ACADEMIC REPORT
Note by Note

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TFCS9025: Advanced Molecular Gastronomy

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Introduction

Culinary transformations are dynamic processes involving systems with structure (This, 2009). Not-transformed foods and sources such as plant and animal tissues are systems, however, complexity in structure increases according to the preparation, combination and interaction of these in a dish. Many phenomena occurring during culinary transformations were studied before the concept of molecular gastronomy was introduced in 1988 by Hervé This. The author defines "molecular gastronomy" as

> ***"A branch of science that studies the physico-chemical transformations of edible materials during cooking and the sensory phenomena associated with their consumption" (This, 2004).***

Even though the concept of molecular gastronomy has being defined and should be clear enough due to its name (gastronomy), the term is usually and mistakenly considered a cooking style, which is, in fact, referring to "molecular cooking", a way to prepare foods by the use of avant-garde tools, ingredients, and methods (This, 2009). Nevertheless, the latter cooking style or the application of molecular gastronomy has helped restaurants, universities, homes, and the food industry, in general, to develop interesting and innovative food products, and this phenomenon will not stop soon (Burke et al., 2016). In truth, these recent concepts are found promissing as almost boundless and more sustainable preparations might be created.

In gastronomy, many claims, uncertain specifications for cooking, tips, among others, have been shared for centuries in families and from cook to cook. However, through molecular gastronomy, these methods have been tested objectively under the name of "culinary precisions" which could amplify and clarify culinary and scientific knowledge for further applications (This, 2006 ; Foolad & Hopia, 2013; Burke et al., 2016). Additionally, "Note by Note" cooking, proposed by This in 1994, as the one that does not include animal or plant tissue systems directly (actual meat, fish or vegetables) to make dishes and only uses pure compounds or fractions to finally get more or less complex systems, is derived from molecular cooking too. It is a method that involves the creation and design of the dish from scratch, it means, the shape, texture, colour, odour, taste, trigeminal sensations, and even the nutritional properties must be generated within the recipe, which adds a new level of complexity and appeal into molecular gastronomy (Burke & Danaher, 2016; Burke et al., 2021).

Note by note cooking fosters creativity and, from an academic aspect, can also foster learning (Burke & Danaher, 2020). An International contest is held annually in Paris, France, and many students, chefs, and amateurs, participate in it demonstrating its vast potential within food science. As for the present year, the topic chosen for Note by Note contest N°10

was savory dice and fibres. Pure note by note cooking is the main molecular cooking promoted through this contest but practical note by note cooking was also permitted. The first one refers to the usage of perfectly pure compounds while the latter allows the use of pure fractions.

Currently, there is no single definition for dietary fibre that is accepted worldwide but there are several different ones. A share perspective of almost of all definitions is non-digestibility in the small intestine, where some carbohydrates pass undigested from the ileum into the colon (Buttris & Stokes, 2008). As part of a definition, the American Association of Cereal Chemists (AACC, 2001) states that dietary fibre includes polysaccharides, oligosaccharides, lignin and associated plant substances and that they promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation. EFSA, in 2007, specified and included within dietary fibres: cellulose, hemicelluloses, pectins, hydrocolloids, resistant oligosaccharides, fructo-oligosaccharides, galacto-oligosaccharides, resistant starch, and lignins.

Hydrocolloids or gums are non-starch polysaccharides fibres characterized by their property of forming viscous dispersions and/or gels when dispersed in water. Their large number of hydroxyl groups increases significantly their affinity for binding water molecules, therefore, their “hydro” or hydrophilic property. They are also colloids, as they produce dispersions, an in-between of a true solution and a suspension (Valdez, 2012). These fibres are widely employed in foods as they provide thickening, gelling, emulsifying, stabilizing, and coating properties, but the main reason of its usage is due to their capability of modifying the rheology of food systems: their viscosity and texture (Valdez, 2012). Gellan gum, gelatin, xanthan gum, carrageenans, local bean gum, agar agar, among many, are hydrocolloids.

Inulin, other type of fibre, is also a source of resistant starch (Trabs et al., 2011). It provides a low glycemic index, it adds sweetness to recipes without skyrocketing blood sugar, and is water soluble (Wildly organic, 2016), becoming a sugar healthier alternative.

Current intake of fibre worlwide are below the recommendations (British Heart Foundation, 2021). For that reason, including in the Note by Note contest N°10 the requirement of inclusion of these type of compounds, is an interesting way of promoting their consumption.

Regardless of whether it is through molecular gastronomy, molecular cooking, science-based cooking, or note by note cooking, one thing is sure: it involves science, and science is a domino chain that gives origin to interesting creations and useful technological applications.

Aim

The purpose of a recipe is to have a precise record of the ingredients used, the amounts needed, and the way they are combined. The aim of the present work was to develop a final note by note cooking recipe and dish—a mushroom and truffle risotto candy-- following the topic and criteria of this year´s Note by Note international contest.

Objectives

- Investigate several pure compounds for potential inclusion in the recipe proposed.
- Test and compare different combinations of the pure compounds to achieve the best recipe candidate.
- Use molecular gastronomy notions to improve the overall properties of the recipe.
- Produce and record the recipe for future consideration.
- Assemble the pure compounds finally chosen for the Note by Note dish.

Materials & Methods

The current project started in March 2022 and finished in April of the current year; it comprised 4 working sessions (each of 2.33 effective hours) in a kitchen for the development and improvement of the recipe and about 3 hours in average for research and analysis of results per session/week. Each working session was dedicated to test and compare different combinations of pure compounds by applying molecular gastronomy notions to improve the overall properties and performance of the recipe. A proper sensory analysis was not carried out considering the aim of the sessions beforementioned and the time constraints. The tasting of each element of the dish was performed by the author of the present work.

The proposed recipe – a mushroom and truffle risotto candy—was represented by gel ovals with cheddar flavour made through cold-oil spherification introduced in a savoury cube with truffle and mushroom flavours, the latter covered with an edible candy wrap. Finally, an inulin “honey” glaze as the sweet element of the “candy” dish was developed and proposed as the final decoration element.

Gel ovals (risotto)

In preparing the gel ovals, the cold-oil spherification procedure proposed by Modernist Pantry (2016) was followed with the incorporation of ingredients besides agar agar (Louis Francois) at 2.5% w/w such as the usage of xanthan gum (En Place) 0.3% w/w, maltodextrine (Sosa) 6.5% w/w, locust bean gum (MSK) 0.8% w/w, and tap water 89.9% w/w for the gelation mixture. 0.05 ml of brown colouring and 0.1 ml of green colouring (Mallard Ferriere) were

added in the solution for a brown-mushroom colour, and 0.45 ml of cheddar coupled with 0.15 ml of olive oil liquid Sosa flavourings for a cheesy and distinguished strong flavour. A plastic disposable syringe was used to create rice-like ovals and a perforated spoon was the most effective and handy utensil to recover them from the cold oil after 2 minutes of rest in it.

Mushroom & truffle cube

Low acyl gellan gum (MSK) at 0.8% w/w was finally chosen as a gelling agent to achieve a clear self-supporting dice through an easy recipe. Tap water at 98.5% w/w and table salt at 1% w/w were also part of the recipe. The hydration of the gum was achieved by the mixing (with manual whiskers) of it with water in a small pot followed by an increase in temperature until 95°C. After complete dissolution, table salt was added to the solution while mixing and, finally, the pot was removed from fire. After 30 seconds of rest, 3 drops (0.15ml) of black truffle (Sosa) liquid flavour and 3 drops (0.15 ml) of the pure note “Chole” (Iqemusu) were used to evoke the fungi distinctive taste and aroma. No colours were added to the solution as a transparent and clear aspect was desired. For the setting, in a previously oiled commercial cube tray, the rice ovals were put at the bottom of each cube and the gellan mixture was added until the top line (surface) of the cubes. Lastly, the cube tray was stored in a conventional kitchen fridge (Electrolux) at 5°C for 1.5 hours.

Edible candy wrap

An edible candy wrap was tested by incorporating together cold tap water 94.7% w/w with unflavoured gelatine powder (Sosa) 4.7% and food-grade glycerine 0.6% (Mistral), as Chef Rudakova (2021) suggested, by pouring and spreading the final solution in a flat, rounded container lid. After 72 h of storage in a closed container in a dark, still, room temperature shelf, the wrap served to enclose the mushroom cube.

Inulin honey glaze

51.6% w/w inulin was caramelized with 48.4% tap water in a small pot at low fire to produce a honey-like healthier glaze decorative feature. This element was originally created from scratch with the inspiration of traditional caramelization with sugar. It was considered ready to remove from fire when the glaze obtained a golden colour and bubbles started to appear in the solution. 0.25 ml (5 drops) of honey liquid Sosa flavour and 0.05 ml (1 drop) of brown colouring were finally added to get the overall honey appearance.

Results

A mushroom and truffle risotto candy was finally represented by gel ovals with cheddar flavour in a savoury cube with truffle and mushroom flavours, the latter covered with an edible candy wrap (see Fig. 1). A fungi and black truffle taste mixed with cheddar and oily notes was congruent with the original idea. A honey glaze decoration as the sweet element of the "candy" dish was proposed and developed as the fibre-including element, but was not incorporated in the final assembly of the dish due to time and experimental constraints.

Fig 1. Mushroom and truffle risotto candy.

Gel ovals (risotto)

Oval and sphere-shaped gels with slight differences in size and a slight brown/buttery colour were obtained. The colour matched the cheddar/olive distinctive flavour notes of it, but differed of the brown-mushroom tones aspired. The texture was uniform, slightly hard and brittle when chewed. The overall appearance slightly resembled risotto hydrated rice grains, however, the size was bigger than real grains and a not uniform shape included some sphere-shaped gels (see Fig. 2 and 3).

Fig. 2. Gel ovals after cold-oil spherification.

Fig 3. Gel ovals inside cubes of cube tray.

Mushroom & truffle cube

A transparent, self-standing savoury cube gel was obtained (Fig. 4). Truffle and mushroom flavours were easily recognized at taste. When chewing, a hard, brittle, and unpleasant texture was perceived. The overall appearance was crystalline and delicate, and gel ovals were recognized inside of the dice.

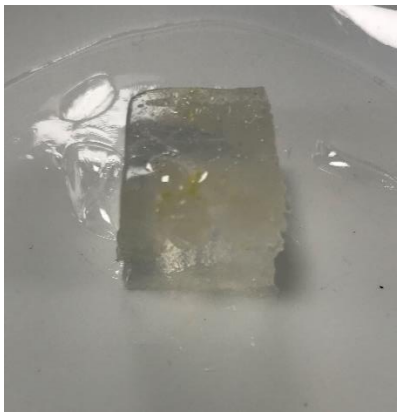

Fig.4. Savoury self-supporting transparent cube with gel oval inclusions.

Edible candy wrap

A transparent, edible candy film was reproduced as shown in Figure 1. It had a flexible and soft texture, it could be manipulated with the hands to achieve the wrapping of the cube, and

no flavours were perceived when tasting it alone. The overall appearance was crystalline and delicate.

Inulin honey glaze

A viscous, caramel-like texture glaze was achieved. It consisted of an amber-coloured, honey-flavoured sweet solution. In contrast with conventional honey, a darker tone and a thicker consistence were evidenced (see Fig. 5). It was not shown simultaneously with the other elements previously mentioned, however, it was proposed as a relevant element for the harmony of the final dish and recipe.

Fig 5. Honey glaze made with inulin powder.

Discussion

The results of the current work suggest that note by note cooking is challenging and complex, with a differentiation in involvement between pure and practical note by note cooking, being the first one more exacting than the latter since achieving a recipe by mixing only perfectly pure compounds demands a higher number of ingredients and resources than to achieve an equivalent recipe with the usage of pure fractions and requires as well more time, research, testing, and, above all, more creativity.

Considering the time and ingredients available and especially the limitations in the quantity and options available of pure notes, a practical – but as close as possible -- to pure note by note cooking was applied for the creation of a mushroom and truffle risotto candy, an original recipe and dish including fibre and a savoury dice. Elements such as gel ovals, a gel cube, an edible candy wrap and an inulin honey glaze were produced as part of the overall proposition, with the main usage of hydrocolloids since they are avant-garde ingredients in molecular gastronomy, many shapes could be achieved through their use and they are considered fibres as well.

Gel ovals (risotto)

The results indicate that cold-oil spherification is an efficient option to produce spheres or oval gels through a spherification method since it requires just one main gelling agent (in this case, agar agar) and the oval-shaped gels are obtained in a small number of steps (<10 steps) and in a short period of time (<10 min). Contrary to the literature found related to flavour and agar, a high flavour release when chewing the gel ovals was perceived. This could be explained due to the significant and conscious increase in flavour addition in the final recipe and due to flavour retention in the gel caused by the spherification, likely behaving as an encapsulation (Carneiro et al., 2022). Since uniform, stable, and resistant ovals were desired for their inclusion and recognition into a cube gel, agar agar was initially considered and finally achieved this texture description. Benefits of the recipe developed also rely on the capability to mould and slightly change-- until certain degree-- the shape to a more oval one instead of the traditional sphere shape achieved through “spherification”. However, it is relevant to note that for softer gels spheres and a more risotto-like texture, other gelling agent such as gellan gum LA and/or other spherification process such as direct or reverse spherification might be suggested to test, as other expert sources agree (Modernist Pantry, 2016).

If colour spheres with this type of spherification are desired, a high amount and care in the combination of food colourings are recommended as the gelling solution must be boiled to be able to set when in contact with the cold oil due to the difference in temperature. Hence, with the increase in temperature of the solution, chemical reactions within the polymers in

the recipe developed could take place as some gelling agents such as xanthan gum are thermoresponsive, meaning that other changes besides viscosity are obtained when heated, including colour changes, what is known as thermochromism (Taylor et al., 2016). Coupled with this suggestion, a fast handle of the solution prepared for the subsequent spherification is also recommended, as the mixture increases considerably in viscosity, making it difficult to work and create the desired spheres.

Mushroom & truffle cube

The transparent, self-standing savoury cube gel shows that gellan gum low acyl delivers crystalline and delicate gels, candidates to high-end dishes and *haute cuisine* contests. Since the texture obtained was still too hard for a final dish, working on concentrations lower than 0.8% is highly recommended for the shape desired, nevertheless, a minimum 0.4% of it should also be considered to set the gel, as Lersch suggests (2014). Focus on concentration tests instead of the inclusion of other gelling agents were followed as no synergistic effects with other substances have been recorded (Lersch, 2014). However, on the positive side, this offers a low-in-number ingredient list in the recipe, with high potential outputs. In addition, the higher the concentration used of gellan gum for the gel, the lower the time required for the gel to set. Thus, working with this gelling agent should be in a rapidly manner. Lastly, when testing gellan gum high acyl as alternative, a high sensitivity to sodium was noted immediately after its addition to the solution prepared and no setting was evidenced even after time of storage, in contrast with that the literature states (Lersch, 2014). According to Xuejiao et al. (2017) gellan gum with sodium ions show high turbidity, viscosity and lower sediment, which matches with the results obtained in the present work, however, Gao (2016) have found that at high salinity concentrations, gellan gum maintains high viscosity, therefore, this could suggest the main cause of what could have hindered the proper formation of the gel since 1% table salt concentration was incorporated in the recipe. If softer and opaque, color-based gells are desired, gellan gum high acyl could be considered, but the elimination or reduction of sodium of the recipe would improve it. Its usage for a transparent savoury dice is not recommended.

In regard to the flavour, working with fast-setting gels constitutes a challenge in note-by-note cooking due to the fact that flavour addition to the gelling solutions improves flavour retention and performance when done at low temperatures, while adding flavourings or notes to a hot solution contributes to the evaporation and flavour release at the moment. Nevertheless, with a fast-setting gel, all the additions must be made while the gel is not formed yet, and so the solution could still be at high temperatures, as it was in the trial in reference. Thus, higher concentrations of flavourings must be employed, and the usage of just one or 2 notes per element is suggested for a better evocation of the original flavour.

Edible candy wrap

The success of the edible candy wrap builds on existing evidence of the effect of glycerine in film-making solutions as it acts as a plasticizer thanks to its small molecular size that allows it to slide in the spaces between molecules of polymer chains, decreasing the strength of hydrogen bonds between the molecules, which finally leads to the boosting of the movement of molecules, what is commonly known as flexibility (Tarique et al., 2021). This is why a transparent and "delicate" but also reduced-in-fragility film could be achieved. The study of Tarique et al (2021) showed as well that an increment in glycerine concentration caused an increment in film thickness and moisture content. It was proposed that these changes could be due to the glycerine molecules upsetting and restructuring intermolecular polymer chain networks, converting all free volumes into a thicker film.

In the first trial and success of making an edible candy wrap, a thin layer was spread over a flat lid and stored on a closed container in a closed shelf. In the second making of the wrap, however, unintentional slight changes were produced during the process, and a slightly thicker layer was spread on the lid. The thickness and moisture increase as stated by Tarique et al. (2021) could explain why even when stored properly, the edible wrap was not even able to be lifted of the lid and was perceived more humid/wet (Fig. 13), as it was already thick enough from the start. In contrast, a thin, dry, and unchewable wrap was obtained after storage in a closed shelf but in no closed container. This shows how relevant is moisture for the success of this wrap and demonstrates the plasticizer effect of glycerine as well. Other potential reason for the failure of the second making of the edible candy wrap that presented fragile properties could be a lower quantity of glycerine finally added to the recipe as a result of human error and the difficulty to handle this type of viscous alcohol. Lastly, a shorter period of storage/rest (36 hours in contrast with 72 hours) might have also affected the proper stability of the film or its moisture content. This resting/storage time becomes a drawback when preparing this element and, in general, a recipe, as long waiting hours are not always pragmatic or useful.

Understanding, as in the previous case, the phenomena and interactions that take place within each recipe as part of molecular gastronomy, helps to foresee further applications beyond the simple usage of the ingredients. Glycerine, for instance, could be considered in the development of bio-degradable or edible food packaging.

Inulin honey glaze

"In the orchestra of a great kitchen, the sauce chef is a soloist" (Point, no date).

The final element of the proposed dish, an inulin honey glaze, even though small in quantity and separated from the other elements, becomes relevant for several reasons. From an artistic and aesthetic aspect, a dish without decorative elements might be dull and unappealing, becoming unappetizing. “Eating” engages more than one sense, and the visual one is as important as tasting, as the first stage of the eating experience involves the visual judgement. In this sense, the presentation of food makes an impression and even a promise within the viewer, so adding colour, interest, taste and texture through garnishes, such as the sauce in reference, gives an overall harmony to the dish. In addition and related to the contest requirements, the glaze included inulin as a pleasant-to-taste fibre.

Inulin demonstrated numerous benefits in its usage as the main ingredient of the glaze prepared. Firstly, regarding food technology matters, it caramelized and showed an analogous caramel effect as sugar when heated. This is in accordance with the literature (Bordas, 2019; Trabs et al., 2011) and adds up value to it as an ingredient since it can provide brown tones, if wanted, and can even undergo Maillard reactions if provided with aminoacids or proteins (Mancilla-Margalli & López, 2002). Secondly, as an analogue alternative to honey glaze, it offers a higher nutritional due to its natural prebiotic and fibre content in comparison with original natural honey since 10 g of the proposed inulin mixture presents about 5 g of fibre while 10 g of honey presents null quantities of this nutrient. Moreover, studies such as the one carried by Trabs et al (2011), insinuate that heated inulin may be more effective in stimulating the growth of Bifidobacteria, a relevant beneficial group within the probiotic’s universe. Alongside, the authors have suggested that inulin caramels may have higher prebiotic effect than native, not heated inulin, an interesting potential added value of the proposed glaze in the current work.

Another benefit of using inulin as a fibre option instead of simple carbohydrates such as sugar, is that since it binds the free water in the recipe, it improves the shelf-life of whatever the product that includes it, retarding the development of microorganisms. Lastly, from a regulatory aspect, inulin is legally classified as food or food ingredient in EU Regulation. Hence, not being a “food additive” could contribute to a higher acceptance from the general public when used in food product or recipes.

Finally, through a “simple” (at first sight) element of the dish such as the garnish, it can be shown that food decoration can extend beyond creativity, reaching also food science and technology. Inulin, in this work serves as a replacement of honey, but in other products could replace corn syrup, for instance, a commonly used ingredient in the food industry.

Conclusions

Along with molecular gastronomy knowledge, a practical note by note cooking recipe was developed following the topic and criteria of this year´s Note by Note international contest through the creation of a mushroom and truffle risotto candy. The assembly of all its elements in a final dish, however, was not fully achieved as the testing and comparison of different combinations of the compounds used to produce the best recipe candidate was challenging and time consuming, and until the very last working session, improvements were pursued. This reflects the complexity of note by note cooking since research, numerous tests, comparisons, and perseverance are all required in the creation of a dish.

The cold-oil spherification process was a simple and an efficient spherification procedure for obtaining gel ovals or spheres. Gelation involves several physical and chemical changes, reactions, and interactions. Hence, care and detail in recipes with gels should be considered. Edible candy wraps follow simple recipes, however, are prone to failure if a thick layer of mixture, not sufficient glycerine, not sufficient rest hours or storage in an open space are applied. Furthermore, the edible candy wrap effect is effectively achievable if no time constraints are set, but long resting/storage hours could be a setback for some projects. Glicerine is favorable for “wrap” style recipes where flexibility is desired. Gellan gum provides transparent, strong gels, nevertheless, quickly manipulation is required as its setting is fast. As per fibre ingredients, dietary cellulose presents an unpleasant taste and texture and its inclusion in recipes might be challenging. As an alternative, inulin showed multiple benefits and was the main contributor of a *healthier* version of a traditional honey glaze.

Future projects on this topic should involve more trial time than the invested in the current work. In addition, working on 1 or 2 flavours or notes when evocating an element of the dish is highly suggested.

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Logbook

MODULE CODE: TFPD9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: Gabriela CORTEZ

FOOD PRODUCT: Note by Note recipe: Mushroom & Truffle Risotto Candy

WEEK NO.: 1 **DATE: 28/03/2022**

Weekly Objectives

- Test and compare different combinations of potential pure and mixed compounds according to the proposed recipes.
- Achieve, at least, 1 of the recipes in terms of gelation.

Materials and Method (Ingredients, Equipment and Method)

Ingredients

Ingredient	Amount
GEL OVALLS	
Iqemusu Frum	0.15 ml (3 drops)
Sosa garlic flavour	0.15 ml (3 drops)
Sosa chardonnay flavour	0.15 ml (3 drops)
Iqmusu piperine	0.05 ml (1 drop)
Xanthan gum En Place	0.4 g
Maltodextrin Sosa	8 g
Locust bean gum MSK	1 g
Agar Agar Louis Francois	3 g
Water	110 ml
Sunflower oil (refined)	200 ml
Olive oil (unrefined)	100 ml
TRUFFLE CUBE	
Water	80 g
Maltodextrin Sosa	12 g
Table salt	3 g
Gellan Gum F MSK	0.25 g
Locust Bean Gum MSK	0.25 g
Green coloring Mallard Ferriere	0.3 ml (6 drops)

Red coloring Mallard Ferriere	0.10 ml (2 drops)
Sosa butter flavour	0.25 ml (5 drops)
Iqemusu Onium note	0.25 ml (5 drops)
Sosa Truffle flavour	0.2 ml (4 drops)

Equipment

- Syringe.
- Manual whisker.
- Cubes tray.
- Metal bowls.
- Small pots.
- Perforated spoon.
- 5°C Electrolux fridge.

Methods

Cold-oil spherification: rice

1. Pour about 200 ml of refined oil (sunflower oil) in a metal bowl and let it rest in the fridge.
2. Pour 110 mL water into a small pot.
3. Mix powdery ingredients (xanthan gum, maltodextrin, locust bean gum, agar agar), and add them in the pot with water while continuously whisking.
4. Bring to boil the mixture while whisking and, immediately, take of the stove.
5. Take the oil of the fridge and keep it at hand while the hot mixture cools.
6. Add to the mixture 3 drops of Frum, 3 drops of garlic Sosa flavour, 3 drops of Chardonnay Sosa flavour, and 1 drop of piperine pure note.
7. Fastly with a syringe, imitate rice grains with the hydrocolloid mixture by sucking the viscous solution and letting it fall in the cold oil.
8. After 2 minutes, with a perforated spoon, take the rice ovals formed of the oil and serve them in a plate.
9. Store in about 100 ml of unrefined oil.

Mushroom cube

1. In a pot with 80 g of water, add while heating and whisking in stove the powdery ingredients each by each until complete dissolution.
2. Remove from fire and let it cool for 1 min.
3. Add colourings and flavours to the mixture.
4. Pour the liquid into one oily well/cube of the tray and store in the fridge (to check the gelling after enough cooling).
5. Repeat all the previous steps with 0.25 more of gellan gum F.

Results and discussion

The cold-oil spherification recipe was followed as proposed and achieved in the first trial in terms of gelation, but not in terms of flavour or colour. No colouring was added to the recipe, nevertheless, the mixture produced a rose colour in the gel ovals. Since this type of spherification was the mainly desired among the 3 options proposed to test (also direct and reverse spherification), no other spherification procedures were tested after this and focus will rely on improving other characteristics of the rice ovals such as colour, flavour and the addition of fibres after this first trial. The gel ovals obtained were firm in texture (see Fig. 6), this is congruent with the materials used (such as agar agar), but the procedure should be done quickly since the gel sets fast (within 1-2 minutes). The texture described will remain as a desired property since a difference in texture and/or visual identification is pursued as the gel ovals must finally be inside the “mushroom” cube.

Regarding the mushroom cube, after 2 days of storage in the fridge, no gelation was achieved. A soft, deformed gel was obtained after taking it out of the tray. Initially, iota carrageenan was proposed in the recipe, nevertheless, it was not available at the moment and in matters of similar texture, gellan was considered as alternative. The concentration of gellan gum was low and below the quantity proposed for gelation (>0.4%) following this recipe, and this was most probably the reason of failure of the first gel. A second gel with 0.4% of gellan was tested, but it didn´t succeed either. Since locust bean gum was part of the recipe and it is not reported to have synergistic affects with gellan, a higher concentration of the latter might be required to achieve the gel. This will be considered for future trials.

In terms of colour, clarity, and flavour of the cube, they were not achieved either: the colour was too dark to represent a brown mushroom and the opaqueness made It impossible to notice the rice balls inside. The flavour was too strong in onion notes and the mushroom notes were lost even with the truffle hint. Thus, further trials on this will be pursued and the lowering or elimination of onium notes will be considered.

Fig. 6. Cold-oil spherification gel ovals.

Conclusions

- Several combinations of pure and mixed compounds were tested to evaluate their performance mainly in terms of gelation. While the mushroom cube attempts were not achieved yet, the gel ovals by cold-oil spherification succeeded.
- For the followed recipe, a higher concentration of gellan gum might be required to obtain a gel.
- The cold-oil spherification process is a simple and effective spherification if no complex balls (liquid in center/melting balls) are desired.
- Gelation involves physical and chemical processes. Hence, it is not a trivial phenomenon to achieve and care in the specifications of the recipe should be taken into consideration.

Recommendations for following week.

For future improvement of the gel ovals, remind to work fast and consider not putting the mixture bowl in the table as it cools faster.

Increase the concentration of gellan gum for future gelation trials.

Add Chole pure note (mushroom note) to better imitate the mushroom flavour in the cube.

MODULE CODE: TFPD9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: Gabriela CORTEZ

FOOD PRODUCT: Note by Note recipe: Mushroom & Truffle Risotto Candy

WEEK NO.: 2 **DATE: 01/04/2022**

Weekly Objectives

- Test and compare different combinations of pure ingredients in the making of the mushroom cube.
- Achieve the mushroom cube in terms of gelation or identification of the gel balls inside of it or in terms of flavour.
- Verify the rice ovals quality characteristics after storage from last week.
- Perform an edible candy wrap recipe.

Materials and Method (Ingredients, Equipment and Method)

Ingredients for different recipes of Mushroom cube

Ingredient	Amount
RECIPE N°1	
Iqemusu Frum	0.05 ml (1 drop)
Sosa chicken flavour	0.05 ml (1 drop)
Sosa olive oil	0.05 ml (1 drop)
Iqemusu chole flavour (mushroom)	0.10 ml (2 drop)
Iqemusu Piperine	0.05 ml (1 drop)
Sosa Truffle flavour	0.05 ml (2 drops)
Green coloring Mallard Ferriere	0.2 ml (4 drops)
Red coloring Mallard Ferriere	0.05 m (1 drop)
Water	80 g
Malic acid Louis Francois	2.5 g
Maltodextrin Sosa	12 g
Table salt	2 g
Iota Carrageenan	0.5 g
Locust bean gum MSK	0.5 g
Flavour enhancer MSK	0.5 g

Dietary cellulose Nutricology	2 g
RECIPE N°2	
Sosa chardonnay flavour	0.05 ml (1 drop)
Sosa chicken flavour	0.10 ml (2 drops)
Sosa olive oil	0.10 ml (2 drop)
Iqemusu chole flavour (mushroom)	0.35 ml (7 drops)
Sosa Truffle flavour	0.45 ml (9 drops)
Cold water	80 g
Malic acid Louis Francois	2.5 g
Maltodextrin Sosa	12 g
Table salt	2 g
Iota Carrageenan MSK	0.5 g
Corn Starch Gem	0.5 g
Flavour enhancer MSK	0.5 g
Dietary cellulose Nutricology	2 g

Ingredients for different recipes of Candy wrap

Ingredient	Amount
Cold water	100 g
Sosa gelatine (unflavoured)	5 g
Food grade glycerine Mistral	0.625 g

Equipment

- Manual whisker.
- Cubes tray.
- Metal bowls.
- Small pots.
- Container lids.

Methods

Mushroom cube. Recipe N° 1.

1. In a pot with 80 g of water, add while heating in stove and whisking the powdery ingredients each by each until complete dissolution.
2. Remove from fire and let it cool for 1 min.

3. Add colorings and flavours to the mixture.
4. Pour the liquid into one well/cube of the tray and store in the fridge (to check the gelling after enough cooling).

Mushroom cube. Recipe N° 2.

1. In a pot with 80 g of water, add the corn starch and mix well until its dissolution. Start heating the mixture and add the rest of the powdery ingredients, each by each.
2. After reaching 80°C, remove from fire and let it cool for 1 min.
3. Add colourings and flavours to the mixture.
4. Pour the liquid into one oily well/cube of the tray and store in the fridge (to check the gelling after enough cooling).

Candy wrap.

1. Mix everything together and whisk without stopping.
2. Bring to boil and simmer together while continuously whisking.
3. When the candy wrap boiled for a minute, remove it from the fire and pour in on top of a flat lid.
4. Store the lid in a dry, dark place, in a container, for 48 h.

Results and discussion

The two mushroom recipes were followed as proposed but no satisfactory cube was obtained. Recipe N° 1 included iota carrageenan and locust bean gum as synergistic gelling agents, nevertheless, the final texture after cooling to let set was still soft. This might be improved with concentrations >1% of Iota carrageenan instead of 1% of the sum of both gelling synergistic agents. The colour and opaqueness didn´t approach the desired mushroom tone and it helped in realizing that just a transparent cube will work as desired with the rice ovals inside of it. The flavour of the truffle or mushroom evocation was not easily recognisable, and a strong bitterness and sandiness was perceived, most likely due to the dietary cellulose added in this new version of recipe. Recipe N°2 improved slightly on texture but the cube was still not able to support the wrapping step with the “candy wrap”. The colour and clarity were not as the desired (transparent) even after not adding any colouring, as a white tone was obtained (see Fig. 7). Regarding the flavour, it started to resemble a truffle recipe, but the aftertaste of the dietary cellulose made it very unpleasant. This indicates that having a much higher proportion of truffle flavouring than other flavouring is more favourable.

Fig. 7. Recipe 1 and 2 tested, recipe 1 on the bottom line (brown cubes), recipe 2 on the rest of the wells.

A thin transparent layer was easily prepared and spread in a flat rounded container lid and stored for 72 h for the evaluation of its properties in the following week as an edible candy wrap (see Fig. 8).

Fig 8. Gelatine and glycerine mixture spread on top of a container lid.

Conclusions

- Two combinations, Iota carrageenan: starch, Iota carrageenan: locust bean gum, were tested to evaluate their performance mainly in terms of gelation. A self-supporting mushroom cube was not achieved in terms of texture, colour or flavour.
- Concentrations of >1% of Iota carrageenan instead of 1% of the sum of two gelling synergistic agents might be considered if using iota carrageenan as a gelling agent.
- Only transparent/clear gelling agents will be considered for future savoury cubes.

- Adding dietary cellulose to the recipe of the main element of it affects considerable the overall flavour. Hence, it will not be considered for future additions in this item.
- The edible candy wrap effect is easy, however, 72 h of waiting to count with the final product might be long under some circumstances.
- Flavour with pure or mixture compounds like Sosa and Iqemusu in note by note cooking is powerful if added in cold, consideration of not mixing to many flavours at once even if a regular recipe have the elements, and just considering the dominant flavour is a more effective approach for imitation and identification of the flavour.
- Lastly, after cold-oil spherification and storage with unrefined oil such as olive virgin oil at 5°C, gel ovals or spheres remain under similar quality conditions as the ones fresh in matters of color, taste and texture.

Recommendations for following week.

Add only chole pure note (mushroom note) and truffle flavour to better imitate the mushroom flavour in the cube.

Consider changing the fibre ingredient or adding it in another element of the recipe such as the rice ovals.

MODULE CODE: TFPD9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: Gabriela CORTEZ

FOOD PRODUCT: Note by Note recipe: Mushroom & Truffle Risotto Candy

WEEK NO.: 3 **DATE: 04/04/2022**

Weekly Objectives

- Verify the edible candy wrap quality characteristics after storage from last week and test its elasticity by wrapping a mushroom cube.
- Achieve the mushroom cube in terms of gelation and identification of the rice balls inside of it (no focus on flavour).
- Perform a new version of rice ovals with the inclusion of dietary cellulose and the improvement of the flavour.

Materials and Method (Ingredients, Equipment and Method)

Ingredients

Ingredient	Amount
Mushroom cube	
Iqemusu chole flavour (mushroom)	0.15 ml (3 drops)
Sosa Truffle flavour	0.15 ml (3 drops)
Water	98.2 g
Gellan gum F MSK	0.8 g
Table salt	1 g
Gel ovals	
Iqemusu Onium	0.05 ml (1 drop)
Sosa olive oil flavour	0.15 ml (3 drops)
Sosa cheddar flavour	0.45 ml (9 drops)
Brown colouring Mallard Ferriere	0.05 ml (1 drop)
Green coloring Mallard Ferriere	0.1 ml (2 drops)
Xanthan gum En Place	0.4 g
Maltodextrin Sosa	8 g
Locust bean gum MSK	1 g

Agar Agar Louis Francois	2 g
Dietary cellulose Nutricology	1 g
Water	110 ml
Sunflower oil (refined)	200 ml
Olive oil (unrefined)	100 ml

Equipment

- Manual whisker.
- Cubes tray.
- Metal bowls.
- Small pots.
- Syringe.
- 5°C Electrolux fridge.
- Perforated spoon.

Methods

Mushroom cube.

1. In a pot with 98.2 g of water, hydrate the gellan while whisking and heat to reach 90-95°C until complete dissolution.
2. Add the salt into the mixture while continuously whisking.
5. Remove from fire and let it cool for 1 min.
6. Pour the liquid into one well/cube of the tray and store in the fridge for 1.5 hours (to check the gelling after enough cooling).

Gel ovals

1. Pour about 200 ml of refined oil (sunflower oil) in a metal bowl and let it rest in the fridge.
2. Pour 110 mL water into a small pot.
3. Mix powdery ingredients, and add them in the pot with water while whisking.
4. Bring to boil the mixture while continuously whisking, and, immediately, take of the stove.
5. Take the oil of the fridge and keep it at hand while the hot mixture cools.
6. Add the flavours and colours to the mixture.
7. Fastly with a syringe, imitate rice grains with the hydrocolloid mixture by sucking the viscous solution and letting it fall in the cold oil.
8. After 2 minutes, with a perforated spoon, take the gel ovals formed of the oil and serve them in a plate.
9. Store in about 100 ml of unrefined oil.

Results and discussion

The mushroom recipe was followed as described and a standing gel savoury cube was achieved. Gellan gum (low acyl) was proposed as one of the options to achieve a savoury transparent dice since it is a clear gelling agent and agar agar and gelatine have already been used in the other elements of the recipe. A high concentration of gellan was proposed for this first trial to guarantee the standing cube and to evaluate the clarity and tone of the cube. With 0.8% of gellan in the recipe, a hard cube was obtained (see Fig. 9 and 10), lower concentrations should be tested for a more pleasant texture. In addition, high acyl gellan could be considered as, in theory, it results in a more elastic and soft gel. A truffle and mushroom flavour was easily and pleasantly perceived as tasted by myself, meaning that focusing on one or two flavours at a time in note by note cooking could more effective than focusing on many in trying to imitate a traditional recipe. The transparency was as desired.

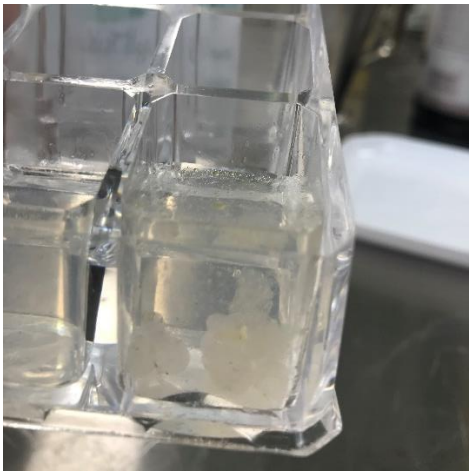

Fig. 9 Savoury transparent cube with rice ovals inside in a cube tray.

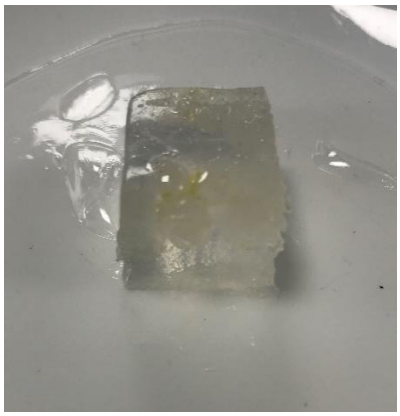

Fig. 10. Savoury transparent cube after removing it from the cube tray.

After a 72 h-storage in a dry, dark, temperature room, a transparent, edible candy wrap was achieved as shown in Figure 11. The glycerine in the recipe, as stated in the literature, decreases the streng of hydrogen bonds within the gelling agent helping in the increase of flexibility.

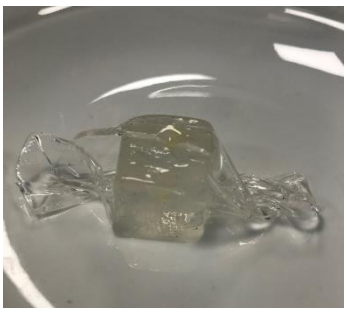

Fig 11. Gelatine and glycerine wrap folded as a candy wrap around the “mushroom cube”.

Regarding the inclusion of dietary cellulose in the rice ovals recipe that previously succeeded, it negatively affected the texture and overall flavour of them since a thicker, not mouldable or easy to work texture was obtained (see Fig. 12) and a bitter/sandy perception once tasted

prevailed, even after using even a lower concentration of this compound, in contrast with the mushroom cube recipe that included it before.

Fig. 12. Attempt of rice ovals through cold-oil spherification.

Conclusions

- The edible candy wrap effect is effectively achievable if no time constraints are set. Glicerine is favorable for “wrap” style recipes where flexibility is desired.
- Achieve the mushroom cube in terms of gelation and identification of the rice balls inside of it (no focus on flavour).
- Perform a new version of rice ovals with the inclusion of dietary cellulose and the improvement of the flavour.
- Gellan gum (low acyl) provides transparent, strong gels, however, quickly manipulation is required as its setting is fast.
- In note by note cooking, focusing on one or two flavours for one element might be more effective than focusing on many trying to evocate a dish.
- Dietary cellulose is not pleasant at taste and its inclusion in recipes might be a challenge.

Recommendations for following week

Work with an alternative of fibre such as inulin in a sauce.

Work with lower concentrations of Gellar gum (LA) to test texture and try gellan gum (HA).

Work in 3 edible candy wraps with colors of the Italian flag.

Focus on cheddar flavour and brown/mushroom color of rice ovals.

MODULE CODE: TFPD9025

MODULE TITLE: Advanced Molecular Gastronomy

STUDENT NAME: Gabriela CORTEZ

FOOD PRODUCT: Note by Note recipe: Mushroom & Truffle Risotto Candy

WEEK NO.: 4 **DATE: 27/04/2022**

Weekly Objectives

- Develop 7 edible candy wraps for the final dish being one of them a trial without storage.
- Test different gellan gum (LA) concentrations to improve texture and softness of the savoury dice.
- Try gellan gum (HA) as a gelling agent to achieve savoury dice.
- Develop final gel ovals in terms of color and flavour.
- Incorporate fibre as a decorative element of the dish.

Materials and Method (Ingredients, Equipment and Method)

Ingredients

Ingredient	Amount
Candy edible wrap	
Cold water	100 g
Sosa gelatine (unflavoured)	5 g
Food grade glycerine Mistral	0.625 g
Mushroom cube N°1	
Iqemusu chole flavour (mushroom)	0.15 ml (3 drops)
Sosa Truffle flavour	0.15 ml (3 drops)
Water	98.5 g
Gellan gum MSK	0.5 g
Table salt	1 g
Mushroom cube N°2	
Iqemusu chole flavour (mushroom)	0.15 ml (3 drops)
Sosa Truffle flavour	0.15 ml (3 drops)
Water	98.4 g
Gellan gum MSK	0.6 g

Table salt	1 g
Mushroom cube N°3	
Iqemusu chole flavour (mushroom)	0.15 ml (3 drops)
Sosa Truffle flavour	0.15 ml (3 drops)
Water	97 g
Agar Agar Louis Francois	3 g
Mushroom cube N°4	
Iqemusu chole flavour (mushroom)	0.15 ml (3 drops)
Sosa Truffle flavour	0.15 ml (3 drops)
Water	98 g
Agar Agar Louis Francois	2 g
Mushroom cube N°5	
Iqemusu chole flavour (mushroom)	0.15 ml (3 drops)
Sosa Truffle flavour	0.15 ml (3 drops)
Water	98 g
Agar Agar Louis Francois	0.3 g
Gel ovals	
Sosa olive oil flavour	0.15 ml (3 drops)
Sosa cheddar flavour	0.45 ml (9 drops)
Brown colouring Mallard Ferriere	0.05 ml (1 drop)
Green coloring Mallard Ferriere	0.1 ml (2 drops)
Xanthan gum En Place	0.4 g
Maltodextrin Sosa	8 g
Locust bean gum MSK	1 g
Agar Agar Louis Francois	3 g
Water	110 ml
Sunflower oil (refined)	200 ml
Olive oil (unrefined)	100 ml
Honey glaze	
Water	15 g (1 spoon)
Inulin powder MyVitamins	16 g
Honey Sosa flavour	0.25 ml (5 drops)
Brown colouring Mallard Ferriere	0.05 ml (1 drop)

Equipment

- Manual whisker.
- Cubes tray.
- Metal bowls.
- Small pots.
- Syringe.
- 5°C Electrolux fridge.
- Perforated spoon.
- Flat container lids.

Methods

Mushroom cube.

1. In a pot with the water, hydrate the gellan while whisking and heat to reach 90-95°C until complete dissolution.
2. Add the salt into the mixture while continuously whisking.
3. Remove from fire and let it cool for 1 min.
4. Pour the liquid into one well/cube of the tray and store in the fridge (to check the gelling after enough cooling).

Gel ovals

1. Pour about 200 ml of refined oil (sunflower oil) in a metal bowl and let it rest in the fridge.
2. Pour 110 mL water into a small pot.
3. Mix powdery ingredients, and add them in the pot with water while whisking.
4. Bring to boil the mixture while continuously whisking, and, immediately, take of the stove.
5. Take the oil of the fridge and keep it at hand while the hot mixture cools.
6. Add the flavours and colours to the mixture.
7. Fastly with a syringe, imitate rice grains with the hydrocolloid mixture by sucking the viscous solution and letting it fall in the cold oil.
8. After 2 minutes, with a perforated spoon, take the gel ovals formed of the oil and serve them in a plate.

Candy wrap.

1. Mix everything together and whisk without stopping.
2. Bring to boil and simmer together while continuously whisking.
3. When the candy wrap boiled for a minute, remove it from the fire and pour in on top of a flat lid.
4. Store the lid in a dry, dark place for 2 days.

Honey glaze

1. In a pot, add inulin and heat it at low fire.
2. Add the water into the pot and let it boil while continuously whisking (the inulin must dissolve well in the water).
3. When the elements integrated, stop whisking and start doing circular movements with the pot.
4. When the glaze achieves a golden colour, put aside of the stove and let it rest.
5. Add 5 drops of honey flavour and brown colouring and mix.

Results and discussion

7 mixtures of glycerine and gelatine were set on top of flat lids to obtain edible wraps for the final dish: 3 were stored for 36 h in a closed container, 3 were stored for 36 h in a closed shelf (but not in a closed container), and 1 was not stored, its flexibility was tested after 1 h made. After the time of rest allocated for each candy wrap, their texture and flexibility was tested. Surprisingly, in regard to the 3 wraps stored in a closed container for 36 h, the texture was brittle and such as gelatine alone (the wraps could not lift off of the lid as shown in Fig. 13). In contrast, the edible wraps that were not stored in a container but in a locker for 36 h could easily detach the lids but were too dry and plastic-like, not pleasant to chewing and to stiff to make the candy wrapping effect around the cube (Fig. 14).

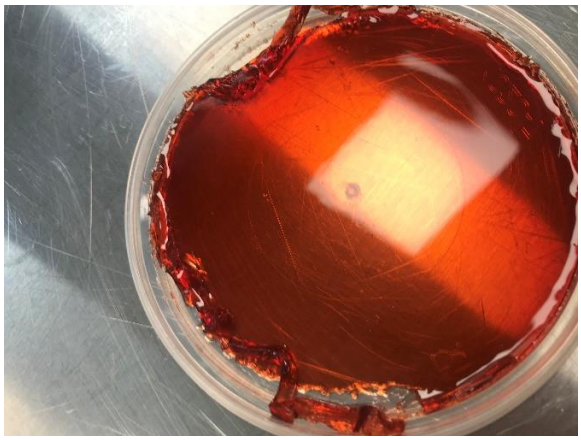

Fig. 13. Glycerine + gelatine attempt of edible wrap after 36 h storage in a closed container.

Fig.14. Glycerine + gelatine attempt of edible wrap after 36 h storage in an open locker.

Regarding the wrap that was tested after 1 h of being made, it disintegrated after trying to detach it from the lid. The differences in texture between the attempts of candy wrap stored and its failure could be explained by several causes: the time of storage was initially suggested for 48 h, 36 h were attempted as per the dynamics of the course. In addition, the height of the layer of mixture on top of the lid (Fig. 8) might be slightly higher than the first candy wrap achieved on previous weeks. Thus, the height of the layer spread could be determinant in the success of the edible wrap, meaning that a thin layer is a must. Finally, since glycerine is an oily compound and the recipe tested used a small amount, leaving some traces behind when pouring it into the mixture might have affected the success in the flexibility of the wrap. As

per the differences between the open and closed storage of the wraps, it has been previously evidenced that a closed container is effective in obtaining the desired texture, an open storage may cause a significant moisture loss.

Gellan gum low acyl was not provided in the working session, hence the test of different concentrations of this compound to improve the softness and texture of the savoury dice could not be performed. Gellan gum high acyl was then tested at 0.5 and 0.6%, however, its opaqueness and white colour, as a thick and milky fluid hindered the final product desired and its setting did not succeed (see Fig. 15 and 16).

Fig. 15. Consistency of mushroom cube recipe N°1 attempt based on gellan gum HA 0.5% before storage.

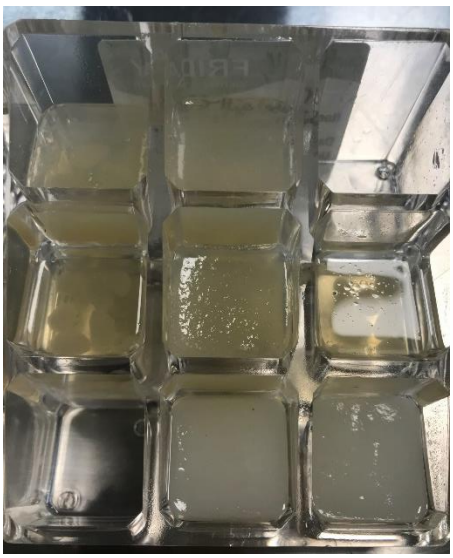

Fig. 16. Agar and gellan cubes. Top left: agar 2%, middle row extreme cubes: agar 0.3%, middle row middle cube: 3% agar, bottom right: gellan gum 0.5 & 0.6%.

Agar agar was subsequently chosen from the ingredients at hand in the final working session as a compound to achieve a self-standing cube. 3%, 2% and 0.3% concentrations of it within 3 recipes were tested. 3% agar agar resulted in a hard, not pleasant texture at taste, while 0.3% could not support the cube form (see Fig. 17 & 19). 2% concentration still resulted in a hard texture. 1% concentration is recommended for future tests with agar agar in future as well as 0.4-0.6% concentrations for future tests with gellan gum low acyl, as the latter seems to offer the best clarity and color for the desired cube (agar agar gives a slightly yellow and turbid tone, which could seem as a broth or soup attempt).

Fig 17, 18, 19. Agar agar mushroom cubes 3-0.3% from left to right.

Gel ovals texture and flavour were achieved as shown in Figure 20. The colour changed during the cooling/resting of the mixture as it was darker in brown tones when prepared (before spherification). This could have happened due to oxidation of the colouring compounds with the recently heated mixture. This must be taken into consideration for future work.

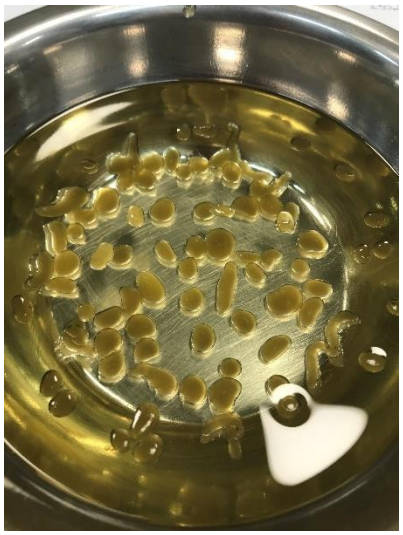

Fig. 20. Gel ovals made through cold-oil spherification.

Regarding the inclusion of inulin in the recipe, a honey glaze was proposed as a decorative feature and since honey gives a good contrast in flavour with truffle recipes. Inulin behaved as granulated sugar when caramelizing (see Fig. 21), so it is a good option for this element. In addition, it contributed –in a healthier way—to the sweetness of the glaze. The caramelization colour may be sufficient for the purpose, however, since it was the first trial of the recipe, addition of brown colour (see Fig. 22) was considered originally to guarantee the similarity with honey, it was in excess though.

Fig 21. Inulin caramelization.

Fig 22. Honey glaze made with inulin powder.

Conclusions

- The edible candy wrap is prone to failure if a thick layer of mixture, not enough food-grade glycerine, not enough rest hours or storage in an open space is applied.
- Low acyl gellan gum concentrations could not be tested.
- High acyl gellan gum was effectively tested as gelling agent, but sensitivity to salts might hinder its setting.
- Gel ovals were achieved for the final dish.
- Dietary fibre was incorporated into the final dish as an inulin honey glaze.