outcome of this project.

Week 3 Results:

In Week 3, research was carried out on various gelling agents and their properties. According to Jose Sanchez, Iota Carrageenan and Kappa Carrageenan as a synergy produce a soft elastic gel. A synergy is the combination of two or more hydrocolloids in order to alter the original rheological properties of the gel to create, modify or enhance inherent traits of each food hydrocolloid (Sanchez, 2016). These were trialled and a desired outcome was achieved regarding the texture of the product. Success occurred in this trial also with the creativity of the dish; which resembled lobsters at the seashore featuring seaweed. Sensory Evaluation results proved that the taste was not preferred by each panellist as it scored the lowest results which are shown in Figure 7 and 8 above. Remarks were made such as the jelly being ‘’too sweet’’. This remark was taken on board and the stevia content was reduced for the final formulation of the product in Week 4. However, the appearance and Overall Acceptability results proved that the dish was an aesthetically pleasing dish which is an extremely desired result of the project.

Week 4 Results:

In Week 4, pebbles and sand were added to the dish to ensure a resemblance to seashore. Gold and Silver edible sprays were used to create the resemblance of pebbles and maltodextrin and yellow food colouring mixed by hand resulted in crumbly textured sand for the final dish. The final formulation was a success in regards to sensory evaluation result shown in Figure 9 and 10 above. The appearance of the dish appeared to be a success with the panellists scoring high marks for appearance of the dish again this week. Remarks such as 'this week they taste much better' and 'just the right amount of sweetness' proved that the reduction of stevia content improved the flavour of the dish, with results scoring high in most panellists marks. The Overall Acceptability scored high again this week as people also commented that 'the pebbles and sand are a great addition to the dish'. Overall the dish was a success due to the aim of the project being completed in which the dish was gelled at the lowest possible concentration utilising pectin.

CHAPTER 5

CONCLUSION

Conclusion

Overall, it can be concluded that this project was a success in terms of gelation, appearance and overall acceptability marks in sensory evaluation trials. However, it can be concluded that further trials could be carried out in order to improve the taste and aroma of the product. From the formulations trialled each week a dish that incorporated Note by Note cooking of pure compounds was achieved.

CHAPTER 6

LOG BOOK

Week 1: 15/11/19

Aim:

- To develop a product in which pectin is used as an ingredient for the gelation process at a minimal sugar content.

Objectives:

- To utilise agar-agar (E406) in combination with pectin to ensure gelling will occur.
- To experiment with various flavour compounds until a preferred flavour is established.
- To test various concentrations of low sugar pectin and agar-agar until preferred texture is accomplished.
- To analyse various contents of sugar in order to create a low sugar pectin jelly product.

Materials:

Table 3: Week 1 Concentrations of Ingredients used in trials

Trial 1		**Trial 2**		**Trial 3**	
Ingredient	**Concentration**	**Ingredient**	**Concentration**	**Ingredient**	**Concentration**
Agar – 1g	1%	Agar – 2g	2%	Agar -2.5g	2.5%
Pectin (Low sugar)- 5g	5%	Pectin (Low sugar)-5g	5%	Pectin (Low sugar)- 2.5g	2.5%
Sugar – 1g	1%	Sugar- 2g	2%	Sugar- 3g	3%
Water -92.4g	92.4%	Water- 90.6g	90.6%	Water – 91.4g	91.4%
Green food colouring- 0.1g	0.1%	Green food colouring- 0.1g	0.1%	Yellow food colouring- 0.1g	0.1%
Spiced apple flavouring – 0.5g	0.5%	Spiced apple flavouring – 0.3g	0.3%	Lemon flavour – 0.5g	0.5%

Table 4: Equipment used for production of product

Whisk	
Sauce pan	
Weighing Scales OHaus – BW series	
Cook – top Berto's Spa Viale Spagna 12 35020 Tribano (PD) Italy Type A1	
Mixing bowls	

Method:

1. All ingredients are weighed and measured.
2. All ingredients are then transferred to a pan.
3. The solution is then brought to the boil on a medium heat.
4. The solution is then transferred into a mould.
5. This is left to cool in the refrigerator and set.
6. Once set, the jelly is then transferred to a serving dish, tasted and results recorded.

Results:

Recommendations for the next week:

- To utilise Trial 3 ingredients for Week 2
- To develop a jell that resembles a ‘cake’
- To eliminate the usage of the Spiced Apple Flavouring

Week 2: 22/11/19

Aim: To be creative with the use of Agar- Agar and Food colouring and to prepare a mock dish of the final product.

Objectives:

- To apply the favoured formulation of ingredients from the previous trial (Trial 3) in developing a 'birthday cake' jelly dish.
- Yellow Food colouring will be applied in replacement of the green for each 'sponge' part of the cake.
- Red Food colouring will be introduced into the 'jam section' of the cake.
- The addition of sprinkles to add a visual of a real cake.

Materials:

Table 5: Week 2 Concentrations of ingredients used for trials

Trial 1.1- Top & Bottom Layer	
Ingredient	**Concentration**
Agar -2.5g	2.5%
Pectin (Low sugar)- 2.5g	2.5%
Sugar- 3g	3%
Water – 91.4g	91.4%
Yellow food colouring- 0.1g	0.1%
Whey Protein(MyProtein)- Birthday Cake Flavour – 2g	2%

Trial 1.2- Middle Layer	
Ingredient	**Concentration**
Agar -2.5g	2.5%
Pectin (Low sugar)- 2.5g	2.5%
Sugar- 3g	3%
Water – 91.4g	91.9%
Red food colouring- 0.1g	0.1%

Method:

1. All ingredients are weighed and measured.
2. All ingredients are then transferred to a pan.
3. The solution is then brought to the boil on a medium heat.
4. The solution is then transferred into a mould.
5. This is left to cool in the refrigerator and set.
6. Once set, the jelly is then transferred to a serving dish and cut into each a rectangle shape for each colour.

7. The yellow rectangle is placed on a serving dish, the red layer on top and the yellow on top of the red.
8. Sprinkles were added.
9. The dish was then tasted and results were recorded.

Results:

Recommendations:

- To discontinue the idea of the jelly that resembles the cake
- To develop a ‘seashore dish’
- To utilise Stevia to add sweetness to the dish

Week 3: 29/1/19

Aim

- To utilise an alternative gelling agent in order to evaluate if a more favourable texture is acquired and also to create a unique dish.

Objectives:

- To utilise Iota Carrageenan and Kappa Carrageenan (E407) as a synergy in combination with low sugar pectin to achieve a more elastic type gel.
- To work with Lobster shaped moulds to establish an even jelly each time. (Red food colouring)
- To use a thin syringe to form long wavy strands that later resembles seaweed as part of the dish. (Green food colouring)
- The elimination of sugar and the utilisation of a naturally derived sugar substitute Stevia (E960).
- The use of Blue food colouring in order to create the water part of the dish.
- The addition of flavours for each concept of the dish.

Materials:

Table 6: Concentrations of Ingredients for week 3

Trial 3.1- Lobsters	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	1%
Water – 95.325g	94.8%
Red food colouring- 0.1g	0.1%
Peach and Coconut Flavour - 0.5g	0.5%

Trial 3.2- Ocean	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	1%
Water – 95.325g	94.8%
Green food colouring- 0.1g	0.1%
Rhum & Tropical Fruit Flavour -0.5g	0.5%

Trial 3.3- Seaweed	
Ingredient	**Concentration**
Iota Carrageenan 1g	1%
Kappa Carrageenan 1g	1%
Pectin (Low sugar)- 2.5g	2.5%
Stevia – 0.075g	0.075%
Water – 95.325g	94.825%
Red food colouring- 0.1g	0.1%
Spearmint Flavour- 0.5g	0.5%

Table 7: Extra Equipment used

Lobster Silicon Mould	
Syringe	

Method:

*As per previous cooking method

Modifications include;

The preparation of the seaweed;

1. Once cooked, the solution is then transferred into a syringe and cooled with water under the tap.
2. The solution is then squeezed into waves on the dish to resemble seaweed.

The preparation of the ocean;

1. Once, cooked the solution is transferred directly to the dish and let cool and set in the refrigerator.

Result:

Recommendations:

- To decreases the concentration of stevia as results showed that the jelly was too sweet
- To keep using the Iota and Kappa Carrageenan synergy as it produced an elastic soft gel which was desired
- To incorporate pebbles and sand onto the dish

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