Molecular Gastronomy Academic Report

Vivian Hor | TFCS9025 | 8 May 2023

Lecturer: Roisin Burke

Table of Contents

Introduction

Food Waste and the Environment

Food waste is one of the world's most prevalent challenges. With the increase in population, rapid growth and urbanization along with industrial development and, shifts in lifestyle and economic status, led to the development of a high amount of food waste (Kaur et al., 2020). About one-third of food produced goes to waste, making up 1.3 billion tonnes per year (FAO, 2011).

When food is thrown, resources involved in the growing, processing, and distributing of food goes to waste as well. Furthermore, uneaten food decomposes and releases greenhouse gases that acts as a blanket to trap heat in our atmosphere. The warming atmosphere causes land ice to melt, leading to a rise in sea-level, which can become a threat to our communities in the future (Mississippi State University Extension, n.d.).

As such, an 'Ocean' Pie was created to depict this food waste issue in an abstract and fun way. It was made using a new culinary technique called Note-by-Note.

Note-by-Note Cooking

'Note-by-Note Cooking' and 'Molecular Cooking' uses the fundamentals of Molecular Gastronomy that has become increasingly popular in recent years (Burke et al., 2016). Molecular Gastronomy, created by chemist Hervé This and physicist Nicholas Kurti, can be described as a scientific discipline that combines the technical, artistic, and social components to develop new foods (Zeece, 2020). Conventional food science is largely involved with industrial production, nutrition and food safety, whereas Molecular Gastronomy focuses on the science behind culinary transformation at a molecular level (Barham et al., 2010; Burke et al., 2016).

Molecular Cooking combines scientific laboratory techniques into the kitchen, creating a new way of cooking. Some techniques used are spherification, freezing using liquid nitrogen and sous-vide cooking (Caporaso, 2021).

Note-by-Note cooking does away with utilizing ingredients such as meat, fish, vegetables, and fruits to form a dish, but instead, it uses pure or mixed compounds to assemble shapes, colours, tastes, odours, temperatures, textures, nutritional aspects and so on (This, 2013).

Note-by-Note cooking is said to be more energy efficient and environmentally sustainable compared to traditional cooking. As compounds in their pure form are usually in the form of powders, crystals, or liquids, it requires less energy to transport as compared to traditional food ingredients that is composed of large quantity of water (This, 2014; This, 2016). Furthermore, the pure compounds are so potent that it only requires a small amount when preparing a dish, making them longer lasting.

In this report, the process of developing the 'Ocean' Pie, the molecular science behind the ingredients, and the feasibility of Note-by-Note cooking will be discussed.

Aim and Objectives

Aim

To develop a Note-by-Note dish in accordance with the "Food Waste" theme.

Objectives

- To develop a pie crust, filling and foam using the note-by-note cooking method.
- To analyze the structural properties of each component on a molecular level
- To discuss the Note-by-Note cuisine contribution to food waste.

Materials and Methods

'Sandy' Pie Crust

Ingredients:

Ingredient	Compounds	Quantity	Supplier
Cocoa butter	Palmitic acid, stearica acid, oleic acid	15g	Barry Callebaut
Olive oil	Oleic acid (83%), linoleic acid, palmitic acid	8g	
Orange Colour	Colour: E110	1 drop	Mallard-Ferriere
Red Colour	Colour: E122	1 drop	Mallard-Ferriere
Green Colour	Colour: E102, E131, E211	2 drops	Mallard-Ferriere
Salt	NaCl	0.3g	
Castor Sugar	Sucrose	3g	
Soy lecithin	Soy lecithin 12 DE	0.3	Sosa
Maltodextrin	Maltodextrin 12 DE	15g	Sosa
Chocolate aroma	Pyrazines	1 drop	Sosa
Evocation Coch	Filbertone	2 drops	Iquemusu

Equipment list:

Equipment	Quantity	Supplier
Steel bowl	2	N/A
Hand blender	1	Robot-coupe
Small pot	1	N/A
Weighing scale	1	Brifit

Method:

1. Weigh out ingredients, keeping maltodextrin separate.
2. Melt cocoa butter and olive oil over bain-marie.
3. Once melted, add the colours, flavours and of soy lecithin to the fats.

4. Blend using a hand blender to emulsify.
5. Allow to cool for 10 mins at room temperature in a steel bowl.
6. Add maltodextrin and break into small pieces that resemble soil.

Agar 'Ocean' Pie Filling

Ingredients:

Ingredient	Compounds	Quantity	Supplier
Agar powder	Agarose, agaropectin	1.5g	Sosa
Water	H_2O	120ml	
Castor Sugar	Sucrose	50g	
Citric acid	Citric acid	0.5g	Louis Francois
Lemon peel aroma	Top 3: limonene, β-pinene, γ-terpinene	1 drop	Sosa
Blue colour	Colour: E131	1 drop	Mallard-Ferriere
Cherry powder	Polyphenols	1g	Sosa

Equipment list:

Equipment	Quantity	Supplier
Steel bowl	2	N/A
Vacuum pack bags	1	N/A
Balloon whisk	1	N/A
Vacuum pack machine	1	La Minerva
Weighing scale	1	Brifit
Fridge	1	Electrolux
Small pot	1	N/A
Hand blender	1	Robot-coupe

Method:

1. Weigh out all ingredients.
2. Mix agar-agar powder, sugar and water together using hand blender until fully dissolve.
3. Once dissolved, transfer to a pot, and bring it to boil while whisking.
4. Once boiled, remove from heat and add citric acid, a drop of lemon peel aroma and blue colouring, mixing until it is dissolved.
5. Place agar-agar in a plastic bag and vacuum until air bubbles are eliminated.
6. While it is still warm, add agar-agar into the "pie crust" that is in the muffin tin mould.
7. Sprinkle cherry powder on top.
8. Allow to set in fridge for 30 minutes.

Orange "Waves" Foam

Ingredients:

Ingredient	Compounds	Quantity	Supplier
Egg white powder	Albumin	20g	Sosa
Castor sugar	Sucrose	40g	
Water	H_2O	147g	
Xanthan gum	Glucose, mannose, glucuronic acid	0.5g	MSK
Orange essential oil	d-limonene, linalool, nerol and geranial	1 drop	MSK

Equipment:

Equipment	Quantity	Supplier
Steel bowl	1	N/A
Balloon whisk	1	N/A
Spoon	1	N/A
Weighing scale	1	Brifit

Method:

1. Weigh out all the ingredients.
2. Whisk together all the ingredients except orange flavour until foam is formed.
3. Once soft peaks are formed, add orange flavouring.
4. Take a dollop of foam and put on top of the set gel pie.

Results and Discussion

An 'Ocean' Pie was successfully developed using Note-by-Note cuisine. It is a conceptual way of portraying the rising sea levels, the effect of greenhouse gases caused by food waste, and the waste floating on the sea.

On a deeper level, the dish was made without lemons, oranges and hazelnuts, which could mitigate the occurrence of food loss through the harvesting, processing and transporting of these ingredients. A detailed calculation comparing both methods has yet to be made. It is also unclear if the production of pure compounds produces less waste than the process of obtaining regular ingredients. Furthermore, the introduction of gels and flavourings as food may not be appealing to the present-day consumer, so the feasibility of this method is questionable. This (2014) argued that the same has been done for milk and wheat, where proteins and amino acids were fractionated and sold to consumers, why can't the same be done for fruits and vegetables? Perhaps with time and familiarity, the Note-by-Note approach can become more feasible.

The development process of 'Ocean' Pie spanned across four weeks was recorded in a weekly logbook in Appendix 1. The concept evolved weekly following trial results.

The 'Ocean' Pie was made with the assembly of three components- the pie crust that represents the sand; the cherry powder topped, translucent, blue filling that represents food waste floating on the ocean; and the foam that represents the waves (Figure 1).

The crust was crumbly and had a strong taste of cocoa butter with a small hint of chocolate and hazelnut. The pie filling was firm and tastes like fresh lemon. The foam melted in the mouth and tastes of sweet oranges.

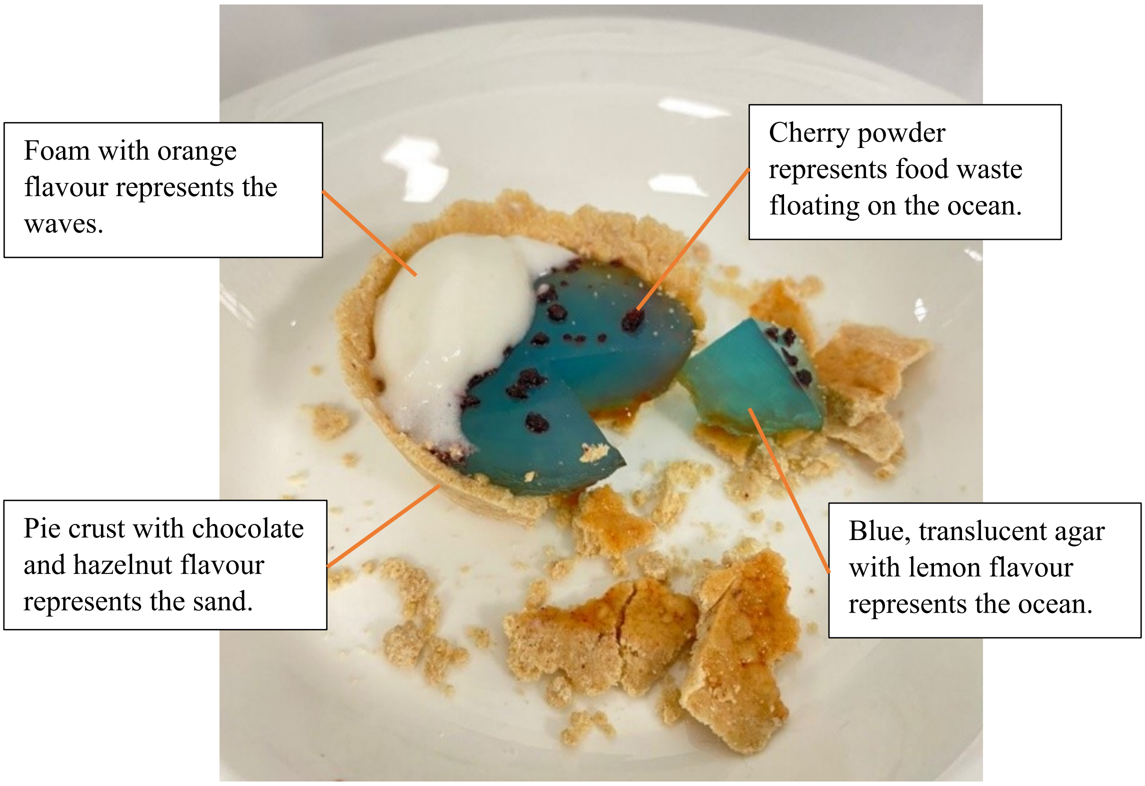

Figure 1 Final product of 'Ocean' Pie.

'Sandy' Pie Crust

Maltodextrin was added to liquid fat to create crumbs for pie crust as it can absorb fat and turn it into powder.

Maltodextrin is a polysaccharide produced from starches through partial hydrolysis. It is typically used to improve powdery appearance and encapsulate flavour, among other functions (Marcus, 2019).

The recommended proportion was 40% maltodextrin to 60% fat (Gisslen, 2014). In the initial trial, the proportion was 20% maltodextrin to 80% fat, which explains

Figure 2 Pie crust that resembles sand.

why it was still a paste and not a powder. When the maltodextrin was added to 40%, a powder form was achieved (Figure 2).

Agar 'Ocean' Pie Filling

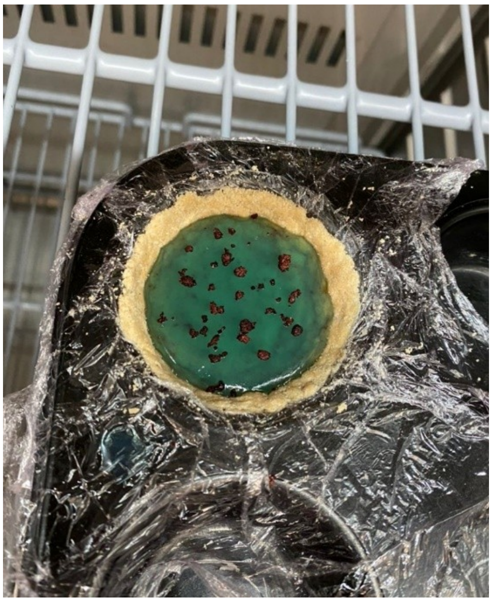

Figure 3 Agar in pie crust before setting.

Agar was selected to be used as the 'ocean' pie filling due to its translucent properties that resembles water when tainted blue, especially before setting (Figure 3).

Agar is a gelatinous polysaccharide derived from seaweed. Its properties are like gelatin hence, making it a good substitute for the animal-based gelling agent in plant-based foods. It is made up of two polysaccharides- agarose and agaropectin (Zeece, 2020). Agarose is the gelling fraction of agar, consisting of chains of repeating alternate units of ß-1,3-linked- D-galactose and a-1,4-linked 3,6-anhydro-L-galactose. The latter is the non-gelling fraction.

Agarose has a helical structure which aggregates to form a three-dimensional network to hold water. Agar must be brought to a boil to fully be hydrated. Upon cooling, the gelation of agar occurs by coil-to-helix transition, followed by the aggregation of helices to form a network structure through hydrogen bonds with water molecules (Figure 4) (Tako et al., 2014).

Agar gels can start to form at 32°C to 40°C, at concentrations of 0.5% to 1.0%. With the addition of sucrose, the gel texture will be harder but less cohesive (Lahaye and Rochas, 1991). This was also observed during the making of Agar 'Ocean' Pie Filling. The agar firmed up far quicker when sucrose was added compared to when no sucrose was added.

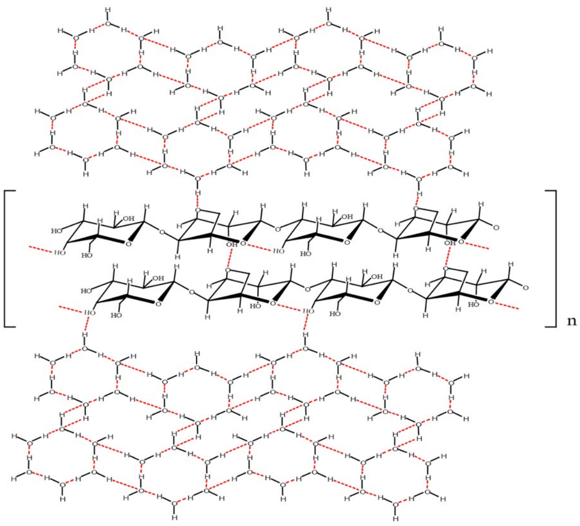

Figure 4 Gelling agarose in water molecules. The dotted lines indicate hydrogen bonding (Tako et al., 2014).

Orange 'Wave' Foam

A foam is a two-phase system consisting of air pockets encapsulated within a thin continuous liquid layer. Some common protein foaming agents include egg white, gelatins, casein, other milk proteins, soy proteins, and gluten (Zayas, 1997).

Egg albumen was the selected protein to make the Orange 'Wave' Foam, as it has excellent foaming properties. When air is whipped into the egg white, tiny air pockets are captured in the thin layer of egg protein that contains hydrophilic and hydrophobic ends. The whisking process unravels the proteins, causing the hydrophilic groups to rearrange towards the water-phase and the hydrophobic groups towards the air phase. The protein coating of the air pockets is linked together, forming a foam (Lomakina and Mikova, 2006).

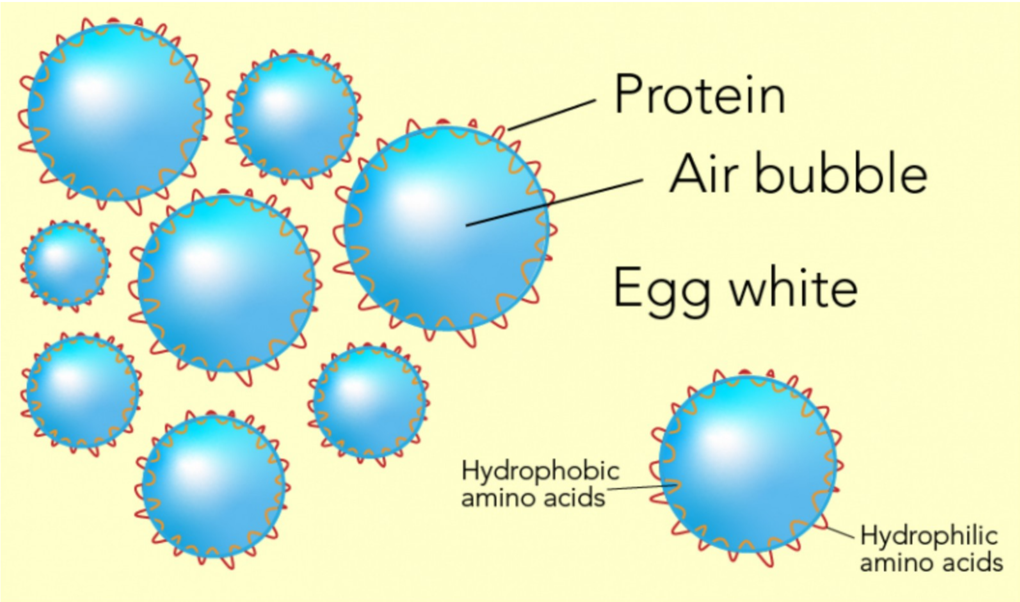

Figure 5 Unfolded proteins coat air bubbles in the egg white, making it more stable. The hydrophilic parts of the protein chains stay in the egg white. The hydrophobic parts surround the surface of the air bubble (Let's Talk Science).

It has been found that addition of sucrose to foam can decrease foam overrun and increase foam stability (Yang and Foegeding, 2010). The addition of sugar to foams resulted in smaller but more abundant bubbles, increasing the stiffness of the foam. Adding acids such as citric or phosphoric acid salts re-shapes bubbles into a hexagon-like shape. Egg white foams made under acidic conditions have better foaming properties with increased volume of approximately 80% compared to foams without acids. There is a synergy effect when acid and sugar are combined in egg foam formation. The foam will have higher number of bubbles while having high stiffness, creating a more stable foam (Bonilla et al., 2022)

Conclusion

An 'Ocean' Pie was successfully developed using Note-by-Note techniques, without using any traditional ingredients. The molecular science behind the creation was analyzed and discussed, with lack of literature found regarding the mechanism of fats absorption by maltodextrin hence, further studies can be done.

There was also not much in-depth literature on the energy use of cooking with compounds compared to using conventional ingredients. Whether or not it can be concluded that Note-by-Note is a more sustainable method, can be further explored.

Reference

Barham, P., Skibsted, L.H., Bredie, W.L., Bom Frøst, M., Møller, P., Risbo, J., Snitkjær, P. and Mortensen, L.M., 2010. Molecular gastronomy: a new emerging scientific discipline. *Chemical Reviews*, *110*(4), pp.2313-2365.

Burke, R., This, H. and Kelly, A.L., 2016. Molecular gastronomy: an introduction. *Reference Module in Food Science*, *1*.

Bonilla, J.C., Sørensen, J.L., Warming, A.S. and Clausen, M.P., 2022. Quantitative image analysis of protein foam microstructure and its correlation with rheological properties: Egg white foam. *Food Hydrocolloids*, *133*, p.108010.

Caporaso, N., 2021. The impact of molecular gastronomy within the food science community. In *Gastronomy and Food Science* (pp. 1-18). Academic Press.

FAO, 2011. Global Food Losses and Food Waste- Extent, Causes and Prevention. Rome, Food and Agriculture Organization of the United Nations.

Gisslen, W, 2014. *Professional Cooking, 8th Edition*. Wiley.

Kaur, J., Rani, G. and Yogalakshmi, K.N., 2020. Problems and issues of food waste-based biorefineries. In *Food Waste to Valuable Resources* (pp. 343-357). Academic Press.

Let's Talk Science. 2019. Meringue: The Science Behind a Wonderfully Fluffy Dessert [online]. Available at: https://letstalkscience.ca/educational-resources/stem-in-context/meringue-science-behind-a-wonderfully-fluffy-dessert#:~:text=Adding%20sugar%20to%20foamy%20egg,the%20bubbles%20even%20more%20stable [Accessed" 7 May 2023].

Lomakina, K. and Mikova, K., 2006. A study of the factors affecting the foaming properties of egg white–a review. *Czech Journal of Food Sciences*, *24*(3), pp.110-118.

Marcus, J.B., 2019. *Aging, nutrition and taste: Nutrition, food science and culinary perspectives for aging tastefully*. Academic Press.

Mississippi State University Extension, n.d. How Does Food Waste Lead to Sea-Level Rise? [online]. Available at: http://extension.msstate.edu/publications/how-does-food-waste-lead-sea-level-rise [Accessed 7 May 2023].

Tako, M., Tamaki, Y., Teruya, T. and Takeda, Y., 2014. The principles of starch gelatinization and retrogradation. *Food and Nutrition Sciences*, *2014*.

This, H., 2013. Molecular gastronomy is a scientific discipline, and note by note cuisine is the next culinary trend. *Flavour*, *2*, pp.1-8.

This, H., 2014. *Note-by-note cooking: The future of food*. Columbia University Press.

This, H., 2016. What can "Artificial Meat" be? Note by note cooking offers a variety of answers. *Notes Académiques de l'Académie d'agriculture de France (N3AF)*, (6), pp.1-10.

Yang, X. and Foegeding, E.A., 2010. Effects of sucrose on egg white protein and whey protein isolate foams: Factors determining properties of wet and dry foams (cakes). *Food Hydrocolloids*, *24*(2-3), pp.227-238.

Zayas, J.F., 1997. *Functionality of proteins in food*. Springer science & business media.

Zeece, M., 2020. *Introduction to the Chemistry of Food*. Academic Press.

Appendices

Appendix 1: Logbooks

MODULE CODE: TFCS 9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: __Vivian Hor____

FOOD PRODUCT: _Peanut Butter Powder Soil_____________________________

WEEK NO.:__ _1_ _____ **DATE:__20/3/2023____**

Aims and Objectives

Aim: To develop first prototype of the concept.

Objective:

- To familiarize myself with ingredients available and processes involved in Note-by-Note cooking.
- To make the peanut butter flavoured "soil" component of my dish.

Materials and Method (Ingredients, Equipment and Method)

Materials:

97g Cocoa Butter
55g Olive oil (70%Oleic acid)
4.2ml orange colour
2 ml red colour
1.5ml green colour
2g Salt
2g Soy lecithin
40g Maltodextrin
2 drops of Hazelnut Flavour

Method:

1. Weigh out ingredients, keeping maltodextrin separate.
2. Melt cocoa butter and olive oil over bain marie.
3. Once melted, add the colours, flavours and 2g of soy lecithin to the fats.
4. Blend in a Thermomix at speed 7 for 2 minutes to emulsify.
5. Allow to cool for 10 mins at room temperature in a steel bowl.
6. Add maltodextrin and break into small pieces that resemble soil.

Results and discussion

The recipe was inspired by the "bacon soil" recipe in the Handbook of Molecular Gastronomy (2021).

59g of olive oil was accidentally added instead of 55g. The product did not turn into powder as it could be due to too much liquid. It could potentially be fixed by adding more maltodextrin, however, there was insufficient time to tweak the product.

Conclusions

Peanut butter powder was not successfully made due to adding slightly too much oil to the recipe.

MODULE CODE: TFCS 9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: __Vivian Hor____

FOOD PRODUCT: _Peanut Butter Soil & Transparent Ravioli__________________

WEEK NO.:__ _2_ _____ **DATE:__27/3/2023____**

Aims and Objectives

Aim: To develop first prototype of the concept.

Objective:

1. To attempt the "soil" again by adding more maltodextrin.
2. To make transparent ravioli.

Materials and Method (Ingredients, Equipment and Method)

SOIL

Materials:

97g Cocoa Butter
53g Olive oil (70%Oleic acid)
4.2ml orange colour
2 ml red colour
1.5ml green colour
2g Salt
2g Soy lecithin
40g Maltodextrin
3 drops of Hazelnut Flavour (Coch)
1.3g chocolate Aroma(Sosa)

Method:

1. Weigh out ingredients, keeping maltodextrin separate.
2. Melt cocoa butter and olive oil over bain marie.
3. Once melted, add the colours, flavours and 2g of soy lecithin to the fats.
4. Blend using a hand blender to emulsify.
5. Allow to cool for 10 mins at room temperature in a steel bowl.
6. Add maltodextrin and break into small pieces that resemble soil.
7. Add 3 g sugar
8. Add 60g malto

TRANSPARENT RAVIOLI

Materials:

250ml Water
1 drops Baked Bread Flavour
0.5g salt
0.6g xanthan gum
2.5g agar-agar
1.3g chocolate Aroma(Sosa)

Figure 6 Whisking agar-agar while boiling.

Method:

1. Take a tray and place it in freezer.
2. Mix all ingredients together, using blender to fully dissolve it.
3. Once dissolved, transfer to pot and bring to boil while whisking (Figure 6).

4. Place agar-agar in plastic bag and vacuum until air bubbles are eliminated.
5. Spread thin layer evenly on ice cold tray that was in the freezer, throwing out any excess liquid to ensure there is no pooling on the tray.

Allow to dry on counter or in fridge (in fridge).

Results and discussion

SOIL

40g of maltodextrin as suggested by original recipe was not enough for it to form a powder. 60g more of maltodextrin was added and it was still pasty. 40g of the paste was separated and 10g more of maltodextrin was added to achieve a powderier consistency. After breaking the pieces, it resembled more of a sandy texture (Figure 7).

Figure 7 Sandy texture after adding more maltodextrin.

TRANSPARENT RAVIOLI

The agar-agar was unable to spread on the frozen tray because it has been left to cool in the bag for too long before being spread thinly on the frozen tray, so it had already started to solidify in the bag. Figure 8 shows the agar clumps.

Figure 8 Agar-agar clumped up.

Conclusions

The peanut butter soil was successfully made with adjustment in the maltodextrin quantity. The agar-agar needed to be spread on the frozen tray while it is hot, or it will start gelling.

MODULE CODE: TFCS 9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: __Vivian Hor____

FOOD PRODUCT: _Food Waste____

WEEK NO.:__ _3_____ **DATE:__17/4/2023____**

Aims and Objectives

Aim: To test spherification and agar-agar.

Objective:

1. To make "pebbles" using reverse spherification of strawberry jam.
2. To attempt to make "fish" and "seaweed" by using agar-agar.

Materials and Method (Ingredients, Equipment and Method)

Pebbles by reverse spherification

Materials:

Sodium alginate bath:

500ml water
2.5g Sodium Alginate (0.5%)

Strawberry jam:

100ml water
3g casein powder
1.5 whey protein isolate
3g sugar
5g strawberry powder
2g calcium gluconate
1 drop passionfruit aroma (Sosa)

Method:

1. To make the alginate bath, in a metal bowl, blend the sodium alginate in 500ml of water using a hand blender until completely dissolved.
2. Transfer the sodium alginate solution to a plastic bag and vacuum the bag of solution until air bubbles are eliminated. Set aside.
3. To make the strawberry jam, weigh out all the ingredients for the strawberry jam.
4. Blend all the ingredients, except the passionfruit aroma, in 100ml of water using a hand blender until dissolved. The consistency should be of thick cream, otherwise, xanthan gum can be added to thicken.
5. Add 1 drop of passionfruit aroma or to taste.
6. Transfer the strawberry jam to a plastic bag and vacuum the bag of solution until air bubbles are eliminated.
7. To make spheres, using a measuring spoon, add the strawberry jam to the alginate bath by dropping the spheres from the top of the alginate bath.
8. Using a slotted spoon, cover the sphere gently to ensure the sphere is completely covered.

9. Let sit in the alginate bath for 2 minutes before removing sphere from alginate bath with a slotted spoon.
10. Rinse sphere in a bath of water.
11. Remove and serve.

Agar-agar fish and seaweed

Materials:

250ml Water
0.6g xanthan gum
2.5g agar-agar

Method:

1. Take a tray and place it in freezer.
2. Mix all ingredients together, using blender to fully dissolve it.
3. Once dissolved, transfer to pot and bring to boil while whisking.
4. Place agar-agar in plastic bag and vacuum until air bubbles are eliminated.
5. While its warm, spread thin layer evenly on ice cold tray that was in the freezer, throwing out any excess liquid to ensure there is no pooling on the tray.
6. Pour another portion into a small plate with a higher lip to create more thickness.
7. Allow the tray and dish to set in the fridge (in fridge).
8. Once the agar-agar sets, cut the thicker agar-agar into a fish shape and the thinner agar-agar into a seaweed shape.

Results and discussion

Pebbles

The Pebbles by reverse spherification failed as the strawberry jam was too runny and did not hold its shape.

Agar-agar fish and seaweed

The agar-agar set well, and shapes managed to be cut out from it. Figure 9 is the cut-out shapes. Colours and flavours can be added to the agar-agar in the next session to provide more sensory appeal.

Figure 9 Agar-agar fish and seaweed

Conclusions

More research needs to be done on the Pebbles by reverse spherification to yield successful spheres. Colours and flavours can be added to the agar-agar to make the “fish” and “seaweed” more appealing.

MODULE CODE: TFCS 9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: __Vivian Hor____

FOOD PRODUCT: __Clear Pie____

WEEK NO.:__ _4_ _____ **DATE:__21/4/2023____**

Aims and Objectives

Aim: To plate and photograph final product.

Objective:

1. To make lemon agar-agar "ocean" as filling for mini pie.
2. To make orange foam to top mini pie.
3. To plate and photograph final product.

Materials and Method (Ingredients, Equipment and Method)

Forming the crust with "sand"

1. Put cling wrap in one muffin hole in a muffin tin.
2. Take "sand" made from previous session and press it against the muffin tin to create a pie crust.

Agar-agar "ocean" pie filling

Materials:

1.5g agar-agar powder
120ml water
50g sugar
0.5g citric acid
Drops of lemon peel aroma (Sosa)
Blue colouring

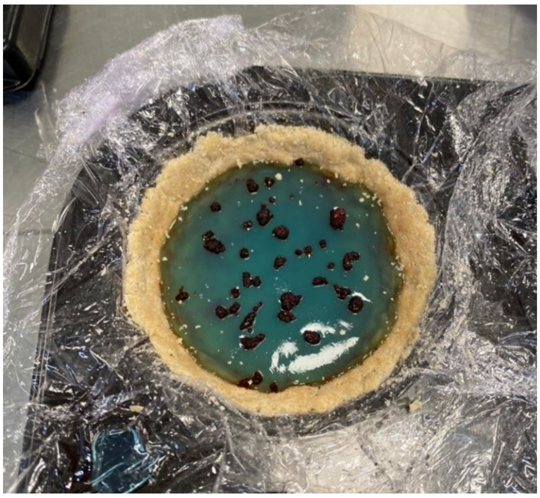

Figure 10 Agar-agar filling in pie crust

Method:

1. Weigh all ingredients.
2. Mix agar-agar powder, sugar and water together using blender to fully dissolve it.
3. Once dissolved, transfer to pot, and bring to boil while whisking.
4. Remove from heat. Add citric acid, a drop of lemon peel aroma and blue colouring. Mix until dissolve.
5. Place agar-agar in plastic bag and vacuum until air bubbles are eliminated.
6. While its warm, add agar-agar to the "pie crust" in the muffin tin mould (Figure 10).
7. Sprinkle cherry powder on top.
8. Allow to set in fridge.

Meringue "waves"

Materials:

147g water
20g egg white protein
40g sugar
0.5g xanthan gum
Drops of orange flavour

Method:

1. Weigh out all the ingredients.
2. Whisk together all the ingredients except orange flavour until foam is formed.
3. Once soft peaks are formed, add orange flavouring (Figure 11).
4. Take a dollop of foam and put it in the set gel pie.

Figure 11 Soft peaks of orange meringue

Results and discussion

The final product is a clear pie representing food waste floating on the ocean.

Conclusions

The final product was successfully plated and photographed (Figure 12).

Figure 12 Final product of clear pie