

The Greenhouse Sprout



Food Innovation and Product Design Masters

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Molecular Gastronomy

TFCS9025 2024 – 2025

Date: May 9th 2025

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Section 1 - Introduction

Note by note cooking is a new and innovative way of exploring the boundaries of what a dish can be. This approach was founded by Hervé This, who first mentioned the concept in his 1994 article published in the *American* (This, 2013). In note-by-note cooking, dishes are made using only pure compounds. Restricting the use of ingredients to pure compounds allows chefs to explore new flavors and textures, but it requires a deeper understanding of the science behind the reactions used in traditional cooking. Note by note cooking has become more and more popular among the culinary and food science community, from being utilized by chefs at the Cordon Bleu to being integrated into universities curriculums and international competitions (*Burke, R. et.al., 2016*).

This report details the creation of a new note by note dish, *The Greenhouse Sprout*. This dish, made up of 6 different components, represents the growth

of a new sprout under the protection of a greenhouse dome. It explores the theme of “Food for the Future” by proposing that the future of food must start a new beginning, it must change and evolve into something that is more natural, closer to earth, like the growth of a sprout. It proposes that this change will occur with the touch of technology, like that of a greenhouse, which will be necessary to protect and allow this change to take root.

The hard crust of the earth is represented by a soil disk, which acts as a base and an anchor point for the dish. A cake base is used to represent the roots, which start small but support the sprout, allowing it to stand. A dirt crumble is used to represent the soft earth, fertilizer and nutrients needed to feed the sprout. A sunshine jam, yellow color and bright in flavor surrounds the sprout, providing light and energy. The sprout itself, shaped in a 3-dimensional way, stands on top of the soil and earth, emerging from its roots. Lastly, the greenhouse dome, represented by a transparent curved disk, covers the sprout, protecting it from any outside harm.

Section 2 – Aim and Objectives

The aim of this report is to create a note-by-note dish that represents the theme of Food for the Future. The success of the dish will be determined by exploring the development of the dish, the main compounds used, the reactions involved, sensory data and interpretation of the theme.

Section 3 – Materials and Methods

Table 1: List of Ingredients

Product	Specific Brand	Photo
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Cocoa Butter

Valrhona "Beurre de Cacao"



Pea Protein Powder

Bulk - Pea Protein Isolate



Fructose

El Granero - Fructose



Cocoa Powder

Citavo - Cocoa Powder



<p>Potato Starch</p>	<p>Family Elephant – “Fécule de Pomme de Terre”</p>	
<p>Wheat Gluten</p>	<p>Biotiva - “Weizengluten”</p>	
<p>Albumin</p>	<p>Louis Francois – Blanc Gallia</p>	
<p>Casein Protein Powder</p>	<p>MyProtein – Casein Protein</p>	
<p>Water</p>	<p>From the tap</p>	<p>N/A</p>

Baking Soda

Gem - Bread Soda



Citric acid

Sosa - Citric Acid



Cinnamon Flavor

Sosa - "Canyella / Canela"



Sunflower oil

The King - Sunflower Oil



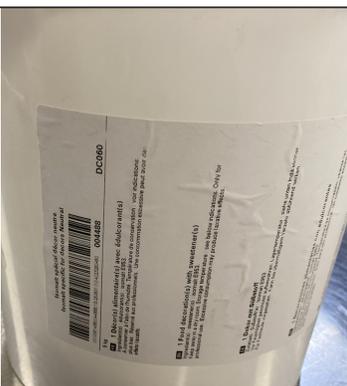
Pectin	Sosa - "Pectin Fruit"	
Matcha Powder	Sosa	
Isomalt	Unknown	

Table 2: List of Equipment

Equipment
Metal Pot
Metal Bowl
Whisk
Butter knife
Combo Oven (Skyline

Premium Combo)
Microwave (Panasonic Proll 1400)
Blast Freezer
Metal Spoon
Silicone Mold
Measuring containers
Parchment paper
Baking Tray
Fridge
Plate
Macro Scale (Russel Hobbs Fusion 5kg Tab Scale)
Micro Scale (Weituro Portable Digital Electric Scale 500g-0.01g)
Serving Plate

Table 3: Soil Disk Methodology

Ingredient	Quantity
Cocoa Butter	20g
Pea Protein Powder	5g
Cocoa Powder	10g
Fructose	10g
Steps:	
Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Mix in other ingredients until it forms a paste. Pour the crumble onto parchment paper.	

Bake at 160C for 10 minutes. Cool in the fridge for 10 minutes.

Table 4: Dirt Crumble Methodology

Ingredient	Quantity
Cocoa Butter	20g
Pea Protein Powder	30g
Cocoa Powder	12.5g
Fructose	16g
Steps: Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Mix in other ingredients. Let cool about 2 minutes until it thickens into a paste. Spread on parchment paper into an oval-like shape. Bake at 160C for 10 minutes. Cool in the fridge for 10 minutes.	

Table 5: Cake Roots Methodology

Ingredient	Quantity
Potato Starch	30g
Wheat Gluten	9g
Fructose	25g
Albumin	8g
Casein Protein Powder	6g
Water	50g
Baking Soda	2.5g
Citric acid	0.1g

Cinnamon Flavor	0.1g
Sunflower oil	1g - just to coat the silicone mold
Steps:	
Mix ingredients together in a bowl using a whisk. Grease the silicone mold with oil. Pour the batter into the mold and bake at 160C for 5 minutes with 30% humidity.	

Table 6: Sunshine Jam Methodology

Ingredient	Quantity
Water	45g
Fructose	30g
Pectin	2g
Citric Acid	1.65g
Steps:	
Mix Pectin and Fructose together. Bring water to a boil. Slowly incorporate the Pectin-Fructose mixture bit by bit into the water. Bring the mixture back to a boil and simmer a few minutes until thickened. Mix in citric acid. Pour into a container to cool. Let set in the fridge for 10 minutes.	

Table 7: Matcha Sprout Methodology

Ingredient	Quantity
Cocoa Butter	200g
Matcha Powder	1g
Fructose	5g

Steps:

Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Add in the matcha and fructose. Let cool until thick but still fluid. Use a spoon to shape into sprout shapes on parchment paper. Cool in the freezer for 10 minutes. Melt the leftovers again to use as a glue to assemble 2 sprouts to make a 3-dimensional effect.

Table 8: Isomalt Greenhouse Dome Methodology

Ingredient	Quantity
Isomalt	100g
Steps: Put the isomalt in a pot and bring to a boil. When a clear liquid is formed, let cool until it is thick but fluid. Prepare a metal bowl by covering it in parchment paper. Pour over a prepared bowl. Let sit for 10 minutes at room temperature to cool. Remove from the parchment.	

Section 4 - Results

Figure 1: Greenhouse Sprout Dish



Figure 2: Individual components of the Greenhouse Sprout Dish

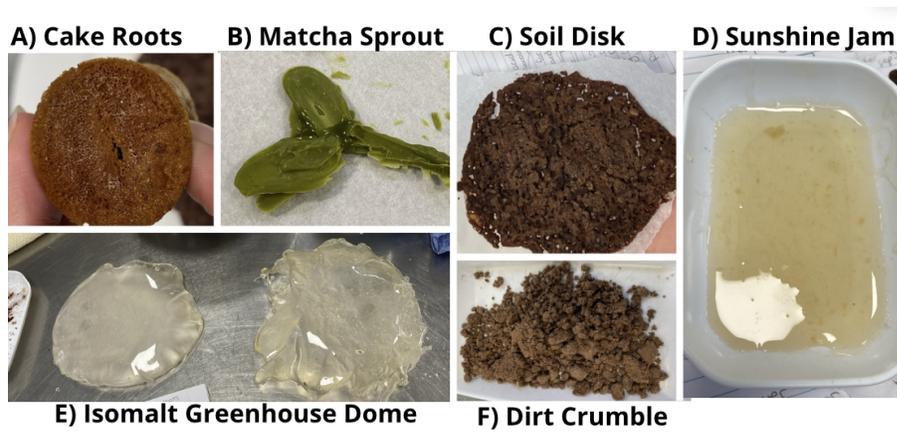


Figure 3: Product Development Gantt Chart

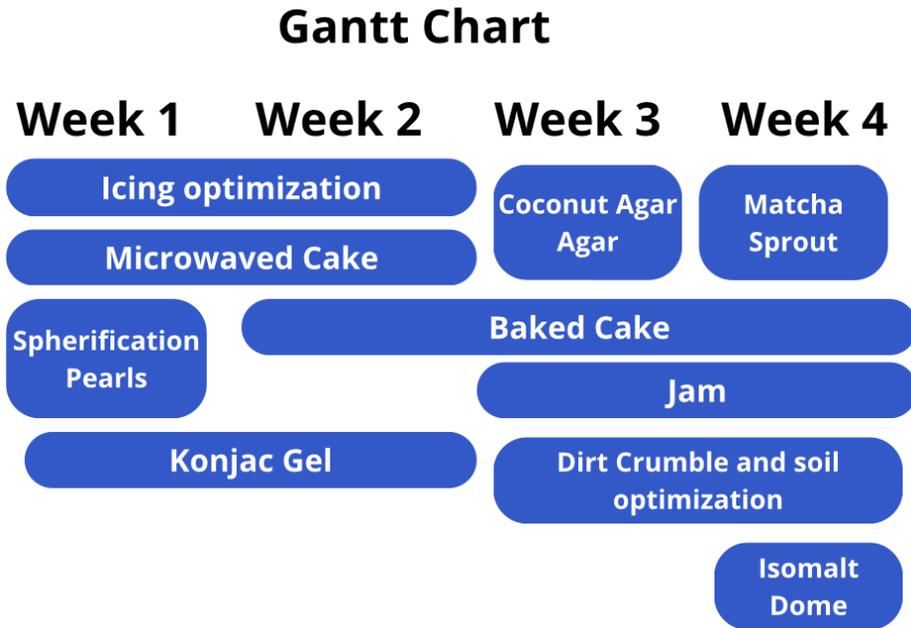
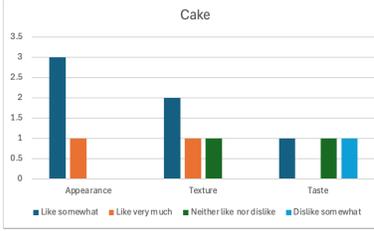
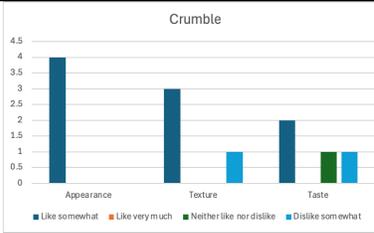


Table 9: Final Sensory Analysis

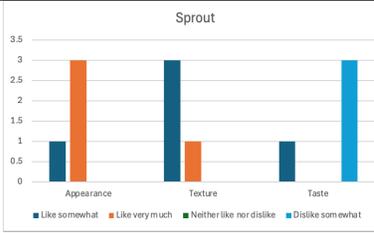
Question	Results	Conclusion																				
How much do you like the sensory properties of the cake?	 <table border="1" style="display: none;"> <caption>Cake Sensory Analysis Data</caption> <thead> <tr> <th>Property</th> <th>Like somewhat</th> <th>Like very much</th> <th>Neither like nor dislike</th> <th>Dislike somewhat</th> </tr> </thead> <tbody> <tr> <td>Appearance</td> <td>3.0</td> <td>1.0</td> <td>0.0</td> <td>0.0</td> </tr> <tr> <td>Texture</td> <td>2.0</td> <td>1.0</td> <td>1.0</td> <td>0.0</td> </tr> <tr> <td>Taste</td> <td>1.0</td> <td>0.0</td> <td>1.0</td> <td>1.0</td> </tr> </tbody> </table>	Property	Like somewhat	Like very much	Neither like nor dislike	Dislike somewhat	Appearance	3.0	1.0	0.0	0.0	Texture	2.0	1.0	1.0	0.0	Taste	1.0	0.0	1.0	1.0	<p>Appearance was well liked</p> <p>Texture was decently liked</p> <p>Taste was not very liked</p> <p>The visual and textural aspects of the dish were good but taste was lacking.</p>
Property	Like somewhat	Like very much	Neither like nor dislike	Dislike somewhat																		
Appearance	3.0	1.0	0.0	0.0																		
Texture	2.0	1.0	1.0	0.0																		
Taste	1.0	0.0	1.0	1.0																		

How much do you like the sensory properties of the crumble?



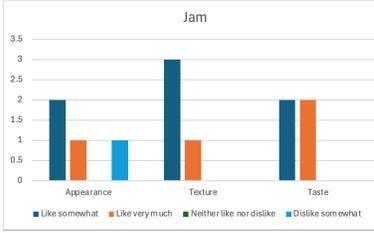
The visual appearance was the best with texture and taste needing improvement.

How much do you like the sensory properties of the Sprout?



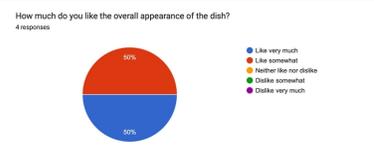
Appearance and texture were well liked. Taste needs improvement.

How much do you like the sensory properties of the Jam?



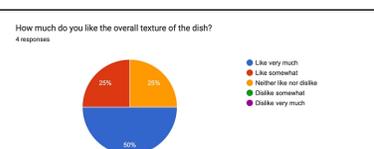
Appearance could use improvement but overall, all attributes had positive ratings.

How much do you like the overall appearance of the dish?



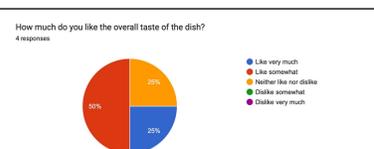
The appearance of the dish was very much appreciated.

How much do you like the overall texture of the dish?



The texture of the dish was decently appreciated as well. Some aspects could use improvement but no negative responses.

How much do you like the overall taste of the dish?



The taste of the dish also needs some improvement but had an overall positive score.

Section 5 – Discussion

Development Process

The final dish *Greenhouse Sprout* was developed over the course of 4 weekly kitchen sessions. In the first week, multiple elements of the dish were started. The cake was made using a microwave but resulted in an incredibly hard texture. Adjustments were made in the second week to adjust the composition for a moister and softer crumb, especially reducing the starch content as retrogradation was suspected of contributing to the hardening. While these changes did improve the hardness of the cake, the texture was still gummy, and appearance was undesirable. Therefore, a change was made in the cooking method, baking was used instead of a microwave. The resulting texture was much better; the appearance had a good browning from the Maillard reaction, the crumb was more soft and airy as well. Due to the limited access to molds, the ones used were quite small, leading to overfilling and uneven baking, the bottom of the cake turning out darker than the top. In the third week minor adjustments were made to the ratios and humidity was used while baking to make a softer and moister crumb.

A few elements were worked on and did not make on the dish, such as the konjac gel and icings. These elements were improved between the first week and the second but were not changing in a way that fit the vision of the dish and ways in which they were intended to be utilized. The icing demonstrated the impact of the use of emulsifiers and fats to make the icing creamier and the impact of different milk proteins on the taste and texture of an icing. The konjac gel was a lesson in understanding the correct ratio of gum to water and the impact of adding gelling aids like calcium gluconate to strengthen the gel network. The coconut agar-agar is another element developed in the third week that did not make its way onto the final dish, however this was due to a lack of time rather than a purposeful decision. The taste was very

good, though the texture a bit soft. As the texture was not quite as solid as desired, it was left as a potential add on to the final dish if time permitted.

In the third week, a lot of changes were made to the dish concept and new elements were added. This included the sunshine jam. In the third week, the jam was overcooked, which led to a gummier texture rather than a gel. While the ratios did not change, by reducing the cooking time and thus the water evaporation, the result jam in the fourth week was more fluid.

The dirt crumble was another element which taught an important lesson. By observing just the results in the fourth week, where a failed attempt at the dirt crumble resulted in the dirt soil, the impact of composition was emphasized. In the soil disk, the cocoa butter was left to cool too long before the solids were added, so only a portion of the total solids could be mixed in. When baked, the higher cocoa butter content melted together the mixture into a disk and solidified when cooling due to recrystallization. In comparison, in the dirt crumble which contained a higher solids content, the mixture was more of a crumble even before baking, compared to the soil which was more of a paste. After baking, the dirt crumble did not melt, but instead became even more powdery and crumbly, giving a drastically different texture to the soil disk despite being made of the same ingredients.

The matcha sprout was made using the opposite principle. A high concentration of cocoa butter and small quantity of solids (matcha) was used to maintain a firm and solid texture. The method used to spread the mixture, due to lack of time, did not create the most smooth and uniform texture. This resulted in some parts of the leaves or stems being thin and fragile. Most of the pieces broke during assembly and needed a lot of melted mixture to glue them back together. While the sprout was made, its appearance was more jagged due to the quick fixes that were needed to compensate for its fragility.

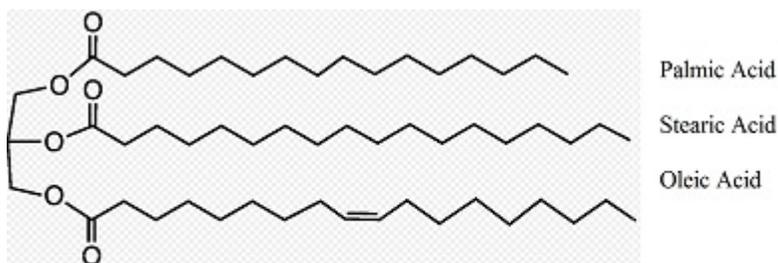
Lastly, the isomalt dome was added in the last week. Two domes were made as the first one was poured when the mixture had cooled too much, making it drip less far down the dies of the bowl. To make a more curved dome, a second isomalt dome was made, but the mixture was poured after a shorter cooling time.

Main Compounds Used

Complex mixtures

- Cocoa Butter

Cocoa Butter is a fat extracted from the cacao tree. Its composition relies on 3 main fatty acids: stearic acid, oleic acid and palmitic acid. These fatty acids are arranged into 3 main triglycerides known as POP (13.8 - 21.8%), POS (26.3 - 44.8%) and SOS (20.0 - 29.4%), which together make up a significant portion of cocoa butter's composition (Silveira et al., 2025). Other particles present in cocoa butter are referred to as "minor components". Present as less than 3%, these include monoacylglycerols, diacylglycerols, free fatty acids and phospholipids (Chen et al., 2021).



(Alchemist, 2024)

- Pea Protein Powder

Pea proteins are isolated during starch extraction from peas (Colmenero, 2014). It is made up of 2 main proteins, globulins and albumins. The main contributor is globulins which are salt soluble and account for up to 80% of the total proteins. These include legumin (11S), vicilin (7S) and convicilin, which contribute to some emulsifying properties (Chen & Sun, 2021).

- Cocoa Powder

Cocoa powder is a product from the cocoa tree. It is a complex flavor molecule that is made of many different molecules. The cocoa beans are pressed to remove fat and treated with an alkali like potassium carbonate and roasted. Its fat content varies from 8 - 26% from residual cocoa butter (composition mentioned above) (Gibson & Newsham, 2018). The specific key flavor compounds can vary based on the processing of the cocoa bean, these include pyrazines, alcohols, aldehydes, acids, esters, etc. (Quelal et al., 2023).

The roasting and fermentation steps of cocoa processing creates melanoidins, a brown pigment created by the Maillard Reaction, a chemical reaction between amino acids and sugars, as well as depolymerized polyphenols, where polyphenol antioxidants in cocoa break down and bind with air, proteins and sugars to create dark pigments (Quiroz-Reyes & Fogliano, 2018).

- Potato Starch

Potato starch is an extract from potato tubers. It is mainly made up from amylose (11.4 - 36.6%) and amylopectin (63.4 - 88.6%) molecules, with amylopectin being the main contributor. Minor components make up less than 2% dry weight in the form of lipids, protein and ash (Tong et al., 2023).

Amylose is a linear glucose polysaccharide whereas amylopectin is a branched polysaccharide (Tomasik & Horton, 2012).

- Wheat Gluten

Wheat gluten is isolated from the wheat plant. It consists of 80% protein content made up of 2 main proteins, glutenin and gliadin. These proteins contribute a unique viscoelastic network that plays a role in elasticity and aeration of baked good products (Zhang et al., 2022).

- Powdered Egg Whites

Egg whites are mainly made of water (88%) and proteins (10%) with less than 1% contribution in the form of carbohydrates and minerals (Tiefenbacher, 2019). This means that powdered egg-whites, its dried form, mainly consists of egg white proteins. Egg whites contain 8 globular proteins, with only in 3 providing quantities: Ovalbumin (54%), ovotransferrin (12%) and Ovomuroid (11%) (Lacroix & Vu, 2014).

- Cinnamon Flavor

Cinnamon flavor is either extracted or formulated based on the composition of cinnamon bark. Extracts usually in the form of oils are mainly made up primarily of cinnamaldehyde (65-80%) and in smaller quantity of eugenol (5-10%) with other compounds present in minute quantities (Knauth et al., 2018). Generally, cinnamaldehyde is known as the main character impact flavor molecule for cinnamon flavor.

- Sunflower Oil

Sunflower oil, a fat derived from the sunflower plant. It is primarily composed of unsaturated fatty acids (85%) and some saturated fatty acids (15%). The specific composition of unsaturated fatty acid can change but is typically within the range of (44-75%) linoleic acid and (14 - 43%) oleic acid (Akkaya, 2018).

- Matcha Powder

Matcha powder is a powdered green tea which contains many active compounds known for their psychoactive properties (theanine and caffeine), bright color (chlorophyll) and flavor (catechins). There are 4 main catechins in matcha, however the most abundant and flavor- impacting is EGCG (epigallocatechin-3-gallate) (Kochman et al., 2020).

- Isomalt

Isomalt is sugar alcohol with about half the sweetening power of sucrose (Bhattacharya, 2023). It is composed of 2 different polyols, 1,1-GMP and 1,6-GPS which are produced during the enzymatic conversion and hydrogenation of sucrose (Sentko and Willibald-Ettle, 2012).

Compounds - no further isolation needed

- Pectin
- Casein Protein Powder

Pectin and casein protein are not simple compounds but isolated enough to be an Individual compound in terms of note-by-note cooking.

Molecules - no further isolation needed

- Fructose (C₆H₁₂O₆)
- Water (H₂O)
- Baking Soda (NaHCO₃)
- Citric Acid (C₆H₈O₇)

Table 10: Summary table of main compounds in each ingredient used

Ingredient	Main molecule or compound
Cocoa Butter	POS Or Mixture of POP, POS and SOS triglycerides
Pea Protein	Pea protein globulins (Legumin, vicilin and convicilin proteins)
Cocoa Powder	Color: melanoidins and depolymerized polyphenols Flavor: pyrazines, alcohols, aldehydes
Potato Starch	Amylopectin Or 2:8 ratio of amylose : amylopectin
Wheat Gluten	Glutenin and Gliadin
Powdered Egg Whites	Ovalbumin
Cinnamon Flavor	Cinnamaldehyde
Sunflower Oil	Linoleic acid Or

	3:7 ratio of oleic acid : linoleic acid
Matcha Powder	Color: chlorophyll Flavor: EGCG (epigallocatechin-3-gallate)
Isomalt	1,1-GMP and 1,6-GPS
Casein Protein	Already a single molecule or compound
Fructose	
Water	
Baking Soda	
Citric Acid	
Pectin	

Sensory Data

A sensory analysis was performed with only 4 panelists during the Week's session; an overview of the questions and responses can be seen in Table 9. Due to the low number of available panelists, the results cannot be said to be statistically significant, however they are still informative of the sensory properties of the dish.

Overall, the appearance of the cake was its strongest point, with a positive evaluation of texture and mixed ratings for taste. The lack of complex flavor might have been responsible for this, as only a small quantity of cinnamon flavor was used, as well as the fact that the cake was not incredibly sweet.

The Crumble was the best rated component in terms of visual of the whole dish. The texture was also quite well received, while the taste was quite lacking. The product was quite bitter due to the cocoa powder and pea protein. A higher quantity of fructose should have been added to balance out the flavors.

The Sprout was well liked in appearance. Due to the short time and fragility of the sprouts, some leaves and stems broke during assembly, making the final sprout used more patched up than originally intended, which could explain the lower rating. The texture which gave a satisfying crunch and snap when bitten into, was the highest rating attribute of the sprout. Lastly, taste was not the most well-liked, likely due to the bitterness of the matcha and the lack of sweetness from the fructose to balance it out. A higher quantity of fructose would help improve this aspect.

The Jam had positive ratings of appearance but was the least appealing in terms of appearance compared to other components of the dish, likely due to its simplicity. The taste and texture were very well liked, showing that it was well optimized in these areas.

When evaluating the overall dish, the panelists gave strong positive reviews about the visual appearance, demonstrating that the dish was very visually pleasing. The texture was quite well received, with no negative evaluations of the dish but one neutral response, meaning while the texture was quite liked, there is room for improvement. The overall taste of the dish was also quite similar in response, the overall positive response mediocre, showing that the flavors present were pleasant, but work needs to be done to ensure that all aspects of the dish contribute to higher flavor level. Based on feedback during the session and personal opinion having tasted the dishes, the simple change of adding more fructose would have helped the taste of most of the dishes, compensating for bitter compounds or creating more depth of flavor and leaning into the sweet profile of the dish.

Legislation Compliance

Additives

EU legislation has attributed E numbers to approved food additives. Many compounds used in this dish are not food additives but rather food ingredients, hence there is no restriction on the dosage that can be present in the dish. The FSAI (Food Safety Authority of Ireland) defines a food additive, according to Regulation (EC) No 1333/2008, as a food substance not normally consumed as a food itself, added for nutritional or technological purposes into the food (Food Additives, FSAI).

Of the ingredients used in the final dish, these are the ingredients considered as additives with a regulated dosage limit. The table below references the legislation, corresponding E number and permitted dosage of the additives used in the final dish. All the additives used have a *quantum satis* dosage limit, which means “as much as is enough”. This implies that while there is no fixed limit on the dosage, it should be used only in the quantities needed for the desired effect and no more.

Table 11: Additives information based on Regulation (EC) No 1130/2011

Ingredient	E number	Dosage
Baking Soda	E500	<i>Quantum satis</i>
Citric Acid	E330	<i>Quantum satis</i>
Pectin	E440	<i>Quantum satis</i>
Isomalt	E953	<i>Quantum satis</i>

Flavorings

The regulation on the usage of flavorings is covered by Regulation (EC) No 1334/2008. Cinnamon flavor, characterized as cinnamaldehyde abides the general conditions for use listed in Article 4, it does not according to

scientific evidence, pose a health risk to consumers nor mislead them. Most flavorings are governed by the same *quantum satis* principle as previously mentioned for additives, unless otherwise listed. Additionally, it is not listed as a non-permitted substance in Annex 3 Part A or substances with maximum levels outlined in Part B. One thing to note is that Coumarin, which is a naturally occurring compound found in cinnamon, has a maximum permitted level of 50 – 5 mg/kg depending on the food-type. In this case, as the cinnamon flavor is interpreted as being cinnamaldehyde, this is not a concern.

Main Reactions

This section outlines the main reactions that occur to make each component of the dish, also highlighting the main flavors.

Cake Roots

A cake has a complex texture to recreate; the elements of the final recipe chosen reflect those of a traditional cake. Flour is replaced by wheat gluten and starch, as these are its main components. The wheat gluten when mixed in the dough binds together to form a gluten network, which gives the dough elasticity and structure (Zhang et al., 2022). The starch, when hydrated by the water in the dough and cooked, gelatinizes, which helps retain moisture and bind the crumb together. Leavening is achieved through baking soda and citric acid, which produce carbon dioxide that gets trapped by the gluten network, aerating the dough.

Eggs and milk that are traditionally found in cakes to tenderize, add moisture and emulsify are replaced with egg white powder (ovalbumin) and casein protein. The mixture of sugars (in the form of fructose) and proteins (pea, casein, ovalbumin) also creates the browning color change observed due to the Maillard reaction, a reaction between amino acids in proteins and sugar

that creates brown pigments. Cinnamon flavoring (cinnamaldehyde) is added for flavor.

Matcha Sprout

The Matcha sprout is made by melting cocoa butter, combining it with sucrose and matcha powder, which evenly distribute in the mixture and then recrystallizing the cocoa butter with these new additions by cooling it.

Soil Disk

The soil disk was done by melting cocoa butter and adding solids to give it a more crumbly texture. The baking melted the cocoa butter to create a single uniform disk. While the cocoa butter recrystallized creating the solidity of the disk when cooling.

Dirt Crumble

The dirt crumble was made by melting cocoa butter and adding a high content of solids. The solids were clumped together by the cocoa butter. As there was a low cocoa butter content, when baking the cocoa butter did not melt and cover the crumble together like it did the disk, but rather just solidified the existing clumps, making them more solid upon cooling down and recrystallizing.

Sunshine Jam

The Jam is created through a pectin gelation reaction. Pectin forms a gel network through long linked chains that traps water, preventing its flow and creating a thickening effect. At least (55-75%) of solids (sugar or fiber) are needed to reduce the water activity of the solution, this allows the pectin molecules to bind to each other effectively. An acid is also needed to lower the pH of the solution and increase the strength of the gel network formed (Said et al., 2023).

Isomalt Greenhouse Dome

To create the clear greenhouse dome, isolate is melted into a clear liquid and poured over a mold to cool until it solidified (in this case a bowl). This is an example of a change of state from crystalline to amorphous, known as the glass transition. Concentrated isomalt, upon reaching its glass transition temperature of 60C (Borde & Cesàro, 2001), transitions to an amorphous state. This is a glass-like state results in transparency and brittleness due to a less ordered molecular arrangement (Raudonus et al., 2000).

Theme Description

The aim of this project was to make a note-by-note dish that fit under the category of Food for the Future. The dish that was created, Greenhouse Sprout, is an interpretation of what the future needs and might look like. Food for the Future has many interpretations, it can be seen in terms of physical food needs, nutritional needs, sustainability and quality needs or futuristic approaches to food.

A greenhouse sprout is a unique ecosystem that is a blend of nature and human interference. A sprout is something very natural, it represents the start of something new or reinvention. It is something that is delicate and with proper care and conditions can grow stronger. Our current food system needs to evolve; the future of food is rooted in change. For both quality and sustainability reasons, foods need to abide by the opposite principles of note-by-note and become more wholesome, less processed and closer to the earth. More processing means more waste, more energy, transport, packaging and loss of nutrients. However, this is not a change that will come easily, as the technological advances we have made make it difficult to give up the convenience and taste of less processed foods. The greenhouse therefore represents the touch of human's beings, of our technology and

ways of being that create a sheltered nature, the closest that we can realistically achieve.

Section 6 - Conclusions

In conclusion, the dish created respected the guidelines of a note-by-note dish and applied them to the theme of food for the future. Legislation was consulted to ensure that additives and flavorings were not present in quantities higher than EU permitted limits. Sensory data demonstrated room for improvement, but overall appreciation of the dish, especially in terms of visual appearance. Progress was made from week to week, as results were considered and changes made to correct what was lacking. An understanding of the key reactions and contributing ingredients was demonstrated through the modifications done every week and the exploration of the main contributing reactions. Overall, this dish accomplished its goals and objectives.

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Commission Regulation (EU) No 1130/2011 of 11 November 2011 amending Annex III to Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives by establishing a Union list of food additives approved for use in food additives, food enzymes, food flavourings and nutrients Text with EEA relevance

APPENDIX 1 - Logbooks

Table 12: Logbook Ingredients List

Ingredients	Brand	Photo
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<p>Potato Starch</p>	<p>Family Elephant</p>	
<p>Casein Protein</p>	<p>MyProtein</p>	
<p>Inulin</p>	<p>Sosa</p>	
<p>Baking Soda</p>	<p>Gem</p>	

Sunflower Oil	The Kind	
Water	Tap water	N/A
Citric Acid	Sosa	
Konjac Gum	Soa	
Mascarpone Powder	Sosa	

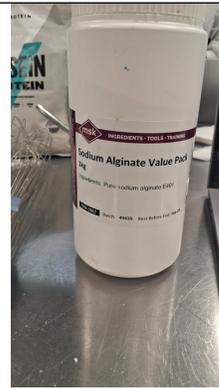
Calcium chloride

MSK



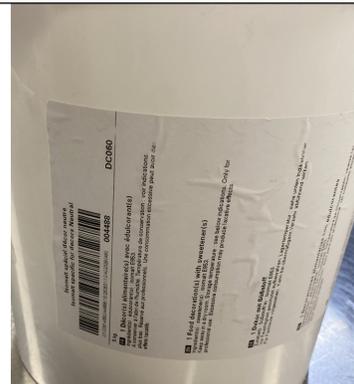
Sodium Alginate

MSK



Isomalt

Unknown



Cocoa Powder

Citavo



No 4 Sotolon Flavor

The Kitchen Laboratory



No 2 Broth Flavor

The Kitchen Laboratory



White Chocolate Flavor

Sosa



Tonka Flavor

Sosa



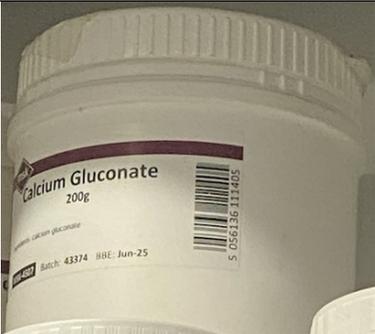
Xanthan Gum

Sosa



Calcium Gluconate

MSK



Soy Lecithin

Sosa



Whey Protein

Bulk



<p>Pea Protein</p>	<p>Bulk</p>	
<p>Albumin</p>	<p>Louis Francois</p>	
<p>Wheat Gluten (Weizengluten)</p>	<p>Biotiva</p>	
<p>Lila Color</p>	<p>Sosa</p>	
<p>Agar-Agar</p>	<p>Special Ingredients</p>	

<p>Coconut Milk Powder</p>	<p>Sosa</p>	
<p>Matcha Powder</p>	<p>Sosa</p>	
<p>Pectin</p>	<p>Sosa</p>	
<p>Cinnamon Flavor</p>	<p>Sosa</p>	

Fructose	El Granero	
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Logbook Materials List

- Metal bowls
- Metal Pot
- Spoons
- Whisk
- Butter knife
- Combo Oven (Skyline Premium Combo)
- Microwave (Panasonic Proll 1400)
- Blast Freezer
- Silicone Mold
- Measuring containers
- Parchment paper
- Baking Tray
- Fridge
- Macro Scale (Russel Hobbs Fusion 5kg Tab Scale)
- Micro Scale (Weituro Portable Digital Electric Scale 500g-0.01g)
- Syringes
- Slotted spoon

Logbook Week 1

(1) Cake

20g Potato Starch

5g Casein Protein

1.5g Inulin

0.3g Baking Soda

9.4g Sunflower Oil

21g Water

0.5g Citric Acid

Microwave for 50 seconds – got rock hard after sitting at room temperature for a while – was ok before

(2) Icing A

30g Water

10g Casein Protein

10g Potato Starch

10g Sunflower Oil

(3) Icing B

20g Water

3.4g Mascarpone Powder

4.8g Whey Powder

(4) Specification pearls

0.5g Sodium Alginate

100g Water

10g Fructose

(5) Calcium Bath

2.5g Calcium Chloride

250mL Water

(6) Kojac Gel

1g Konjac Gum

5g Inulin

500mL water

Results

Figure 4: Week 1 Microwaved Cake



Figure 5: Week 1 Icing A (casein-based) and Icing B (whey-based)

Icing A



Casein

Icing B



Whey

Figure 6: Week 1 Konjac Gel



Figure 7: Week 1 Spherification Pearls

Syringes



Pearls



Discussion

In the first week, multiple elements of the dish were started. The cake was originally made by microwave, an attempt to use a more sustainable method of cooking, consuming less energy. Starch and casein protein were used to replace flour. Inulin was added as a fiber source and to help absorb water. Baking soda and citric acid were used as a rising agent. Sunflower oil was used as a fat source and water to hydrate the dough. The resulting cake had a decent texture, no flavor was added as the first attempt was just to verify the texture, but after cooling the cake quickly became incredibly hard. This is likely a retrogradation reaction from the cooling of the starch.

Two icings were made, one using casein protein and starch, the other using whey protein and mascarpone for flavor. The first icing (A) was too liquid in texture and the second icing (B) had an unpleasant taste from the flavor combination of the ingredients used, despite having a thicker, more desirable texture.

A konjac gel was attempted, as an innovative gel that could be used by itself or as a part of the icing. However, the concentration of konjac was too low, the gel did not get thick enough to hold its shape and remained fluid.

Pearls were made using spherification, different syringe sizes were used to see what sizes were possible to achieve. The goal was to make large pearls, which based on these results, would be better done with reverse spherification.

Conclusion

The cake needs to be modified in order to have better sensory properties. Wheat gluten will be added to get a better texture and less starch will be used to prevent the hardening effect when cooling. The icing needs a better

flavor, so alternative solids will be explored such as pea protein and emulsifiers like soy lecithin will be used to try and get a creamier, smoother texture. The Konjac gel will be attempted again but in a more concentrated formulation and calcium gluconate will be used to help with the formation of a stronger gel network. The spheres take a lot of time and would need a lot of reformulation to be made into reverse spherification therefore its better to concentrate on the other elements of the dish.

Logbook Week 2

(1) Microwave Cake

- 50g Potato Starch
- 5g Wheat Gluten
- 0.5g Xanthan gum
- 15g Fructose
- 50mL water
- 10mL Sunflower Oil
- 2 Drops Sotolon Flavor
- 2 Drops Broth Flavor
- 1g Cocoa Powder

Mix ingredients and microwave for 60s.

(2) Baked Cake

- 30g Potato Starch
- 7.5g Wheat Gluten
- 15g Fructose
- 8g Albumin
- 6g Casein
- 38g Water

1g Baking Soda
0.25g Citric Acid

Mix ingredients and bake at 160C for 8 minutes.

(3) Flavored Baked Cake

30g Potato Starch
7.5g Wheat Gluten
15g Fructose
8g Albumin
6g Casein
38g Water
1g Baking Soda
0.25g Citric Acid
3 Drops White Chocolate Flavor
3 Drops Tonka Flavor

Mix ingredients and bake at 160C for 8 minutes.

(4) Icing C

20g Casein Protein
20mL Water
0.2g Soy Lecithin
0.2g Xanthan gum
5g Fructose

Mix together ingredients.

(5) Icing D

10g Casein Protein

22mL water
0.2g Soy lecithin
4g Sunflower oil
2g Fructose

(6) Konjac Gel 2.0

150mL Water
47g Fructose
5g Calcium Gluconate
10g Konjac Gum

Combine ingredients in a pot and bring to a boil over the stovetop.

Results

Figure 8: Week 2 - Microwave Cake



Figure 9: Week 2 - Baked Cake

In the mold Sliced open



Figure 10: Week 2 - Konjac Gel

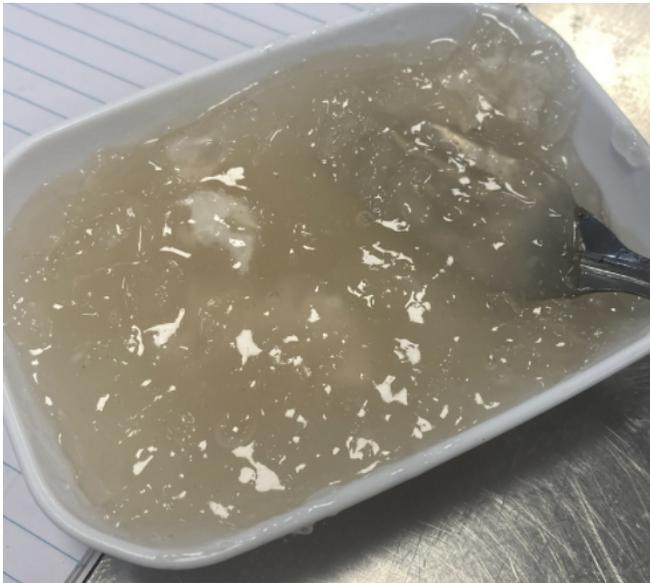


Figure 11 - Week 2 - Icing C (higher solids) and Icing D (oil and more water)

Icing C



Icing D



Discussion

The microwave cake was made again with the addition of wheat gluten to form a gluten network and add elasticity to the dough, xanthan gum to help bind together, fructose for flavor and taste, egg white protein for texture and moisture retention and some flavoring agents (sotolon flavor, broth flavor and cocoa powder). The intention was to make a sweet but earthy cake flavor. While the microwaved cake was much better with these modifications, the texture and visual appearance wasn't very appetizing. Despite the many flavors added in, the cake still did not taste of much, only showing a color change from the flavoring agents.

To improve the texture and appearance, the same dough, without the flavorings (as they could not be perceived) was baked in silicone molds in the oven. This resulted in a much better appearance and texture compared to the microwaved cake.

The konjac gel was remade with a higher concentration and with calcium gluconate to aid in the formation of the gel network. A thicker, jelly-like

texture was achieved; however the texture was not as smooth or pleasant as intended and the taste was very plain and watery. It wouldn't contribute much to an icing due to these properties, especially when a thick, stiff icing was desired, meaning a watery and gloopy texture would only work against this.

Two icings were developed again. The first, icing C was made using soy lecithin and xanthan gum, but was a little too thick in texture and chalky in mouthfeel. The second, icing D, was made with soy lecithin and sunflower oil; to create a creamier taste and less casein was used to have a slightly runnier texture. While the texture of the last icing, icing D, was very close to the desired result, the taste of the protein was too strong to mask and still gave an unpleasant, chalky mouthfeel.

Conclusion

The cake was successfully improved, however the konjac gel and icing were still not developing as desired. At this point a decision was made to make a drastic change and try new elements for the dish in the next week, leaving behind these components. A plan was made to try out a jam, coconut agar and cocoa butter crumble to add with the cake on the final dish.

Logbook Week 3

(1) Cake

30g Potato Starch

9g Wheat Gluten

25g Fructose

8g Albumin

6g Casein

38g Water
2.5g Baking Soda
0.1g Citric Acid

Mix ingredients and bake at 160C for 8 minutes with 30% humidity. Cool at room temperature.

(2) Jam

65g Water
60g Fructose
4.8g Pectin
3.3g Citric Acid

Mix Pectin and Fructose together. Bring water to a boil. Slowly incorporate the Pectin-Fructose mixture bit by bit into the water. Bring the mixture back to a boil and simmer a few minutes until thickened. Mix in citric acid. Pour into a container to cool. Let set in the fridge for 10 minutes.

(3) Crumble

50g Cocoa Butter
14.5g Whey Protein
0.2g Lila Color
12g Potato Starch

Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Combine with ingredients to form a paste. Spread on a parchment paper and bake at 160C for 3 minutes. Cool in the freezer for 5 minutes. Crumble by hand.

(4) Coconut Agar

0.8g Agar-Agar

30g Water

5g Coconut Milk Powder

50g Fructose

Mix together ingredients in a saucepan. Bring to a boil and simmer for a few minutes until thickened. Pour into a container and let cool and set in the fridge for 10 minutes.

Results

Figure 12: Week 3 - Cake before and after baking



Figure 13: Week 3 - Jam



Figure 14: Week 3 - Crumble

Melted



**Cooled into
a paste**



**Baked, cooled
and crumbled**



Figure 15: Week 3 - Coconut Agar



Discussion

The cake was made again with the same main ingredients, but a few changes to the ratios used. Slightly more wheat gluten was used to try and get a softer, springier texture and a higher quantity of fructose was used to improve the taste. The baking process was also changed to include humidity, again to improve the moistness of the cake and create a softer crumb.

The jam was made using pectin, water, fructose and citric acid. A flavoring agent was going to be added at the end, however while making it, it was observed that the pectin gave the mixture a natural, yellow tint, while the citric acid imparted a lemon-like flavor. When tasting the jam, the appearance and flavor resembled that of a lemon-flavored jam, this fit well with the sunshine element, so no flavor was added. However, the mixture was cooked too long, resulting in a jam that upon cooling, was too thick in texture. It was less like jam and more like jelly.

The crumble was made using cocoa butter and color was added to make it more visually pleasing. Whey protein and starch was used as the solids to make the cocoa butter crumbly rather than brittle. The resulting mixture formed a paste which was then baked. The results were interesting in texture

and appearance, but they did not deliver the expected soft and crumbly texture. Instead, these were more like crumbled shards. This is likely due to a lack of solids, the quantity of cocoa butter was too high and solidified the crumble rather than giving it a powdery texture.

A coconut milk powder was used to make an agar-agar gel. The resulting gel had a good texture, though a little soft. However, the flavor impacted from the coconut milk powder was very good. The idea was to place this agar in flower molds, possibly adding different colorants, to make colorful flowers.

Conclusion

The would be made with this final recipe of optimized cake. The jam and agar agar would be used as is, while the crumble would be incorporated with an increased solids content. The visual of the dish as a whole needed to be worked on to present for the next week. The sprout concept was decided on and preliminary recipes for the sprout and isomalt dome were prepared.

Logbook Week 4

(1) Soil Disk

20g Cocoa Butter

5g Pea Protein

10g Cocoa Powder

10g Fructose

Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Mix in other ingredients until it forms a paste. Pour the crumble onto parchment paper. Bake at 160C for 10 minutes. Cool in the fridge for 10 minutes.

(2) Dirt Crumble

20g Cocoa Butter
30g Pea Protein
12.5g Cocoa Powder
16g Fructose

Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Mix in other ingredients. Let cool about 2 minutes until it thickens into a paste. Spread on parchment paper into an oval-like shape. Bake at 160C for 10 minutes. Cool in the fridge for 10 minutes.

(3) Matcha Sprout

200g Cocoa Butter
1g Matcha Powder
5g Fructose

Melt the cocoa butter with a bain-marie technique (metal bowl over a pot of boiling water). Add in the matcha and fructose. Let cool until thick but still fluid. Use a spoon to shape into sprout shapes on parchment paper. Cool in the freezer for 10 minutes. Melt the leftovers again to use as a glue to assemble 2 sprouts to make a 3-dimensional effect.

(4) Sunshine Jam

45g Water
30g Fructose
2g Pectin

Mix Pectin and Fructose together. Bring water to a boil. Slowly incorporate the Pectin-Fructose mixture bit by bit into the water. Bring the mixture back

to a boil and simmer a few minutes until thickened. Mix in citric acid. Pour into a container to cool. Let set in the fridge for 10 minutes.

(5) Roots Cake

30g Potato Starch

9g Wheat Gluten

25g Fructose

8g Albumin

6g Casein Powder

50g Water

2.5g Baking Soda

0.1g Citric Acid

0.1g Cinnamon flavor

~1g Sunflower oil (used to coat the silicone mold)

Mix ingredients together in a bowl using a whisk. Grease the silicone mold with oil. Pour the batter into the mold and bake at 160C for 5 minutes with 30% humidity.

(6) Isomalt Greenhouse Dome

100g Isomalt

Put the isomalt in a pot and bring to a boil. When a clear liquid is formed, let cool until it is thick but fluid. Prepare a metal bowl by covering it in parchment paper. Pour over a prepared bowl. Let sit for 10 minutes at room temperature to cool. Remove from the parchment.

Results

Figure 16: Week 4 - Isomalt Dome



Figure 17: Week 4 - Root Cake



Figure 18: Week 4 - Soil Disk and Dirt Crumble

Soil Disk Dirt Crumble



Figure 19: Week 4 - Matcha Sprout pieces



Figure 20: Week 4 - Sunshine Jam



Figure 21: Week 4 - Final Dish Assembly

(1) Assemble Base **(2) Plating**



(3) Add Sprout **(4) Add Dome**

Discussion

In the last kitchen session, the final dish had to be put together. The cake was made the same way as the previous week, as it was the result of multiple optimizations. The dirt crumble was made using cocoa powder for flavor and color, the higher quantity of solids made exactly the desired texture, which was soft and crumbly. The soil disk, which uses the same recipe as the dirt crumble, was actually a failed attempt. While making the dirt crumble, the cocoa butter was left to cool for too long. As the cocoa butter had cooled, the mixture thickened before enough solids could be added. When baked, the crumble melted into a disk, due to the higher cocoa butter content, creating a solid disk. However, as the texture was interesting and fit well with the concept, it was incorporated into the dish.

The matcha sprout was made using cocoa butter and matcha powder. Unlike the crumble, where a solid, brittle texture was not desired, for the sprout, that was the goal. This is why a high quantity of cocoa butter was used with very little powder. As there was not enough time, the sprout shape was made using a spoon to spread the cocoa butter-matcha mixture on the parchment using a spoon. A piping bag would have been better in making uniform shapes and keeping a thicker consistency. Once cooled, the sprout were very fragile and broke easily during assembly into 3-dimensional shapes. Had they been thicker in texture, they should have been able to maintain their shape better.

Lastly, the isomalt was melted and poured onto a prepared bowl. It cooled and was removed and placed on the dish. Due to its very hard texture, this element was only decorative and could not be eaten. Two domes were made, as the first was poured when it was too cool, resulting in the isomalt not dripping far enough down to cover the curve of the bowl.

It was previously mentioned that the agar-agar gel would be kept and made into flowers. This aspect was omitted due to lack of time.

Sensory data was done very quickly, with a small panel. The results are discussed in the report.

Conclusion

The concept of the dish came together well. While some modifications are still needed in taste, the visual appearance of the dish made a drastic improvement in the last week.