Molecular Gastronomy: “Breakfast deception”

Note by Note Cooking

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I. Introduction

Molecular Gastronomy is a scientific discipline that looks for the mechanisms of phenomena occurring during dish preparation and consumption (This, 2013). Basic chemistry has been the starting point for new cuisine techniques (Barham, et al., 2010), where food science takes part into using new ingredients to achieve new textures, shapes, or flavors (Burke, This and Kelly, 2016). By the other hand, gastronomy is characterized by tradition, passion, leading chefs even to express their own emotions and visions through the dishes they produce (Barham, et al., 2010). Therefore, it can be said that molecular gastronomy involves producing food with new tools, ingredients, and methods (Traynor, 2013) for example the use of siphons to make foams, ingredients such as sodium alginate and gelling agents to create new textures, and methods such as chocolate Chantilly, *beaumés*, etc. (This, 2013).

One of the applications of molecular gastronomy, is Note-by-Note (Nunn) cooking, which involves preparing dishes using pure compounds (water, saccharides, amino acids, proteins, polyphenols, etc.) or more practically mixture of compounds (This, 2013). As the raw materials are only compounds, the cook designs the dish in all aspects (color, flavor, texture, consistency, etc.) (This and Burke, 2016, pp.810). There are two types of NbN, pure Note by Note cooking and practical Note by Note cooking; for the first one only pure compounds are used (for example: amylose or amylopectin) and the latter uses simple mixtures (starch: amylose 85% and amylopectin 15%) (This and Burke, 2016, pp.810). Nevertheless, this type of cuisine is very novel and still raises concerns regarding nutrition, physiology, and toxicology (This, 2013).

It is known that the use of food additives in common products contributes to the reduction of food waste as they allow to extend food's shelf life (microbiologically and sensory) (Gomes, et al., 2020). Now imagine the impact of using only compounds instead of a whole food matrix, its potential benefits in sustainability are transportation (better to transport dried material than fresh products where it can have +90% water), longer shelf-life (no Aw), less energy (food ingredients with no water can be stored without cold technologies), among others (This and Burke, 2016, pp.810).

According to UN Food and Agriculture Organization (FAO), food can be lost or wasted; food loss refers to the decrease in edible food mass at the production, post-harvest, and processing stages of the food chain (prevalent in developing countries); while food waste refers to the discard of edible foods at the retail and consumer levels (mostly in developed countries) (FAO, 2016).

In a study by Monier et al. (2010), it was found that, approximately 180 kg per person per year (kg/p/y) of food are wasted annually in the EU, where 101 kg/p/y are generated at consumer level (76 kg for households and 25 kg for the food service sector). Meaning that households are the highest contributor to food waste generation. Another study by FUSIONS (Food Use for Social Innovation by Optimizing Waste Prevention Strategies) provided an estimation of food waste generated at European level considering the total food chain of 173 kg/p/y, 21 kg/p/y of which are generated at food service and 92 kg/p/y by households (Stenmarck et al., 2016). Differentiating in between product categories, Vanham et al., 2015 found that the categories of fruit and vegetables are together responsible for 63% of the food waste generated.

Although, as mentioned before NbN cooking by itself can aid into reducing food waste, another strategy might be by "reusing" the waste. In this regard, along with pure compounds banana peels were used in this project as an ingredient.

Every day, tons of banana peel are wasted in fruit markets and in households, at the same time, peels are also being discarded industrially, when bananas are processed into banana flour, chips, and other good biomass (Zaini et al., 2022). What's being wasted apparently, it's of "no value", but banana peels can offer high dietary fiber and phenolic compounds. It is important to mention, that they also contain several anti-nutritional factors such as tannins, oxalate and phytate (Arslan and Ozcan, 2010), nevertheless most of these can be eliminated through processes such as heat treatment (Zaini et al., 2022). Nowadays, products such as chicken sausage, chicken patties, cookies and edible food wrapper are being developed with peels to increase fiber, protein, and phenolic content (Zaini et al., 2022; Devatkal et al., 2014; and Santhoskumar, et al., 2019).

II. Aims & Objectives

Having the topic of "Food Waste" as a brief, the objective of this project was to create a dish following Note by Note cooking and redesigning the banana peel as a potential ingredient in day-to-day products.

Specific objectives are:

- Including the food waste topic in the dish (by integrating the banana peel).
- Have at least 80% of pure compounds in the recipe (as close as possible to pure Note by Note).

III. Materials & Methods

The dish is divided in three elements: the egg yolk (mango spheres), the egg whites (marshmallow foam), and pieces of bacon (banana peal caramelized). Some of the recipes are adaptations from other authors (mango sphere, marshmallow foam) and other are new recipes created for this project (mango juice, caramelized banana peel).

a. Ingredients

From table I to V the formulation of each element can be found. The following list includes the ingredient used as well as supplier.

- Lyophilized mango - Sosa Ingredients
- Xanthan gum – En-Placee Foods UK
- Calcium Chloride: MSK Ingredients
- Vanilla flavor - Euro Vanille
- Glucose syrup (Belgogluc CF-81) – BELGOSUC
- Dietary Fiber Cellulose – NutriCology®
- Albumin Powder – Sosa Ingredients
- Cinnamon Ground – Schwartz ™

- Sodium Alginate - MSK Ingredients

Table I. Mango Juice Formulation

Mango juice	**%**
Water	68%
Sugar	27%
Xanthan gum	0.34%
Lyophilized mango	4%

Table II. Mango Spheres Formulation (Egg yolk).

Mango Spheres	**%**
Calcium lactate	1.6%
Water	16.4%
Mango Juice	82%

Table III. Alginate Bath Formulation

Mango Spheres (alg. Bath)	**%**
Sugar	86.1%
Water	13%
Sodium Alginate	0.9%

Table IV. Marshmallow Foam Formulation (Egg whites).

Marshmallow foam	**%**
Water	47.1%
Xantham gum	0.3%
Cellulose	0.3%
Vainilla	0.8%
Salt	0.5%
Albumin	1.0%
Powdered sugar	50%

Table V. Banana Peel Formulation (Bacon).

Caramelized banana peel	**%**
Banana peel	53.0%
Glucose	37.9%
Cinnamon	3.0%
Vainilla	6.1%

b. Materials and equipment

- 5 small stainless-steel bowl
- 2 medium stainless-steel bowl
- 2 large stainless-steel bowls
- 1 stainless steel baking tray
- 1 spoon
- 1 whisk
- 1 small pot
- 1 perforated spoon
- 1 ice mold (spherical)
- Electrolux gas hob
- Oven Electrolux Professional, SkyLine Premium Electric Combi Oven 10GN1/1
- Weight scale, Etekcity model EK9000
- Mixer Chambers Engineering Dublin with whisk
- Robot coupe® R 2
- Freezer and Fridge Electrolux

c. Methodology (dish)

1. *Mango juice*

All the ingredients mentioned in Table I were weighted separately in stainless-steel bowls in the scale Etekcity model EK9000. The sugar and water were mixed in the Robot coupe® R 2 for 30 seconds. Once these ingredients were homogeneously mixed, slowly xanthan gum was added, and everything was mixed again for 30 – 60 seconds (making sure the mixture was lump free). Finally, the lyophilized mango was added into the Robot coupe® R 2 and it was further mixed for 30 seconds (see figure 1 in results section).

2. *Mango spheres and alginate bath*

To form the mango spheres, first the calcium lactate was weighted in a small stainless-steel bowl. The water was weighted in a small pot and then place into low heat in the hob for 3 minutes. The calcium lactate was added and mixed with a whisk till it was fully dissolved (around 5 minutes). The mixture was removed from the heat, and it was left to cool down for 10 minutes. Finally, the necessary mango juice according to the formulation (table II) was weighted and added to the water with calcium lactate to be further mixed till achieve a homogeneous liquid (30 – 60 seconds).

Once the mixture was ready, it was poured into a spherical ice mold, and it was placed in the freezer (-18°C) for 2 hours. While the spheres were in the freezer, the alginate bath was prepared according to the formulation shown in table III in a big stainless-steel bowl. The mixture was placed in a vacuum bag and was vacuumed 3 times to eliminate the bubbles. After this process, the mixture was placed in the fridge (4°C) till its use.

When the mango spheres were completely frozen (figure 2), they were placed in the alginate bath for 3 minute (figure 3) with a spoon, then they were rinsed in a medium stainless-steel bowl with water. This step was done when all the other elements (egg whites and bacon) were ready to be able to place the egg yolk in the dish.

This recipe apart from the mango juice, was adapted from Thomas Keller (2008).

3. *Marshmallow foam*

This methodology was adapted from Martin Lersch (2014) – who uses the same ingredients except for albumen. All ingredients were weighted separately in small stainless-steel bowls. First, the cellulose was dispersed in half the amount of water weighted and it was left in the fridge for 30 minutes to allow hydration. In another small stainless-steel bowls, the xanthan gum was mixed with the remaining water (if lumps remain the suggestion is to mix it in the Robot coupe®.

After 30 minutes of leaving both ingredients to hydrate, they were poured in a stand mixer (Chambers Engineering Dublin) and the mixture was whisked for 30 seconds. The vanilla and salt were added and mixed in medium speed for 1 minute. After this step, sugar was added little by little and finally the albumen was added. Everything was mixed at medium-high speed for 3-5 minutes (till achieving a dense and elastic white foam) (figure 5).

The foam was stored in a fridge at 4°C till the other elements of the dish were ready.

4. *Caramelized banana peel*

Using a knife, the pulp from the banana peel was scraped and discarded. The peels were weighted and placed in a baking tray with baking paper. The cinnamon and vanilla were weighted in a small stainless-steel bowl. Then, the glucose syrup was weighted in a small pot and was heated over low heat in a hob, while continuously mixing with a small spatula. The vanilla and cinnamon were added to the pot and mixed till it was a homogeneous mixture. After this, the glucose mix was poured into the banana peels till they were fully coated. The tray was placed in the oven at 170°C for 15 minutes. After this time, the tray was removed from the oven and the banana peel was left to cool down till its use (figure 5).

5. *Serving the dish*

Once all the elements were ready, the dish was prepared by first getting the marshmallow foam from the mixer bowl with a spoon. 100 grams of the foam were served in a plate, and with the spoon a “well” in the middle was created, to be able to place there the mango sphere. Once the foam was ready, the process of spherification with the alginate bath (as described in step 2) was carried and the mango sphere was placed in the well of the foam. Finally, the banana peel was positioned around the foam (15 grams). The final dish is called breakfast deception because the appearance emulates fried egg with bacon, but all the elements are sweet (see figure 6).

d. Colorimetry

Colorimetry parameters of all the elements were taken with the “Colorimeter App”. The red, green, and blue values were converted to L*, a*, b* with the website Nix™ Color Sensor.

IV. Results

From figure 1 to 6 the development process of each element is graphically demonstrated. All the elements did achieve the visual appearance required to emulate an egg yolk (mango sphere), egg white (marshmallow foam) and bacon (caramelized banana peel). Table VI includes the colorimetry result of each element. These outcomes will be discussed in the following section.

Figure 1. Mango Juice.

Figure 2. Mango spheres.

Figure 3. Spherification process.

Figure 4. Marshmallow foam.

Figure 5. Caramelized banana peel.

Figure 6. Finished dish.

Table VI. Colorimetry results

	Egg yolk (mango sphere)	Egg whites (marshmallow foam)	Bacon (banana peel)
L*	50.80 ± 2.72	95.3 ± 0.75	15.49 ± 8.64
a*	3.12 ± 1.83	-1.88 ± 0.78	16.80 ± 1.99
b*	56.2 ± 2.18	1.2 ± 1.68	21.50 ± 10.63

V. Discussion

The dish breakfast deception was successfully created, and the elements do emulate fried eggs and bacon. This can be perceived by its visual appearance and color values. The texture of the dish was achieved thanks to the additives used such as xanthan gum, sodium alginate, calcium lactate and cellulose. In table VII the functional properties of each ingredient in its dish are described.

Table VII. Raw materials functional properties

Ingredient	Product	Functional properties
Xanthan gum	Mango Juice and Marshmallow foam	Textural properties (gives viscosity and shear-thinning behavior).[1]
Lyophilized mango	Mango Juice	Provided flavor, aroma, and color.
Sugar	Mango Juice	Provided sweetness and textural properties (viscosity).[2]
Calcium lactate + sodium alginate	Mango sphere	Textual properties (thermoirreversible gel in presence of calcium ion) This mix is used to create spherification. [1]
Cellulose	Marshmallow foam	Textual properties (helps form and stabilize foams when cold). [1]
Albumin	Marshmallow foam	Textural properties (protein denatures when whipping, leading to a foam). [3],[4]
Powdered sugar	Marshmallow foam	Textural properties (sugar facilitate the creation of bubbles and increases volume of foam)[4] and flavor (sweetness).[4]
Glucose syrup	Caramelized banana	Sweetness and allows caramelization reaction.[3]
Vanilla	Marshmallow foam and caramelized banana	Provides flavor.[3]
Cinnamon	Caramelized banana	Provides flavor and color. [3]

[1]Lersch, M. (2010). Texture–A hydrocolloid recipe collection. (v.3.0, 2014).
[2]Badui Dergal, S. (2006). *Química de los Alimentos.* 4th Ed. Mexico: Pearson.
[3]Badui Dergal, S. (2012). *La ciencia de los Alimentos en la práctica.* 1st Ed. Mexico: Pearson. P.241
[4]Sari, B.W., Hayuningtyas, A., Jitphongsaikul, P., Chherti, V. and Hamad, A. (2022). Effects of Emulsifier Type and Ingredient on the Foam Stability of Meringue. Research In Chemical Engineering (RiCE), 1(2), pp.64-69.

To ensure that the additives were used according to the authorized limits, the Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives was reviewed. The additives: E 327 (calcium lactate), E 401 (sodium alginate), E 415 (xanthan gum), E 460 (cellulose) have a *quantum satis* limit. This means that no maximum numerical level is specified, and substances shall be used in accordance with good manufacturing practice, at a level not higher than is necessary to achieve the intended purpose and provided the consumer is not misled (EC Regulation 1333/2008).

The mango spheres were created through frozen reverse spherification, this process consists of shaping a liquid (mango juice with calcium lactate) into a sphere using sodium alginate bath (Sen,

2017). The process happens through gelation, sodium alginate is a polysaccharide obtained by the binding of sodium ions (Na^+) to the carboxy group of alginate (Yuasa et al., 2019). In the absence of divalent ions (i.e., Ca2+, Mg2+) alginates only improves the viscosity of a solution; but in the presence of divalent ions, especially calcium, they form strong gels (Lee and Rogers, 2012). In this case the process of spherification was based on an ion-exchange reaction between Na^+ and $Ca^{(+2)}$ where they form a salt bridge (egg-box model), responsible for the "skin" or outer gel layer of the spheres (Lee and Rogers, 2012) (see figure 7).

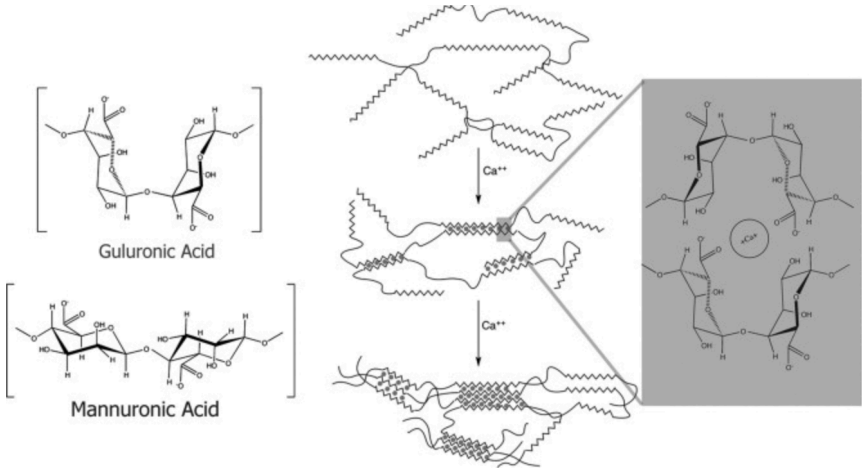

Figure 7. Chemical structure representation of the divalent ion salt bridge.
Source: Lee and Rogers, 2012

As shown in the Appendix A, logbook 1, as the spheres were meant to resemble an egg yolk, without using a spherical mold the shape of the gel was not regular. It was needed to add a preforming step, which ended up being freezing the mango juice for 2 hours to be able to have a regular shape. After dropping the mango sphere into the alginate bath, a thin coat of gel formed around the ball as the calcium reacted with the sodium alginate.

The egg yolk values for L* (lightness) was 50.80 ± 2.72, a* (red-green color) 3.12 ± 1.83 and b* (blue-yellow color) 56.2 ± 2.18, meaning that the spheres were light in color, towards yellowness based on the color scale. This might be attributed to the carotenoids in mango, which have red, orange, and yellow pigment (Rodriguez-Amaya, 1999). Low and Pui (2020) found colors L* in a range from 50.59 to 54.77 in mango spheres done by frozen reverse spherification, being in accordance with the result obtained (50.80 ± 2.72). The values for a* and b* are also in accordance with the obtained as they range from 5.52 to 7.57 and 45.49 to 51.22 respectively. These results are comparable with real egg yolk colorimetry where L*, a*, b* were found at 54.67±0.54, -2.18±0.14 and 45.07±0.55 respectively (Landers, et al., 2005) and 59.2±1.6, 0.70±1.35 and 47.4 ± 1.65 (Spasevski, et al., 2018).

Low and Pui (2020) also found that the peak force of the compression cycle (force necessary to break the gel structure,) which is the firmness of the jelly sphere, ranged from 14.33g to 30.00g. When the time of immersion in the sugar and alginate bath was shorter (5 minutes), the peak force was smaller. Also, the results of a longer immersion time in sugar lead to harder and more elastic spheres. In this case the mango spheres where immersed for only 3 minutes, therefore lower values for peak force and elasticity are expected.

To create the marshmallow, foam the whipping process and ingredients like powdered sugar and albumin were needed (table VII). During the whipping process the albumin denaturalizes, allowing the hydrophobic groups to stand up on the surface, this directly affects the entrance of the air into the network, structure, and mouthfeel of the final product (Mardani et al., 2022). This aeration process it's stabilized with the powdered sugar, which facilitates the process and increases the volume of the foam (Sari et al., 2022). The xanthan gum and cellulose were added to provide more viscosity and to stabilize the foam respectively.

Mardani et al. (2022) studied the effect of albumin on marshmallow foam. They tested concentrations from (0.1–0.9%) and found that it plays a very important role as the correlation between albumin concentration and viscosity was positive and negative for bubble size (smaller bubbles and more homogeneous texture). At the same time, Nepovinnykh et al. (2018) found that creating a synergy of hydrocolloids (xanthan gum / carob bean gum) helps to increase elasticity and shape retention. As the formulation used contains a similar percentage of albumin (1%) than Mardani et al. (2022) and it also includes a synergistic hydrocolloid (xanthan gum and cellulose) it can be suggested that the foam created would have similar viscosity and elastic results; nevertheless, the mixing time can also influence those values. Even though micrographs of the product were not taken, figure 8 includes those obtained by Mardani et al. (2022) for illustration purposes. For future research it would be enriching to test these parameters to evaluate its effect on the foam.

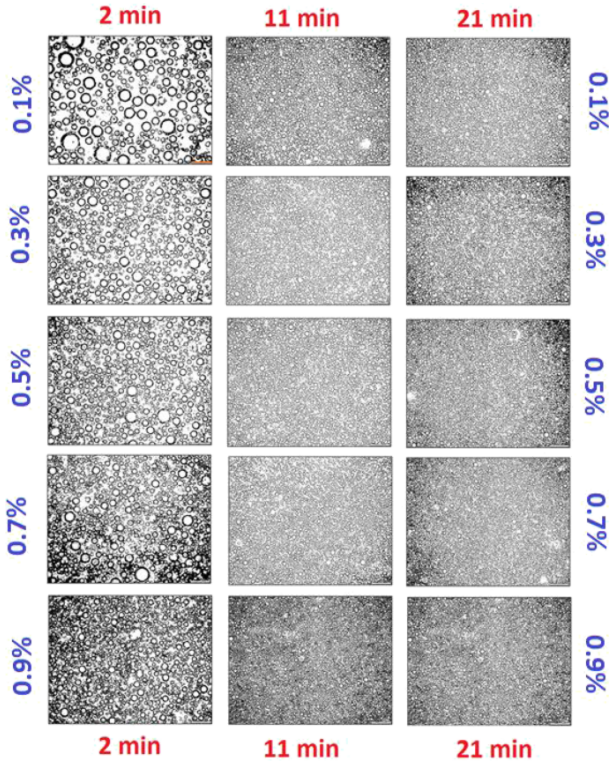

Figure 8. Effect of albumin concentration on light micrographs of marshmallow dough produced at 750 RPM on rheometer at different time periods.

Source: Mardani et al, 2022.

Percentage in blue = albumin concentration, time in red = mixing time.

The foam had a value of L* 95.3 ± 0.75, a* -1.88 ± 0.78 and b*1.2 ± 1.76, meaning that the predominant color is white. These values are in accordance with those found by Ozcan et al. (2022) with L* of 90.96 ± 0.22, a* 5.15 ± 0.04 and b* 8.09 ± 0.06. At the same time, these values agree with real egg white colorimetric parameters, which range from L* 95.52, a* -1.68 and b*1.56 (obtained also with colorimetry app with real fried egg).

Figure 9. Banana peel with glucose syrup, cinnamon, and vanilla mixture.

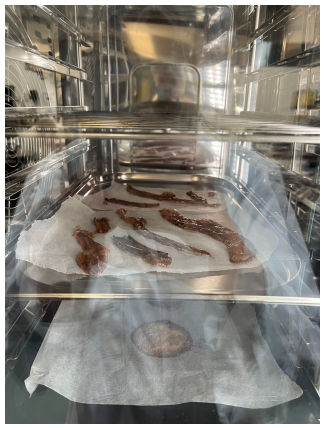

Figure 10. Baking procedure.

Figure 11. Final banana peel bacon.

The banana peel as caramelized bacon is a new recipe. The glucose syrup was added to give a sweet flavor and to get the caramel which surrounded the peel, and which gave attributes (color) that helped to obtain the bacon-like appearance. This is due to the caramelization process which takes part at temperatures above 160°C, where sugar turns into a yellow liquid which changes in color with the rise of temperature, producing chemical reactions which gives polymeric pigments such as melanoidins (brown pigments) (Badui, 2012). The caramelized banana had colorimetric values of L*, a*, b* of 15.49 ± 8.64, 16.80 ± 1.99 and 21.50 ± 10.63 respectively. The color of the cooked banana peel is darker than real bacon, nevertheless the color of the caramel had values of L* 43.06, which is similar than L* for real bacon (32.76). This means that the peel by itself was not visually comparable to bacon, but in conjunction with glucose syrup this might be achieved.

During the heating process, the banana peel also dehydrated, reduced in size, and change its form (shrink) (figure 9-11). These changes allowed the peel to resemble a piece of bacon. At the same time, the use of glucose syrup and the dehydration of the peel gave the product a brittle texture.

Finally, for setting the dish (figure 12) all the elements were placed on the plate as described in the methodology. As mentioned through the report, it resembles fried egg and bacon but the ingredients such as lyophilized mango, sugar, vanilla, cinnamon, and powdered sugar make the dish sweet, converting it into a breakfast deception. The idea of creating the dish as a breakfast, it's to create awareness on how any common dish such as breakfast, can be prepared more sustainable. It's possible that consumers won't have the same ingredients at home, but it may serve

as a source of inspiration and to foster creativity to reuse common waste such as banana peels. The dish is sweet to represent that even though there's a huge food waste problem, there's still hope.

Figure 12. Final dish: *"Breakfast deception".*

VI. Conclusion & Recommendations

The produced dish had the desired attributes for texture, color, and flavor. The ingredients used allowed to create the appropriate structures such as gel or foam. At the same time, they were used in accordance with Regulation (EC) No 1333/2008 on food additives. In this way, molecular gastronomy, specifically Note by Note cooking proved to be a powerful tool to create products of any shape, flavor, texture out of pure compounds.

The objectives of the project were met as the topic of food waste was included in the dish and the banana peel successfully proved to be a versatile ingredient which can be further explored for other type of recipes at home or for the creation of food products. It is a source of fiber and antioxidants that nowadays is discarded as trash and has a lot of potential for the cuisine and food industry. On the other hand, NbN also proved its efficacy on creating a dish out of pure compounds, this kind of desserts may be recreated with less energy if the ingredients transported are dried powder and don't need refrigeration for storing.

This project was a good exercise to foster creativity and to think out of the box solutions for the way we create food.

VII. References

Arslan, D., and Özcan, M. M. (2010). Study the effect of sun, oven and microwave drying on quality of onion slices. *LWT-Food Science and Technology, 43*(7), 1121–1127.

Badui Dergal, S. (2006). Química de los Alimentos. 4th Ed. Mexico: Pearson.

Badui Dergal, S. (2012). La ciencia de los alimentos en la práctica. 1st Ed. Mexico: Pearson. p.241

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. Doi: http://doi.org/10.1021/cr900105w

Burke, R., This, H. and Kelly, A.L., 2016. Molecular gastronomy: an introduction. *Reference Module in Food Science*, *1*. Doi: http://dx.doi.org/10.1016/B978-0-08-100596-5.03384-9

Devatkal, S. K., Kumboj, R., & Paul, D. (2014). Comparative antioxidant effect of BHT and water extracts of banana and sapodilla peels in raw poultry meat. *Journal of food science and technology, 51(*2), 387–391.

EC Regulation 1333/2008 REGULATION (EC) No 1333/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008 on food additives.

Food and Agriculture Organization of the United Nations (FAO) (2013). *Summary Report: Food wastage footprint impacts on natural resources*. [Online] Available at: https://www.fao.org/3/i3347e/i3347e.pdf [Accessed 3 May 2023].

Stenmarck, Å., Jensen, C., Quested, T. and Moates, G. (2016). Estimates of European food waste levels. FUSIONS. [Online] Available at: https://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf

Gomes, L.R., Simões, C.D. and Silva, C. (2020). Demystifying thickener classes food additives though molecular gastronomy. *International Journal of Gastronomy and Food Science, 22*, p.100262. Doi: https://doi.org/10.1016/j.ijgfs.2020.100262

Keller, T., 2008. *Under pressure: cooking sous vide*. Artisan Books.

Landers, K.L., Howard, Z.R., Woodward, C.L., Birkhold, S.G. and Ricke, S.C. (2005). Potential of alfalfa as an alternative molt induction diet for laying hens: Egg quality and consumer acceptability. *Bioresource Technology, 96*(8), pp.907-911

Lee, P. and Rogers, M.A. (2012). Effect of calcium source and exposure-time on basic caviar spherification using sodium alginate. *International Journal of Gastronomy and Food Science, 1*(2), pp.96-100. Doi: https://doi.org/10.1016/j.ijgfs.2013.06.003

Lersch, M. (2010). Texture–A hydrocolloid recipe collection. (v.3.0, 2014).pp.95.

Low, Y.L. and Pui, L.P. (2020). Optimization of mango-pineapple jelly sphere production by frozen reverse spherification using a full factorial design. *Acta Scientiarum Polonorum Technologia Alimentaria, 19*(2), pp.207-218.

Mardani, M., Kilicli, M., Toker, O.S., Yeganehzad, S., Niazmand, R., Palabiyik, I. and Konar, N. (2022). Investigation of process parameters and albumin concentration as foaming agent on quality of marshmallow dough: production simulation with rheometer. *Rheologica Acta, 61*(4-5), pp.339-351.

Monier, V., Mudgal, S., Escalon, V., O'Connor, C., Gibon, T., Anderson, G., Morton, G. (2010). Preparatory study on food waste across EU 27. *Report for the European Commission (DG ENV – Directorate C) BIO Intelligence Service (BIOIS*), Paris.

Nepovinnykha, N.V., Klyukinaa, O.N., Kodatskiya, Y.A., Ptichkinaa, M.P., and Yeganehzadb, S. (2018). Study of the stability of foam and viscoelastic properties of marshmallow without gelatin. *Foods and Raw materials, 6*(1), pp.90-98.

Ozcan, Y., Icyer, N.C., Ozmen, D. and Toker, O.S. (2022). Effect of soapwort extract as an alternative to albumin on the physical, textural, sensory, and rheological properties of marshmallow. *Journal of Food Processing and Preservation, 46*(11), p.e16931.

Rodriguez-Amaya, D. B. (1999). Changes in carotenoids during processing and storage of foods. Arch. Latinoam. *Nutr., 49(*3 Suppl. 1), 38S–47S.

Santhoskumar, A. U., Vaishnavi, R., & Karunakaran, T. (2019). Studies on mechanical properties and biodegradation of edible food wrapper from banana peel. Asian J. *Adv. Basic Sci, 7*(2), 01–04.

Sari, B.W., Hayuningtyas, A., Jitphongsaikul, P., Chherti, V. and Hamad, A. (2022). Effects of Emulsifier Type and Ingredient on the Foam Stability of Meringue. *Research In Chemical Engineering (RiCE), 1*(2), pp.64-69.

Sen, D.J. (2017). Cross linking of calcium ion in alginate produce spherification in molecular gastronomy by pseudoplastic flow. *World Journal of Pharmaceutical Sciences*, pp.1-10.

Spasevski, N., Puvača, N., Pezo, L., Tasić, T., Vukmirović, Đ., Banjac, V., Čolović, R., Rakita, S., Kokić, B. and Džinić, N. (2018). Optimisation of egg yolk colour using natural colourants. *European Poultry Science*, 82.

This, H. (2013). Molecular gastronomy is a scientific discipline, and note by note cuisine is the next culinary trend. *Flavour 2*, 1. Doi: https://doi.org/10.1186/2044-7248-2-1

This, H. and Burke, R. (2016). “Note by Note Cooking and Note by Note Cuisine”. In: Handbook of molecular gastronomy: scientific foundations, educational practices, and culinary applications. Crc Press. P.810

Traynor, M. (2013). *Innovative food product development using molecular gastronomy: a focus on flavour and sensory evaluation. Doctoral thesis.* Technological University Dublin. doi:10.21427/D7BG85

Vanham, D., Bouraoui, F., Leip, A., Grizzetti, B., Bidoglio, G., 2015. Lost water and nitrogen resources due to EU consumer food waste. Environ. Res. Lett. 10. https://doi.org/10.1088/1748-9326/10/8/084008.

Yuasa, M., Tagawa, Y. and Tominaga, M. (2019). The texture and preference of “mentsuyu (Japanese noodle soup base) caviar” prepared from sodium alginate and calcium lactate. *International Journal of Gastronomy and Food Science,* 18, p.100178. Doi: https://doi.org/10.1016/j.ijgfs.2019.100178

Zaini, H. B. M., Sintang, M. D. B., & Pindi, W. (2020). The roles of banana peel powders to alter technological functionality, sensory and nutritional quality of chicken sausage. Food Science & Nutrition, 8(10), 5497–5507.

VIII. Appendices

Appendix A: Logbook

I.I Logbook 1: Evaluation of initial formula

MODULE CODE: TFCS9025
MODULE TITLE: Advanced Molecular Gastronomy
STUDENT NAME: Karen Trevino
FOOD PRODUCT: Breakfast deception
WEEK NO.: 1 **DATE:** 20/03/23

Weekly Aims and Objectives

- First trial of molecular gastronomy project.
- Create recipe of orange juice note by note.
- Encapsulate orange juice with sodium alginate (egg yolk).
- Try to do foam as egg whites.
- Bake banana peels with glucose syrup to make "caramelized bacon"

Materials and Method (Ingredients, Equipment and Method):

Table VIII. Formulation logbook 1

Mango Juice	%
Water	68%
Sugar	27%
Xanthan gum	0.34%
Liophilized mango	4%
Mango Sphere	
Calcium lactate	1.6%
Water	16.4%
Mango juice	82.0%
Alginate bath	
Water	86.1%
Sugar	13.0%
Sodium alginate	0.9%
Marshmallow foam	
Water	48.9%
Xantham gum	0.3%
Methyll Cellulose	0.3%
Vainilla	0.8%
Salt	0.8%
Powdered sugar	48.9%

Banana peel syrup	
Glucose syrup	86.2%
Cinnamon	6.9%
Vainilla	6.9%

Equipment

- 5 small stainless-steel bowl
- 2 medium stainless-steel bowl
- 2 large stainless-steel bowls
- 1 stainless steel baking tray
- 1 spoon
- 1 whisk
- 1 small pot
- 1 perforated spoon
- 1 ice mold (spherical)
- Electrolux gas hob
- Oven Electrolux Professional, SkyLine Premium Electric Combi Oven 10GN1/1
- Weight scale, Etekcity model EK9000
- Mixer Chambers Engineering Dublin with whisk
- Robot coupe® R 2
- Freezer and Fridge Electrolux

Process Mango Juice:

1. Weight all ingredients separately.
2. Mix sugar and water in robotcoupe.
3. Add xanthan gum slowly making sure the mixture is lump free.
4. Add lyophilized mango and mix.
5. Place aside.

Mango sphere:

1. Weight calcium lactate.
2. Add to the 50ml of water and heat gently to dissolve the lactate
3. Add mango juice.

Alginate bath

1. Create alginate bath by combining sugar and alginate whisk into water and all to hydrate for 10 minutes.
2. Drop the mango mixture into alginate bath using spoon remove after 2 minutes.
3. Remove into water and wash of solution.

Results and discussion

- This first week I only had time for doing the mango juice and the mango spheres as the session was shorter.

- I did two trials, first one I used orange colorant and the juice turned out almost red (see figure 13).
- Second trial I did not use any colorant and the juice was better in appearance (see figure 14), nevertheless it seems the mixture was to liquid because I couldn't form the mango spheres (figure 15).
- For next session I will try frozen reverse spherification, in which I will pour the mango juice with calcium lactate in spherical ice tray and froze 1 hour at least, after that I will do the spherification with sodium alginate.

Figure 13. 1st trial mango juice.

Figure 14. 2nd trial mango juice.

Figure 15. 1st trial of spherification.

Conclusions

- Do not use colorant for mango juice as it's too intense for small batches.
- As the sphere must resemble egg yolk size, try frozen spherification to be able to maintain product form.

Recommendations for following week.

- Do frozen reverse spherification: pour calcium lactate mixture with juice in ice tray and freeze one hour before doing the spherification.
- I will reduce the percentage of mango juice in the calcium lactate bath (table IX).

Table IX. Mango sphere reformulation

Ingredient (mango sphere)			%
Calcium lactate	5	g	2.4%
Water	50	g	24.4%
Mango juice	150	g	73.2%

- I am going to start with the freezing step to be able to freeze it in class and use it later.
- After this, I am going to hydrate the methyl cellulose and leave it in fridge for 30 minutes.

- While both things happen, I am going to remove the pulp from the banana peels to be able to move forward with the other recipes in the waiting times of the other activities.

Referenes

Lersch, M. (2010). Texture–A hydrocolloid recipe collection. (v.3.0, 2014).p.95.

I.2 Logbook 2: Frozen reverse spherification, foam and banana

MODULE CODE: TFCS9025
MODULE TITLE: Advanced Molecular Gastronomy
STUDENT NAME: Karen Trevino
FOOD PRODUCT: Breakfast deception
WEEK NO.: 1 **DATE:** 27/03/23

Weekly Aims and Objectives

- Encapsulate orange juice with sodium alginate (egg yolk) by frozen reverse spherification.
- Try to do foam as egg whites.
- Bake banana peels with glucose syrup to make "caramelized bacon"
- Plate all together.

Materials and Method (Ingredients, Equipment and Method)

Table X. Formulation logbook 2.

Mango Juice	%
Water	68%
Sugar	27%
Xanthan gum	0.34%
Liophilized mango	4%
Mango Sphere	
Calcium lactate	1.6%
Water	16.4%
Mango juice	82.0%
Alginate bath	
Water	86.1%
Sugar	13.0%
Sodium alginate	0.9%
Marshmallow foam	
Water	47.1%
Xantham gum	0.3%
Methyll Cellulose	0.3%
Vainilla	0.8%
Salt	0.8%

Albumen	3.8%
Powdered sugar	47.1%
Banana peel syrup	
Glucose syrup	86.2%
Cinnamon	6.9%
Vainilla	6.9%

Equipment

- 5 small stainless-steel bowl
- 2 medium stainless-steel bowl
- 2 large stainless-steel bowls
- 1 stainless steel baking tray
- 1 spoon
- 1 whisk
- 1 small pot
- 1 perforated spoon
- 1 ice mold (spherical)
- Electrolux gas hob
- Oven Electrolux Professional, SkyLine Premium Electric Combi Oven 10GN1/1
- Weight scale, Etekcity model EK9000
- Mixer Chambers Engineering Dublin with whisk
- Robot coupe® R 2
- Freezer and Fridge Electrolux

Process Mango Juice:

1. Weight all ingredients separately.
2. Mix sugar and water in robotcoupe.
3. Add xanthan gum slowly making sure the mixture is lump free.
4. Add lyophilized mango and mix.
5. Place aside.

Mango sphere:

1. Weight calcium lactate.
2. Add to the 50ml of water and heat gently to dissolve the lactate
3. Add mango juice.

Alginate bath

1. Create alginate bath by combining sugar and alginate whisk into water and all to hydrate for 10 minutes.
2. Drop the mango mixture into alginate bath using spoon remove after 2 minutes.
3. Remove into water and wash of solution.

Marshmallow foam:

1. Weight all ingredients separately.
2. Disperse methyl cellulose in 125 g water and leave 30 minutes in refrigerator to allow complete hydration.
3. Mix xanthan with some of the powdered sugar (to avoid lumping) and disperse in 125 g with immersion blender.
4. Combine methyl cellulose and xanthan mix in the bowl of a large mixer with a whisk.
5. Add vanilla and salt and turn speed to medium.
6. Once soft peaks form, add sugar a little at a time. Foam should become more dense and elastic (texture is something in between marshmallow fluff and canned vanilla frosting).
7. Foam can be spooned out for serving.

Banana peel:

1. Using a spoon, knife, or offset spatula scrape the pulp from the skin. Discard.
2. Weight ingredients.
3. Heat glucose in pan.
4. Add the peels in a flat layer making sure to evenly coat them with glucose syrup and cinnamon.
5. Oil a pan, lie down the peels with half an inch of space between them, over medium low heat let the peels begin to sizzle, and sputter for a couple of minutes, then flip them. Do this 2-3 times until the sugars have caramelized, and the peels are becoming dark.
6. Remove peels and place them on wire rack to cool.
7. Serve immediately, or store in an airtight container.

Results and discussion

- The session this second week was much more productive, it was possible to complete the preparation of all the elements of the dish
- For the mango spheres, this week I did frozen reverse spherification, in which I poured the mango juice with calcium lactate in spherical ice tray (figure 16) and I froze it for 1 h 30 min.
- After all the other elements of the dish (foam and banana peels) were ready, the frozen mango was poured in the alginate bath to form the spheres (figure 17)
- The result was much better than last session, since the product maintained its form.
- For the marshmallow foam: the foam obtained was not very strong at first, therefore I added 20 grams of albumen to the formula. After this, a very flexible and aired foam was obtained.
- The colour was very white (as whished), the texture was great (figure 18) and the flavour was sweet. For next session I could add more vanilla to improve the flavour, but it wasn't bad.
- For the banana peels: the first step was to remove the pulp from the peel, when the banana was very ripe this was easy, but in green bananas it's not. Therefore it's better to use ripe bananas.
- When heating the glucose in the pot, it burned a bit, therefore for next session I will keep the heat lower.
- After cooking the bananas, the texture was really good (crunchy and breakable) – but it tasted a little bit burned (figure 19 and 20). This could be due to the glucose which burned a bit when being melted or due to the oven cooking/temperature time.

- In general, the plate was sweet as wished and the presentation was liked by my colleagues.

Figure 16. Frozen mango + lactate.

Figure 17. Mango spheres in alginate bath.

Figure 18. Marshmallow foam.

Figure 19. Banana peels before baking.

Figure 20. Banana peels after baking.

Figure 21. Final dish logbook2.

Conclusions

- Good texture in all the elements – the calcium lactate and alginate achieved the gel of the egg yolk, the whipping action with icing sugar and albumen resulted in a foam as expected. Even though the bananas burned a little, the crunchy texture was a good antagonist of the other textures of the plate.
- Improve flavour (not burned) of banana peels.

Recommendations for following week.

- Melt glucose at lower temperature.
- Lower the temperature of baking of bananas.

Referenes

Lersch, M. (2010). Texture–A hydrocolloid recipe collection. (v.3.0, 2014).P.95.

I.3 Logbook 3: finishing details

MODULE CODE: TFCS9025
MODULE TITLE: Advanced Molecular Gastronomy
STUDENT NAME: Karen Trevino
FOOD PRODUCT: Breakfast deception
WEEK NO.: 3 **DATE: 21/04/23**

Weekly Aims and Objectives

- Use less egg albumin in marshmallow foam since other sources use from 0.1-0.9%
- Cook the banana at lower temperature (don't burn sugar).

Materials and Method (Ingredients, Equipment and Method)

Table XI. Formulation logbook 3.

Mango Juice	%
Water	68%
Sugar	27%
Xanthan gum	0.34%
Liophilized mango	4%
Mango Sphere	
Calcium lactate	1.6%
Water	16.4%
Mango juice	82.0%
Alginate bath	
Water	86.1%
Sugar	13.0%
Sodium alginate	0.9%
Marshmallow foam	
Water	47.1%
Xantham gum	0.3%
Methyll Cellulose	0.3%
Vainilla	0.8%
Salt	0.5%
Albumin	1.0%
Powdered sugar	50%
Banana peel syrup	
Glucose syrup	86.2%
Cinnamon	6.9%
Vainilla	6.9%

Equipment

- 5 small stainless-steel bowl
- 2 medium stainless-steel bowl
- 2 large stainless-steel bowls
- 1 stainless steel baking tray
- 1 spoon
- 1 whisk
- 1 small pot
- 1 perforated spoon
- 1 ice mold (spherical)
- Electrolux gas hob
- Oven Electrolux Professional, SkyLine Premium Electric Combi Oven 10GN1/1
- Weight scale, Etekcity model EK9000
- Mixer Chambers Engineering Dublin with whisk
- Robot coupe® R 2
- Freezer and Fridge Electrolux

Mango spheres:

1. The mango spheres were already done (they were frozen and just the part of the alginate bath was repeated).

Marshmallow foam:

1. Weight all ingredients separately.
2. Disperse methyl cellulose in 125 g water and leave 30 minutes in refrigerator to allow complete hydration.
3. Mix xanthan with some of the powdered sugar (to avoid lumping) and disperse in 125 g with immersion blender.
4. Combine methyl cellulose and xanthan mix in the bowl of a large mixer with a whisk.
5. Add vanilla and salt and turn speed to medium.
6. Once soft peaks form, add sugar a little at a time. Foam should become more dense and elastic (texture is something in between marshmallow fluff and canned vanilla frosting).
7. Foam can be spooned out for serving.

Banana peel:

1. Using a spoon, knife, or offset spatula scrape the pulp from the skin. Discard.
2. Weight peels and place in baking tray with baking paper.
3. Weight cinnamon and vanilla in small stainless-steel bowl.
4. Weight glucose syrup in a small pot.
5. Heat the glucose syrup, vanilla, and cinnamon over low heat.
6. Once the mix is completely liquid, pour it over the banana peels.
7. Place the tray in the oven at 170°C for 15 minutes
8. After this time, remove tray from the oven and leave the banana peel to cool down till its use.

Results and discussion

- The banana peel resulted in a sweeter flavor (not bitter because it didn't burn) and the color was also paler (more reddish instead of marron, more bacon like) (figure 22).
- This might be due to the caramelization of the sugar, which takes part at temperatures above 160°C, where sugar turns into a yellow liquid which changes in color with the rise of temperature, producing chemical reactions which gives polymeric pigments such as melanoidins (brown pigments) (Badui, 2012).
- Last session the temperature was well above 160°C (190°C) and when heating up the syrup in the pot it was heated over medium-high heat, which lead to burning the sugar.
- This new temperature and process proved to be much better for cooking the banana peels.
- The marshmallow foam with 1% of albumin behaved the same as the last session. Having the same results of foaming it was decided to keep the percentage of 1%.
- In general, all the plating of the dish improved, even though the foam % was reduced, the foam maintains its shape as it was whipped thoroughly (5-10 minutes), and the mango spheres also maintained their shape. The bacon looked much more appetizing as previous picture (fig 21 vs fig 23).

Figure 22. Caramelized banana peel.

Figure 23. Finished dish (logbook 3).

Referenes

Badui Dergal, S. (2012). La ciencia de los alimentos en la práctica. 1st Ed. Mexico: Pearson. p.241

Lersch, M. (2010). Texture–A hydrocolloid recipe collection. (v.3.0, 2014).P.95.