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Introduction

Molecular Gastronomy

Molecular gastronomy is a scientific sub-discipline of food science whereby the phenomena of which occur during the culinary transformations are observed. Cooking practices such as Molecular Cooking and Note-by-Note Cooking are examples of applications involved in molecular gastronomy and have become increasingly popular in recent years. The main objective of molecular gastronomy is to determine the physical and chemical properties which are involved in the preparation and cooking of food, which in turn discovers new mechanisms and applications within the food industry (Burke, This and Kelly, 2019).

Hungarian physicist Nicolas Kurti and French chemist Hervé This created the idea of molecular gastronomy in 1988 as they felt that the gap between food science and cooking at home and in restaurants was becoming too large. This proposed the term molecular gastronomy but Kurti suggested the term molecular and physical gastronomy. It wasn't until Kurti's death that molecular gastronomy became the preferred term (Khymos, 2020).

Note-by-Note Cooking

Upon writing an article for *Scientific American*, This and Kurti first thought of the idea of Note-by-Note cooking. This was investigating the properties of paraethylphenol, a compound which contributes to the smell of leather given off by vintage Burgundy wines, when he suggested the idea of adding this compound to other foods in order to create new recipes and dishes. Soon enough, more of these compounds were investigated and the idea of using Note-by-Note cooking, a culinary technique and application of molecular gastronomy, to create new dishes involving compounds arose (This and Debevoise, 2014).

Note-by-note cooking ensures that the nutritional value of its dishes is better than that of natural foods. Using the note-by-note method to cook will be more energy efficient and environmentally sustainable than traditional uses of cooking, which is very relevant in today's society (Columbia University Press, 2020). The initial proposal for not-by-note cooking was to improve food but this developed onto making dishes entirely from compounds. It does not use foods such as meat, fish, vegetables etc. but instead use pure compounds or a mixture of them. The role of the chef in note-by-note cooking is very important as they are responsible in designing the shapes, colours, tastes, odours, temperatures, textures and overall nutritional value of the dishes (This, 2013).

Pectin

Pectin is a carbohydrate polymer found in the cell structure of all plants. The term pectin covers a number of polymers which vary in molecular weight, chemical configuration and the content of natural sugars from different plant types. These plants produce pectins with different functional properties and one of the most common property is gelling. These gelling properties have been known for centuries and the isolation of commercial pectin began in the twentieth century (Flutto, 2003). A pectin gel is formed when it is heated in order to dissolve before being cooled down and allowed to set. Different pectins will gel according to pH levels and sugar content. The gelling of high-ester pectin involves the binding of hydrogen bonds and hydrophobic reactions to link the individual pectin chains together. They form when water is bound by sugar which in turn forces the pectin chains to stick together, creating a 3-dimensional molecular net. Low-ester pectins require calcium ions in order to gel and can gel at higher pH values. Pectin is used in the food industry due to its gelling properties as well as its stabilizing and thickening properties. It is used in jams, marmalades and also as an alternative to starches in sauces (Scienceofcooking.com, 2020).

Aims

The aim of this assignment is to create a dish using Note-by-Note cooking whereby only pure compound are used. The main ingredient, pectin, must be included in this dish where the gelling of pectin is obtained by using the lowest content of sugar. The dish which is being created must follow the guidelines and rules set out by Annc CCNAN 8. Using the knowledge of food science and the skills of culinary arts, the gelling of the pectin must be investigated using a variety of pure compound ingredients and the creation of the dish must be discussed in this assignment.

Materials and Method

Ingredients

Cherry Crumb:

Freeze-Dried Cherries - SOSA Cirera 2-10mm (glucose syrup, cherry pulp, modified potato starch, sodium alginate)



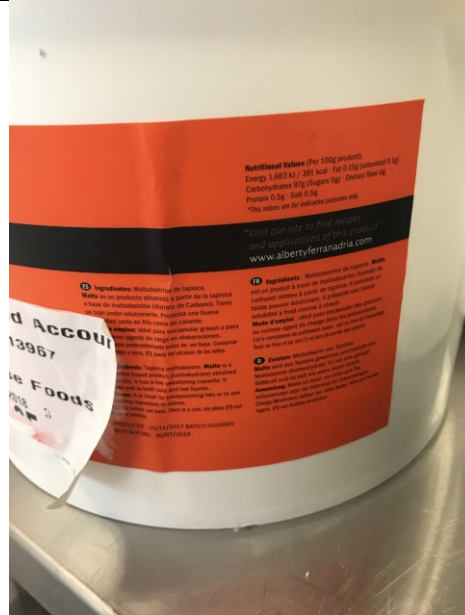
Amerise Flavour Compound - iqemus (almond, cherry and pistachio evocation)





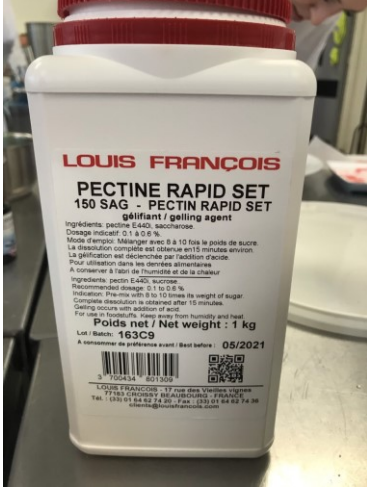
Coconut Oil – KTC (100% pure coconut oil)



Maltodextrin - Texturas Albert y Ferrandria (tapioca maltodextrin)



Cherry Gel:

<p>Water</p>	
<p>Fructose – SOSA Fructose (derived from corn syrup)</p>	
<p>Agar – Texturas Albert y Ferrandria (agar powder)</p>	
<p>Rapid Set Pectin – Louis Francois Pectin Rapid Set (pectin, sucrose)</p>	

Malic Acid – msk



Amerise Flavour Compound – iqumusu
(almond, cherry and pistachio evocation)



Blue Food Colouring – Mallard Ferriere SAS



Red Food Colouring – Sosa (Ponceau 4R)



Chocolate Snow:

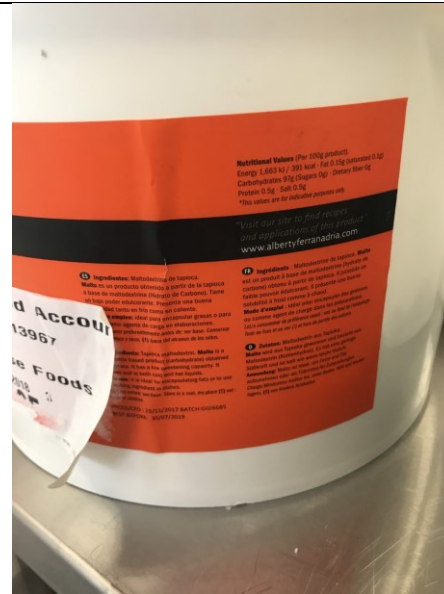
Cocoa powder – (100% Cocoa Powder)
Valrhona



Coconut oil - KTC (100% pure coconut oil)



Maltodextrin – Texturas Albert y Ferrandria
(tapioca maltodextrin)



Equipment

Microscales – Silver Crest Microscales

Weighing Scales – CELY PS-50 Scales

Silicone Moulds – 1.5inches

Robot Coupe – Blixer 3

Saucepans

Whisk

Jug

Sieve

Mixing Bowls

Method

1. Weigh out all ingredients accurately for the cherry gel.
2. In a jug, mix together the water, food colouring and almond flavour compound.
3. Pour the contents of the jug into a saucepan and add in the pectin, fructose, malic acid, and agar and whisk until dissolved.
4. Bring the saucepan to the boil and pour the contents into moulds.
5. Leave the pectin gels to cool and set.
6. Whilst the pectin is setting, measure out the ingredients for the cherry crumb.
7. Using a Robot Coupe, blitz the freeze-dried cherries.
8. Mix together the blended cherries, maltodextrin, almond flavour compound and coconut oil to make the crumb.
9. In a separate bowl, mix together cocoa powder, coconut oil and maltodextrin to make a chocolate snow to garnish the dish.
10. When the pectin has set, remove from moulds and place them on a plate, along with the cherry crumb and chocolate snow.

Final Recipe

Ingredients

Cherry Crumb:

12g Freeze-dried cherries – SOSA Cirera 2-10mm (glucose syrup, cherry pulp, modified potato starch, sodium alginate)

0.3 ml Amerise flavour compound – iqemus (almond, cherry and pistachio evocation)

5g Coconut Oil – KTC (100% pure coconut oil)

20g Maltodextrin – Texturas Albert y Ferrandria (tapioca maltodextrin)

Cherry Gel:

100ml Water

16g Fructose – SOSA Fructose (derived from corn syrup)

0.5g Agar – Texturas Albert y Ferrandria (agar powder)

2g Rapid Set Pectin – Louis Francois Pectin Rapid Set (pectin, sucrose)

0.5g Malic Acid – msk

0.3ml Amerise Flavour Compound – iqumusu (almond, cherry and pistachio evocation)

0.1ml Blue Food Colouring – Mallard Ferriere SAS

0.36g Red Food Colouring – Sosa (Ponceau 4R)

Chocolate Snow:

12g cocoa powder – (100% Cocoa Powder) Valrhona

5g coconut oil - KTC (100% pure coconut oil)

20g maltodextrin - – Texturas Albert y Ferrandria (tapioca maltodextrin)

Method

1. Weigh out all ingredients accurately for the cherry gel.
2. In a jug, mix together the water, food colouring and almond flavour compound.
3. Pour the contents of the jug into a saucepan and add in the pectin, fructose, malic acid, and agar and whisk until dissolved.
4. Bring the saucepan to the boil and pour the contents into moulds.
5. Leave the pectin gels to cool and set.
6. Whilst the pectin is setting, measure out the ingredients for the cherry crumb.
7. Using a Robot Coupe, blitz the freeze-dried cherries.
8. Mix together the blended cherries, maltodextrin, almond flavour compound and coconut oil to make the crumb.

9. In a separate bowl, mix together cocoa powder, coconut oil and maltodextrin to make a chocolate snow to garnish the dish.
10. When the pectin has set, remove from moulds and place them on a plate, along with the cherry crumb and chocolate snow.

Results



Figure 1 Final Dish

Sensory

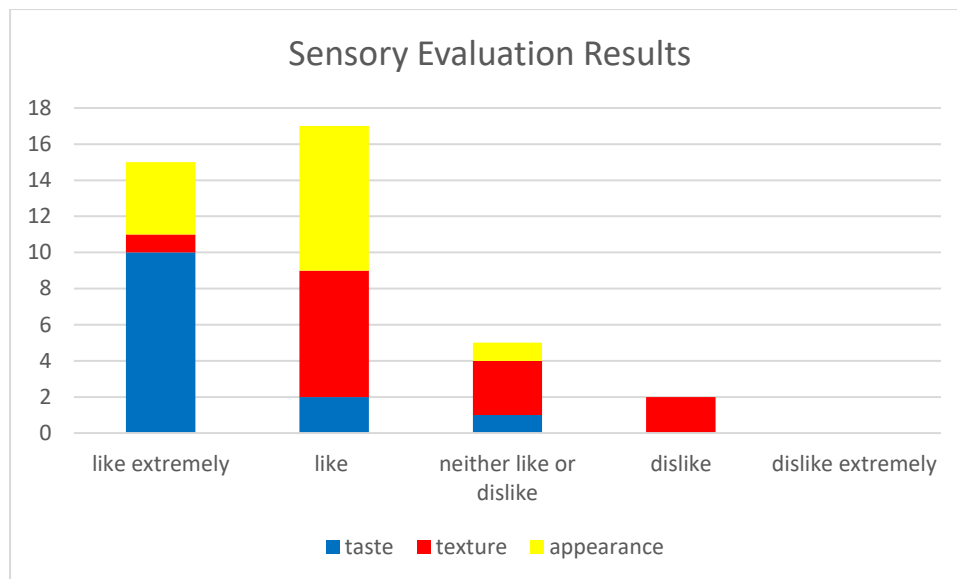
Sensory evaluation was carried out on a number of factors relating to this dish, including taste, texture and appearance. Participants were asked to rate the dish according to their preference: dislike extremely, dislike, neither like or dislike, like and like extremely. Participants were asked to simply place a tick in the box which suited their preference. They were asked to fill out the table below:

Table 1 Example of Sensory Analysis

Rating Scale	Texture	Taste	Appearance
5. Like Extremely			
4. Like			
3. Neither Like nor Dislike			
2. Dislike			
1. Dislike Extremely			

A total of 13 people took part in sensory evaluation of this dish. When asked to rate the texture of the dish, the answer that was most prevalent was 'like'. When asked to rate the appearance of the dish, the most common answer of 'like' also. When asked to rate the taste of the dish, the answer which was most common was 'like extremely'. These results were significant in relation to finding the perfect texture of the gel and also in relation to finding a taste which is very similar to sour cherry.

Table 2 Sensory Evaluation Results



Discussion

Sensory Evaluation

Results from the graph in the results section shows that the most likeable aspect of this dish was its taste. 10 out of 13 people extremely liked the taste of the dish. In relation to taste, the gel had the distinctive ‘sour cherry’ taste, which was because of the addition of malic acid. This ingredient is responsible for the sour flavour and malic acid is added to a number of foods in the industry to give foods a sour/tarte taste. The Amerise flavour compound from iqemusuru contributed towards the cherry flavouring. Amerise is a compound which is found in a variety of fruits such as cherries, almonds, peaches and plums (Iqemusuru, 2020).

Results from the graph show that the texture of the dish was ranked mostly as likeable. 7 out of 13 people liked the texture of the dish, however 3 people neither liked or disliked the dish and 1 person disliked the texture of it. The texture was in relation to the gel. It is important to get the right texture of gel as it is the main component of the dish. The perfect texture which was required was a firm gel which held its shape and also brittle enough to melt in the mouth. The cherry gel had a firm texture and it did hold its shape when set, however it was slightly too soft and had a bit of a mushy texture rather than a melt in the mouth texture. This could be due to the fact that not enough agar was added to gel, as agar help to gel and set certain textures. 0.5g of agar was used in this recipe, however this could have been increased to 0.6-0.7g in

order to get the desired texture. More time in the kitchen would be required in order to perfect this aspect of the dish.

Results from the graph show that the people who took part in the sensory evaluation mostly ranked the appearance of the dish as likeable. 8 out of 13 people liked the appearance, whereas 4 people extremely liked the appearance and 1 person neither liked or disliked it. The appearance of the dish is in relation to the overall presentation of the dish and how the elements of the dish complemented each other. The presentation of the dish was quite simple – 3 round disks of cherry gel, separated by a line of cherry crumb and dusted with the chocolate snow. As the flavours of the dish were quite simple, the presentation was therefore quite simple. Again, the presentation of the dish could be improved if more time was made available in the kitchen.

Pectin Gelling

After working with a number of pectins and artificial sweeteners, the final pectin and sweetener which was used was rapid set pectin from Louis Francois and Fructose from Sosa. The rapid set pectin was able to set with a low content of sugar and fructose was the most suitable sugar for this. Upon realising that rapid set pectin was the most suitable for this dish as it created a brittle but firm gel, a number of experiments were set up using different quantities of fructose in order to set the pectin. After using a variety of different quantities, 16g of fructose to 2g of pectin was found to be the most suitable in order to set the pectin. Other pectins were used such as pure pectin from lemon rind and yellow pectin from Louis Francois. The pure pectin was too time consuming to produce and would not set properly using different sugars and the yellow pectin did not set when using artificial sweeteners such as fructose or sorbitol. This could be due to incorrect measurements of ingredients.

Conclusion

The dish which has been created showed elements of both note-by-note cooking along with pectin gelling. The dish was mostly created using pure compounds as much as possible and the pectin was created using pectin and a low sugar content. The pectin set successfully and created a brittle gel which held its shape.

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Appendices

Log Book

Week 1

Aim:

The aim of this kitchen class is to work with a variety of different pectins and artificial sugars. This is required in order to investigate which pectin sets the best using artificial sweeteners.

Objectives:

- To investigate which pectin sets best using artificial sweeteners.
- To extract pure pectin from the rind of lemons.

Equipment:

chopping board and knives, saucepans, jugs, Microscales – Silver Crest Microscales, Weighing Scales – CELY PS-50 Scales, whisk, cheesecloth.

Recipe:

9 lemons

236ml water

118ml lemon juice

Rapid set pectin

Yellow Pectin

Fructose

Sorbitol

Method:

1. Extract pure pectin by peeling the rind off the lemons.
2. Boil the lemon rind in water and lemon juice for 30-40 minutes before squeezing the contents into a bowl using a cheesecloth.
3. Investigate the gelling of the different pectins by following the manufacturer's instructions on the packaging.
4. Determine which pectin sets the best using the different artificial sugars and sweeteners.

Results and Recommendations:

The pure pectin was extracted from the lemon rind and was put in the freezer to be used in next week's class. The process was long and slow and therefore not ideal for the tight time schedule that is spent in the kitchen. Therefore, this method of extraction is not suitable for this brief under such a short space of time.

Different pectins were used in order to find out their gelling strengths. Out of the three pectins used, it was found that rapid set pectin created the most stable gel, whereas the other pectins created a softer gel which did not hold their shape as well. A number of artificial sugars and sweeteners were used also, and it was found that fructose was the sugar which allowed the gels to set the best. For next week's class, different quantities of rapid set pectin and fructose will be used along with other gelling agents such as agar in order to find the desired gelling capacity.

Week 2

Aim:

The aim of this week's class is to determine the correct measurements of ingredients in order to obtain the correct gelling and setting properties of the dish. Flavours will also be investigated using specific flavour compounds.

Objectives:

- to create a brittle and stable gel using rapid set pectin and fructose.
- To obtain the correct measurements of pectin and fructose to create the desired gel.
- To incorporate agar into the gel.
- To investigate flavour compounds.

Equipment:

Mixing bowls, saucepans, jugs, Microscales – Silver Crest Microscales, Weighing Scales – CELY PS-50 Scales, whisk.

Ingredients:

100ml Water

16g Fructose – SOSA Fructose (derived from corn syrup)

0.5g Agar – Texturas Albert y Ferrandria (agar powder)

2g Rapid Set Pectin – Louis Francois Pectin Rapid Set (pectin, sucrose)

0.3ml Amerise Flavour Compound – iqumusu (almond, cherry and pistachio evocation)

Method:

1. Weigh out ingredients accurately for the gel, making sure to weigh out different quantities of pectin and fructose to make different gels.
2. In a jug, mix together the water and almond flavour compound.
3. Pour the contents of the jug into a saucepan and add in the pectin, fructose and agar and whisk until dissolved.
4. Bring the saucepan to the boil and pour the contents onto a shallow tray.
5. Leave the pectin gels to cool and set.
6. Choose which pectin and fructose quantity created the best gel.

Results and Recommendations:

From using the pure pectin extracted from the lemon rind last week, there was insufficient quantities of pectin obtained in order to carry out more than 1 experiment, therefore only one gel was made and it did not set properly. This means that pure pectin has been ruled out in the process of making this dish.

Different quantities of pectin and fructose were used to set the gel. After carrying out a number of experiments, it was found that using 2g of pectin and 16g of fructose created the most stable gel. Adding 0.5g of agar to the gel gave it a smoother texture and helped it to set more. The kitchen had a number of flavour compounds from the company iqemus and one of these compounds was Amerise. Amerise contained notes of cherry and almond which fits in with the overall flavour of my dish. This flavour compound is now going to be incorporated into the gel.

Next week's class will involve creating accompaniments for the gel to complete the dish. Another aim is to obtain the correct colouring for the gel to associate sour cherry. Incorporating red and blue food colouring will help towards achieving this aim.

Week 3

Aim:

The aim of this week's class is to create accompaniments such as a cherry crumb to complete the dish. The colour of the gel will also be worked on this week in order to create the perfect 'cherry red' colour. The flavour of the gel will also be changed in order to create a sour cherry flavour.

Objectives:

- To create a cherry crumb to accompany the cherry gel.
- To create the perfect 'cherry red' colour in the gel using food colourings.
- To create the sour cherry flavour in the gel using malic acid.

Equipment:

Microscales – Silver Crest Microscales, Weighing Scales – CELY PS-50 Scales, Silicone Moulds – 1.5inches, Robot Coupe – Blixer 3, Saucepans, Whisk, Jug.

Ingredients:

Freeze-dried cherries – SOSA Cirera 2-10mm

Amerise flavour compound – iqemus

Coconut Oil – KTC (100% pure coconut oil)

Maltodextrin – Texturas Albert y Ferrandria

Water

Fructose – SOSA Fructose

Agar – Texturas Albert y Ferrandria

Rapid Set Pectin – Louis Francois Pectin Rapid Set

Malic Acid – msk

Amerise Flavour Compound – iqumus (almond, cherry and pistachio evocation)

Blue Food Colouring – Mallard Ferriere SAS

Red Food Colouring – Sosa (Ponceau 4R)

Method:

1. Weigh out ingredients accurately for the cherry crumb.
2. Using a Robot Coupe, blitz the free-dried cherries.
3. Mix together the cherries, maltodextrin and coconut oil to create the crumb.
4. This method was carried out three times using different quantities of ingredients until the right consistency of crumb was achieved.
5. Combining the ingredients for the pectin gel, 3 batches of the gels were made with different food colours until the correct colour was desired.
6. The first batch of pectin gel was made using red food colouring only.

7. The second batch was made using equal measurements of red and blue colouring.
8. The third batch was made using mostly red food colouring with a drop of blue colouring which created the deep red/purple colour of cherries.

Results:

It was important to get the colour right in the cherry gel in order to give the appearance of a deep cherry colour. The gel made with only red colouring was too bright in colour. The gel made with equal measurements of blue and red colouring was too dark purple in colour, not representing the deep red colour of cherries. The third batch using mostly the red colouring with a drop of blue colouring resulted in a deep red/purple colour which reflected the rich cherry colour. For the final class next week, the third batch will be used to create the final dish.

Malic acid was another ingredient which has been added to the gel. Malic acid is added to foods in order to give it a sour/tarte taste, therefore adding it to the gel and combining it with the cherry flavour creates a sour cherry flavour.

A cherry crumb was made using freeze-dried cherries, coconut oil and maltodextrin. This further increases the cherry flavour of the dish and creates a bright pink colour which will be incorporated into the overall dish. Next week will involve creating a cherry gel using all aspects investigated over the last 3 weeks. All components of the dish will be plated up and presented.

Week 4

Aims:

The aim of this week's class is to make all components of the dish. The cherry gel, cherry crumb and a chocolate snow will be prepared, plated up and presented. Using all of the components investigated over the last 4 weeks, the final dish will be presented.

Objectives:

- The create the final dish using the cherry gel, cherry crumb and chocolate snow.

Equipment:

Microscales – Silver Crest Microscales, weighing Scales – CELY PS-50 Scales, silicone, moulds – 1.5inches, robot Coupe – Blixer 3, saucepans, whisk, jug, sieve, mixing Bowls

Ingredients:

12g Freeze-dried cherries – SOSA Cirera 2-10mm

0.3 ml Amerise flavour compound – iqemus

5g Coconut Oil – KTC (100% pure coconut oil)

20g Maltodextrin – Texturas Albert y Ferrandria

100ml Water

16g Fructose – SOSA Fructose

0.5g Agar – Texturas Albert y Ferrandria

2g Rapid Set Pectin – Louis Francois Pectin Rapid Set

0.5g Malic Acid – msk

0.3ml Amerise Flavour Compound – iqumus

0.1ml Blue Food Colouring – Mallard Ferriere SAS

0.36g Red Food Colouring – Sosa (Ponceau 4R)

12g cocoa powder – (100% Cocoa Powder)

5g coconut oil - KTC (100% pure coconut oil)

20g maltodextrin -- Texturas Albert y Ferrandria

Method:

1. Weigh out all ingredients accurately for the cherry gel.
2. In a jug, mix together the water, food colouring and almond flavour compound.
3. Pour the contents of the jug into a saucepan and add in the pectin, fructose, malic acid, and agar and whisk until dissolved.
4. Bring the saucepan to the boil and pour the contents into moulds.
5. Leave the pectin gels to cool and set.
6. Whilst the pectin is setting, measure out the ingredients for the cherry crumb.
7. Using a Robot Coupe, blitz the freeze-dried cherries.
8. Mix together the blended cherries, maltodextrin, almond flavour compound and coconut oil to make the crumb.
9. In a separate bowl, mix together cocoa powder, coconut oil and maltodextrin to make a chocolate snow to garnish the dish.
10. When the pectin has set, remove from moulds and place them on a plate, along with the cherry crumb and chocolate snow.

Results and Recommendations:

The final dish was created and sensory evaluation was carried out. The results of the sensory evaluation are presented in the Results and Discussion section above, however the main conclusion of this dish is that a sour cherry gel was created with a brittle firm gel that held its shape after setting. The cherry crumb accompanied the gel well as it contributed to the overall cherry flavour and the bright pink colour contributed to the overall appearance of the dish. A chocolate snow was also made to garnish dish and to bring it all together. Both the crumb and snow were made using maltodextrin, which contributed to the texture of the dish as the maltodextrin melts in the mouth. Increasing the amount of agar in the gel will help to create a more firm and brittle gel as the gel in the final dish was too soft.