Note by Note Cooking

Utilizing Beer Waste Components to Enhance Tapioca Starch Bread Characteristics

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Introduction

This report delves into the concept of molecular gastronomy and its application in addressing the global issue of food waste. Molecular gastronomy is a scientific discipline that merges culinary arts with principles of physics, chemistry, and biology to explore the fundamental transformations that occur during food preparation (Burke et al., 2016). Developed in the late 20th century, it revolutionized the culinary world by providing a deeper understanding of the physical and chemical processes underlying cooking techniques (Lobefaro et al., 2021).

At the core of molecular gastronomy is the concept of "Note by Note" cooking, a reductionist approach that dissects food components into their fundamental building blocks. Chefs can create precise and innovative dishes by isolating and reassembling individual compounds, offering precise control over flavor, texture, and presentation. This approach relies on scientific techniques like emulsification, spherification, gelification, and foaming, as well as specialized tools and ingredients such as liquid nitrogen, vacuum chambers, and hydrocolloids (This, 2019). Through these techniques, chefs can manipulate the physical properties of ingredients, resulting in unique textures and transforming familiar flavors. The objective of note by note cooking extends beyond culinary creativity. It serves as a platform for scientific exploration, deepening our understanding of the complexities of taste, aroma, and mouthfeel by dissecting and reconstructing food at a molecular level.

While molecular gastronomy explores the art and science of cooking, it can also intersect with the global issue of food waste (Precup et al., 2021). Reports by the Ministry of Ecology and the FAO indicate that approximately one-third of the food produced worldwide is lost or wasted annually, in total about 1.3 billion tons annually, with detrimental effects on the environment, economy, and society. This waste occurs throughout the supply chain, from production to consumption, and poses challenges in developing and developed countries alike (Göbel et al., 2015). Addressing food waste requires the collaboration of multiple stakeholders, including governments, farmers, food processing and distribution companies, restaurants, NGOs, and households. Efforts to combat food waste are crucial for achieving sustainable development goals, preserving natural resources, and reducing poverty and inequality.

Within the context of molecular gastronomy and food waste, by showcasing the similarities in ingredients between bread and beer, this report underscores the potential for creative utilization of beer waste components to elevate the quality and sensory attributes of tapioca starch bread.

The beer production process involves several successive operations, including malting, milling, mashing, lautering, adding hops or hop extract, boiling the beer wort with these additives, disposal of spent hops and precipitated trub, cooling the wort and aeration, fermentation with yeasts, removal of yeast, conditioning, and packaging. The most abundant brewery by-product is formed after the mashing process, known as "spent" grain, while another type of waste is generated after boiling the wort in the kettle, resulting in the precipitation of high molecular weight proteins (hot trub), which contains spent hops. Yeasts are added during fermentation, and most yeasts are removed (brewers spent yeast) from the young beer before packaging (Rachwał et al., 2020).

The accumulation of brewery wastes poses economic and ecological challenges, leading to the search for ways to reduce industrial waste production. The food industry aims to change the traditional approach to waste products by finding new applications and turning them into co-products (Fărcaş et al., 2017. Brewery by-products have the potential to be utilized in the food industry due to their properties, but their current use is limited. Food science and technology focus on valorizing food industry by-products for the production of chemicals, raw materials, and other value-added compounds (Bharat Helkar and Sahoo, 2016).

While the focus remains on a theoretical exploration, this report serves as a foundation for future research and development in the field of molecular gastronomy, inspiring further experimentation and innovation in utilizing beer waste and by-products in note by note cooking. Furthermore, the exploration of beer waste within molecular gastronomy presents a unique and innovative approach. While beer waste has traditionally been repurposed in various food products (Olivares-Galván et al., 2022) , its application within molecular gastronomy dishes opens up new possibilities for culinary creativity and experimentation.

Aims and Objectives

The aim of this project is to explore and demonstrate the creative utilization of beer waste components in molecular gastronomy cooking techniques to develop innovative and visually captivating dish. Additionally, the project aims to raise awareness about the global issue of food waste and promote sustainable practices within the food industry by showcasing the potential of repurposing beer waste components within practical note by note cooking.

Objectives:

- Theoretically explore and evaluate the potential of utilizing beer waste components in molecular gastronomy cooking techniques.
- Raise awareness about the critical issue of food waste in the food industry, specifically within the context of beer production, and emphasize the importance of adopting sustainable practices throughout the food supply chain.
- Investigate and optimize the utilization of tapioca starch and gluten in bread recipes to achieve a unique and desirable texture that aligns with the overall concept of the dish.
- Investigate the potential of using ale yeast in bread baking to enhance the flavor and texture of the bread.
- Use green coloring to visually represent the characteristic color of hops in the dishes, ensuring a visually captivating presentation.
- Experiment with nutritional yeast and maltodextrin as effective flavor enhancers and texturizers in the yeast and grain component of the dish.
- Explore and refine molecular gastronomy techniques to create a beer-inspired foam using with the objective of achieving a visually appealing beer-like foam.

Materials and Method

Element	[g] per Recipe	[%] per Recipe	Ingredient	Producer*
Bread	20	4.65	Tapioca Starch	COCK
	100	23.3	Gluten	Bio-Bäckerei Spiegelhauer
	70	16.3	Egg White Powder	Louis François
	55	12.8	Serum Milk Proteins	Sports Supplements Limited t/a Bulk™
	2	0.5	Ale Yeast	Fermentis
	180	41.9	Water	/
	3	0.7	Salt	/
Spent Grain	20	18.2	Agar-Agar	SOSA
	20	18.2	Nutritional Yeast	Marigold Engevita
	10	9.1	Maltodextrin	SOSA
	10	9.1	Coconut Oil	KTC
	30	27.3	Water	/
	20	18.2	Barley Malt Extract	Meridian Foods
Spent Hops	10	90.5	Maltodextrin	SOSA
	0.05	0.4	Green And Yellow Coloring	II Punto Italiana
	1g	9	Water	/
Spent Yeast	20	5.6	Agar-Agar	SOSA
	20	5.6	Nutritional Yeast	Marigold Engevita
	10	2.8	Maltodextrin	SOSA
	10	2.8	Coconut Oil	KTC
	300	83.3	Water	/
Foam	100	89.3	Water	/
	10g	8.9	Egg White Powder	Louis François
	2g	1.8	Lecithin	SOSA
	one drop	0.04	Lemon Flavoring	MSK Ingredients Ltd

*Picture of each ingredient/model can be seen in appendences.

Equipment*	
Stove	Electrolux Modular Cooking Range Line 2-Burner
Oven	Electrolux Skyline Premium
Immersion Blender	Robot Coupe Stick Blender MP450 Ultra
Robot Coupe	Robot Coupe Cutter Mixer R2

Utensils	
7x	Kitchen Bowl
1x	Oven Tray
2x	Saucepan
2x	Plate

Bread

- In a bowl, mix together all the dry ingredients.
- In a separate bowl, dissolve the yeast in a small amount of warm water.
- Add the dissolved yeast to the dry mixture and stir well.
- Gradually add the remaining water to the mixture, stirring constantly.
- Continue to knead the dough until it becomes elastic and smooth.
- Cover the dough and let it rest in a warm place for 15 minutes.
- Preheat the oven to 220°C.
- Divide the dough into small pieces and shape them into desired shapes.
- Place the bread in the oven and bake for 10-15 minutes or until golden brown.
- Remove from the oven and let it cool.

Spent grain

- In a saucepan, mix together 300ml of water and 20g of agar agar.
- Bring to a boil, then reduce heat and simmer for about 5 minutes, stirring constantly, until the agar agar has dissolved.
- Add 20g of nutritional yeast, 10g maltodextrin, and 10g of coconut oil to the saucepan. Whisk until fully incorporated.
- Add 20g of barley malt extract for the color.
- Remove the mixture from heat and pour it on a plate. Allow it to cool and solidify for about 30 minutes at room temperature.
- Once the mixture has solidified, use Robot Coupe to break it into small pieces that resemble spent yeast.
- To serve, arrange the spent yeast pieces on a plate.

Spent hops

- Place 10 g of maltodextrin in a bowl.
- Mix a few drops of green and yellow food coloring with water. The amount of food coloring will depend on the intensity of green color, so adjust to your preference.
- Using a fork or a whisk, mix the maltodextrin and colorings together until the maltodextrin absorbs the liquid and forms a powder with the desired color.
- If the mixture is too dry, add a few drops of water at a time and continue mixing until achieve the desired consistency.

Spent yeast

- In a saucepan, mix together 300ml of water and 20g of agar agar.
- Bring to a boil, then reduce heat and simmer for about 5 minutes, stirring constantly, until the agar agar has dissolved.
- Add 20g of nutritional yeast, 10g of maltodextrin, and 10g of coconut oil to the saucepan. Whisk until fully incorporated.
- Remove the mixture from heat and pour it on a plate. Allow it to cool and solidify for about 30 minutes at room temperature.
- Once the mixture has solidified, use Robot Coupe to break it into small pieces that resemble spent yeast.
- To serve, arrange the spent yeast pieces on a plate.

Foam

- In a bowl, combine 10g of egg white powder with 100g of water. Mix well until the egg white powder is fully dissolved.
- Transfer the mixture to a blender or a mixing container suitable for an immersion blender.
- Add 2g of lecithin powder to the mixture. Lecithin acts as a stabilizer and helps to create a stable foam.
- Add one drop of lemon flavor to the mixture, to taste.
- Use an immersion blender to blend the mixture on high speed for about 1-2 minutes, until a thick and foamy texture is formed.
- Allow the foam to rest for a few minutes to allow any bubbles to settle.
- Skim off any excess foam from the top, leaving behind the stabilized foam.

Results

In the experimental part of the project, the ingredients listed in Table 1 were used to create a visually appealing bread. The extra components in the dish were included to visually convey the similarities between the ingredients commonly used in beer and bread production. Additionally, the appearance of these components resembled the visual appearance of beer ingredients, helping to tie the dish together thematically.

Tapioca Starch Bread

Over the course of two weeks, the bread recipe was developed and refined. In the first two weeks, a Note by Note recipe (Burke Róisín et al., 2021) was initially intended to be used as a reference to develop a new bread. However, due to the absence of a key ingredient, wheat starch, an alternative approach was taken. Instead, two new breads were developed using corn and tapioca starch with two different yeast strains, lager and ale yeast. A total of four breads were baked and evaluated, with the bread made with corn starch showing unsatisfactory results (Figure 1-3). The texture of the bread was dry, and the crust separated from the inner part of the bread, making it unsuitable for the desired final dish.

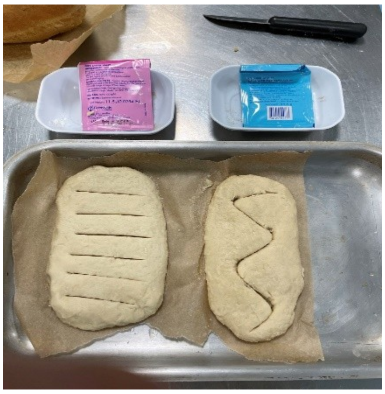

Figure 2: Corn Starch Bread Before Baking

Figure 3: Corn Starch Bread After Baking

Figure 1: Comparison of Tapioca Starch and Corn Starch Bread

On the other hand, the bread made with tapioca starch (Figure 4-6) using both lager (below the pink sachet) and ale yeast (blue sachet) showed better characteristics. During baking, however, the dough started to form a ball shape instead of the intended bread shape, indicating potential challenges in the baking process.

Figure 4: Tapioca Starch Bread Before Baking

Figure 5: TSB forming a ball shape during baking

Figure 6: TSB After Baking

In the next week challenges in achieving the desired shape and texture were still present. Despite increasing the gluten content in the recipe, the first batch resulted in a ball-shaped bread. Attempts were made to vary the shape and reduce the baking time in subsequent batches, however, the bread had a tough texture. Ultimately, changes were made to the recipe that resulted in a grissini-like texture, although the bread ended up being harder than attended (Figure 8 and 9). While the texture was not optimal, the final product did have an improved visual appeal.

Figure 8: Final Recipe - Tapioca Starch Bread After Baking

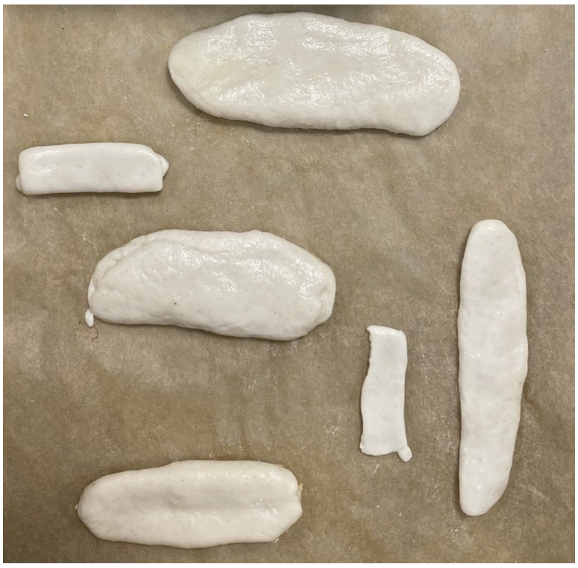

Figure 7: Final Recipe - Tapioca Starch Bread Before Baking

Furthermore, it is important to acknowledge that the texture of the bread could have been more akin to traditional wheat bread if wheat starch had been used as a key ingredient, since the texture was too chewy (Figure 7). Based on the evaluation of the breads made with tapioca starch and ale yeast, the overall appearance of the Note by Note bread was deemed satisfactory. However, further development could be done to further improve the texture and taste of the final dish. Although the texture was not completely reminiscent of traditional wheat bread, given the time constraints, the obtained texture was considered satisfactory. It is worth noting that the use of wheat starch or what spent grain, could potentially improve the texture of the final product. Further research and experimentation are needed to refine the recipe and optimize the recipe.

Figure 9: Tapioca Starch Bread

“Beer” Grains and Yeast”

Continuing with the experimentation, "spent grain and spent yeast" were produced using the same recipe (Table 1), with the addition of malt barley extract to the spent grain mixture to achieve the desired color. The resulting products demonstrated satisfactory color appearance, although there is still potential for improvement in texture. Moreover, both products had a similar taste, with the spent grain being noticeably sweeter due to the presence of barley malt extract. It is important to highlight that further refinement in taste could be achieved through the exploration of different ingredient combinations and recipe adjustments to create a more distinctive flavor profile for each product, while still aligning with the overall beer concept.

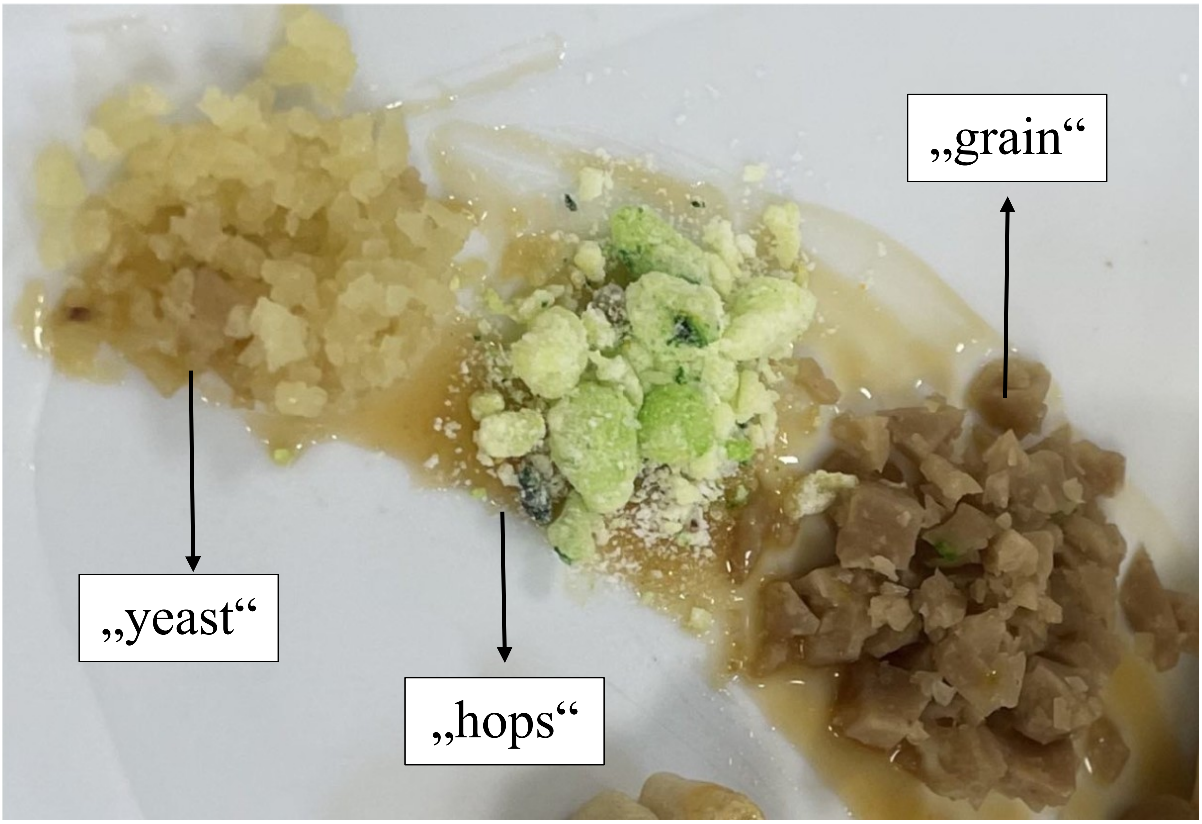

Figure 10: Additional Elements of the Dish

“Beer” Hops

In the hops development experimentation, two different recipes were attempted. The first recipe involved utilizing the spherification technique with green food coloring. Unfortunately, the spherification of the brewers' spent hops was unsuccessful. This issue may have resulted from the size of the spheres produced, as smaller spheres were attempted, which may have led to challenges with spherification.

During the second experimentation, a new recipe was employed, as shown in Table 1. Maltodextrin was mixed with green and yellow food coloring to create a powder that resembled hop powder and hop pellets in appearance. However, obtaining the desired texture proved challenging, as adding too much water caused the maltodextrin to become too wet, resulting in the loss of its sand-like texture. Additionally, the food coloring was too thick, and had to be mixed with water separately before adding it to the maltodextrin mixture, making it difficult to obtain the desired texture. Despite these challenges, the final product was deemed satisfactory in terms of appearance and was successfully used in the dish however the taste and uniformness of the shape could be further improved (Figure 10).

“Beer” Foam

In the experimentation of the "beer" foam recipe, the aim was to create a foam that imitates the appearance of beer foam using ingredients that are commonly found in molecular gastronomy. In the first attempt of the foam creation, satisfactory results were not obtained (Figure 11). Upon evaluation of the results, it was determined that the beer foam requires further improvement to achieve the desired texture (Figure 12). The texture was observed to be too gel-like, whereas the desired texture was more akin to foamy, such as that of egg whites. Moving forward, in the next week final recipe utilized the ingredients from the Table 1.

The final recipe produced a satisfactory result in terms of texture and consistency, although there were some limitations in achieving a more realistic beer-like appearance.

Figure 11: “Beer” Foam First Attempt

One of the main issues was the density and color of the foam, which appeared to be too dense and a bit whiter than of beer foam. The foam included lemon flavour to mimic the wheat beer taste palate. Further experimentation and adjustment of the recipe may be necessary to achieve a more authentic appearance that more closely resembles that of beer foam.

Figure 12: Final Presentation of the "Beer"Foam

In the experimentation process, in the first attempt to create a beer trace using neutral oil, malt extract, xanthan gum and colorants was made. However, the result was unsatisfactory as the mixture lacked a distinct beer-like flavor and the color was not vibrant enough. Adjusting the amount of malt extract did not significantly enhance the taste, and the addition of xanthan gum did not improve the texture. As a result, an alternative approach was explored. The alternative method involved using barley malt extract as a direct drizzle on the plate, as shown in Figure 12. This approach offered a malty component that complemented the other beer ingredients on the plate. The malt extract added a subtle sweetness and a rich color that enhanced the overall sensory experience of the dish.

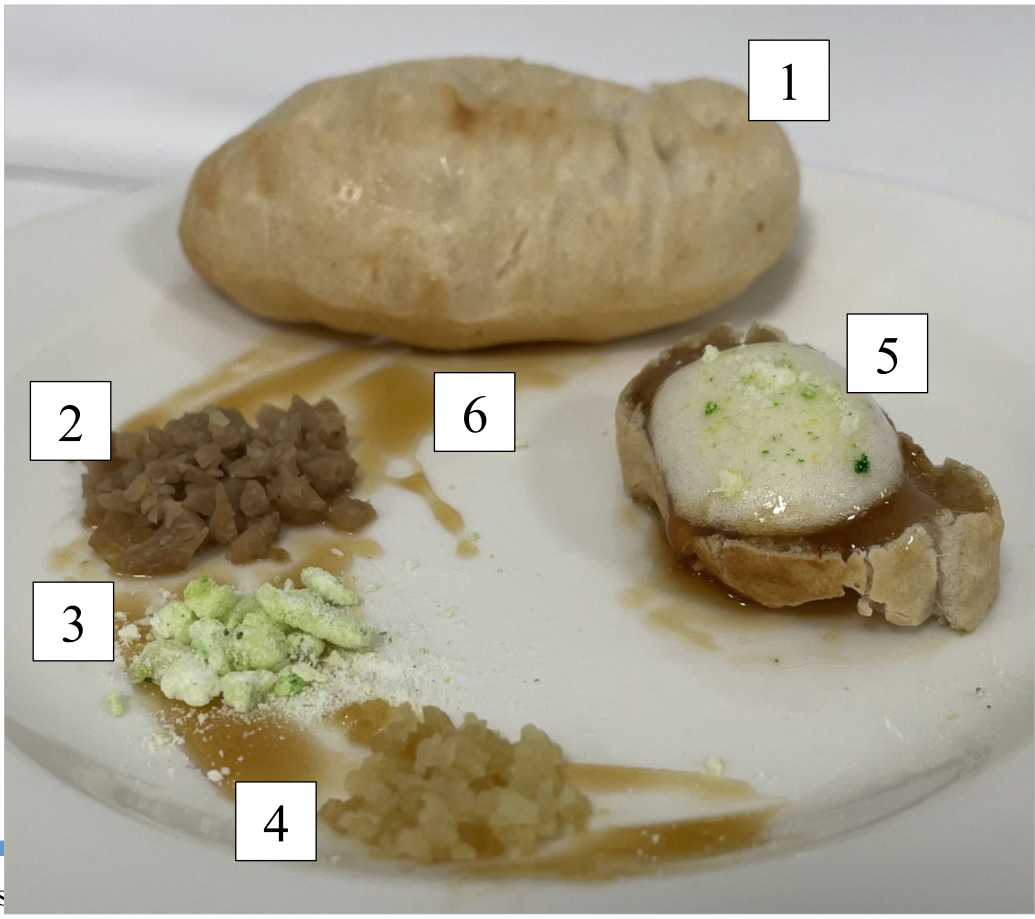

Figure 13: Final Presentation of the Dish

In conclusion, the culmination of the four-week course is reflected in the final plating of the dish, including bread (1), "spent" grain (2), "beer" hops (3), "spent" yeast (4), "beer" foam (5) and "beer" trace (6), presented in the Figure 13.

Discussion

Tapioca Starch Bread

Regarding the final recipe for the bread and the main issues faced such as ball shaped bread and too chewy texture that is not traditional bread like, there could be several reasons why tapioca starch bread formed a ball shape after a few minutes of baking. Tapioca starch has a high amylopectin content and low amylose content (Charles et al., 2005), which contributes to its unique properties such as high viscosity, chewiness, and translucent appearance (Hsieh et al., 2019). When heated, the starch granules in tapioca starch absorb water and swell, resulting in a gel-like texture. This gel-like texture can become more pronounced when baked, causing the bread to form a ball shape as it loses its ability to hold its shape. The one possible solution for the issue could be to use enzymes like transglutaminase, which can cross-link proteins in the dough, resulting in a firmer and more elastic structure (Bauer et al., 2003). This can help the bread hold its shape better and prevent it from collapsing into a ball. Additionally, amylase could be other option since it can be used to break down the starch molecules in the tapioca starch and create a more traditional bread-like texture (Lagrain et al., 2008). Furthermore, more experiment with using different types of flours or starches, such as potato starch or corn starch, which may have properties that are more similar to wheat flour could be used. Furthermore, tapioca starch has a high water-absorbing capacity (Prameswari et al., 2018), which can lead to a rapid expansion of the dough during baking, causing the bread to rise and then collapse into a ball shape. The other possible solution could be methylcellulose, a thickener and emulsifier that can be used to improve the texture and structure of gluten-free bread (Kim and Yokoyama, 2011). It is also possible that the tapioca starch bread lacked sufficient gluten formation, which can result in a weak bread structure that is prone to collapse.

It is important to note that the baking temperature and time may also play a role in the final outcome, and further investigation may be necessary to determine the exact cause of this issue.

Furthermore the other solution could be to use hydrocolloids, such as xanthan gum, sodium alginate or guar gum, which can enhance the viscosity and elasticity of the dough, resulting in better gluten formation (Encina-Zelada et al., 2019) . Finally, incorporating an emulsifier, such as lecithin, can also help improve gluten formation by stabilizing the dough and reducing the risk of gluten breakdown during mixing and fermentation (Gómez et al., 2004).

Egg white powder and serum milk proteins contain proteins that can also help to improve the structure and texture of the bread (Han et al., 2019) . The proteins in egg white powder can help to strengthen the gluten network (Peng et al., 2022) , while the proteins in serum milk can add moisture and tenderness to the crumb (Tang et al., 2016).

In the current recipe first suggestion would be to work with the current ingredients and increase the gluten content and decrease the tapioca starch content, as well as incorporating more protein isolates such as soy or whey protein, that can improve the texture and structure of the bread, or finally, utilization of different beer yeast strains.

Bread Fermentation

Ale yeast is a type of yeast that is commonly used in beer brewing, and it has several characteristics that can affect the texture and flavor of tapioca starch bread. Ale yeast can contribute to the fermentation of the dough, producing carbon dioxide gas, which helps to create the desired rise in the bread (Heitmann et al., 2015). However, ale yeast may not be as effective in fermenting tapioca starch bread as it would be in a wheat-based bread due to the lack of gluten formation in the dough. As stated in the literature, further improvement could be done in the recipe by using other beer yeast strains, such as S. cerevisiae T-58 and S. cerevisiae s-23 that has better properties in bread making (Heitmann et al., 2015). However, the used Ale yeast Safale S-04 have not enough literature to discuss about its properties in the bread making. It is also worth noting that there are several other factors that can affect the performance of ale yeast in bread making, such as the temperature, hydration level, and pH of the dough.

Additional Elements of the Dish

Regarding the dish's additional element (grain, yeast, hops, and foam), there is potential for further improvement by creating a "beer spread" obtained by mixing the three ingredients with a bit of water, served in place of the malt extract trace shown in Figure 13. Each ingredient's flavor should resemble its characteristic in beer production (such as hop bitterness, malt sweetness, etc.) When all four components are mixed together, the result is a "beer spread" that can be spread onto bread and topped with foam to mimic the experience of enjoying a pint of beer. By extracting and concentrating their flavors, and utilizing solubility-enhancing techniques, a spreadable mixture can be created. However, further research and understanding are necessary to fully realize the feasibility and intricacies of this concept within molecular gastronomy.

Possibilities of Beer Waste Utilization

Moving forward to the real beer production waste and characteristics of the brewers spent grain. Brewing generates large amounts of residues including barley malt rootlets, spent hops, and spent yeast. These residues are sustainable and rich sources of compounds with valuable nutritional and functional properties such as proteins, polyphenols, and polysaccharides. The most abundant residue from brewing (85% of the total residue) is the brewing spent grain (BSG) (Olivares-Galván et al., 2022).

Brewers Spent Grain

BSG is the solid residue obtained from filtering the mixture of malt and water after mashing. It is composed of barley shells, remaining endosperm starch granules, and other materials. It contains a high moisture content (63–80%) (Thiago et al., 2014). Brewer's spent grain (BSG) contains essential components such as fibre and lignocellulosic materials from plant cell walls, proteins, and PCs, while vitamins and minerals are present in smaller amounts. BSG is composed primarily of fibre, which can account for up to 70% of the residue. This fibre is mainly made up of cellulose (12-25%), hemicellulose (20-35%), and lignin (12-28%) (Karlović et al., 2020; Rachwał et al., 2020). The high protein content of BSG (74-78% of malt protein) makes it a potential source of healthy functional food, similar to whey protein. About 30% of the total protein content in BSG is composed of essential amino acids (Fărcaş et al., 2017).

BSG is typically rich in essential amino acids such as lysine, leucine, phenylalanine, isoleucine, threonine, and tryptophan. However, the specific amino acid profiles of BSG can vary depending on the type of malt used during the brewing process (Waters et al., 2013). Despite their nutritional value, BSG proteins are not extensively utilized in food products due to their insolubility (Fărcaş et al., 2017). Nevertheless, research has demonstrated that the insoluble protein fraction obtained from BSG can serve as a substrate for the production of hydrolysates, which can be incorporated into food products (Vieira et al., 2016). Protein hydrolysates derived from BSG exhibit a range of desirable biological properties in the food industry, including emulsifying, antimicrobial, anti-inflammatory, and immunomodulatory activities (Crowley et al., 2015; McCarthy et al., 2013).

Brewers Spent Hops

Hops are added to the wort when boiling takes place. It enhances beer quality, stabilizes bubbles, inhibits glycolysis, and preserves and clarifies the wort. Before fermentation, spent hops (SH) are removed from the wort by filtering (Karlović et al., 2020; Rachwał et al., 2020). Despite the low amount of SH released during beer preparation, it shows the highest amount of proteins (20–70%) among brewing residues and a high phenolic content. Main amino acids in SH proteins are leucine, valine, alanine, serine, glycine, tyrosine, lysine, and proline. Regarding PCs, catechin, kaempherol, quercetin, and proanthocyanidins are the most abundant. Additionally, essential oils, such as α-humulene, β-myrcene, and limonene (241, 19.1, and 11.2 µg/g, respectively) are also present in SH (Anioł et al., 2007; Bedini et a. Moreover, α- and β-acids, yielding bitter flavour, are also present (Anioł et al., 2007; Bedini et al., 2015; Karabín et al., 2016).

Brewers Spent Yeast

In the last step of beer production, yeast turns fermentable sugars into ethanol and carbon dioxide. Yeasts accumulate at the bottom (lager yeast) of the tank or on the surface (ale yeast) and are removed by centrifugation or filtration. Recovered yeasts can be re-used to produce beer again up to six times (Rachwał et al., 2020; Thiago et al., 2014). Regardless they are repitched or not, they are finally discarded resulting in a residue called brewer's spent yeast (BSY)(Rachwał et al., 2020). BSY is the second most abundant residue from brewing (10–15%) (Rachwał et al., 2020). The amount of BSY depends on fermentation parameters, type of microorganism, inoculum concentration, and wort composition. In addition to a high moisture content (85–90%), it presents a considerable amount of proteins and carbohydrates. Proteins in BSY are rich in glutamic acid, histidine, alanine, and aspartic acid (Amorim et al., 2016; S, while methionine and cysteine are usually the amino acids limiting their nutritive value. Especially interesting is the fact that some of most abundant amino acids are flavour enhancers—glutamic acid, aspartic acid, glycine, alanine (Amorim et al., 2016; Sosa-Hernández et al., 2016; Vieira et al., 2016). An appreciated constituent of BSY carbohydrates fraction are β-glucans. β-glucans consist of a heterogeneous group of glucose polymers. Furthermore, BSY also contains B-group vitamins and flavour enhancer nucleotides with a high potential in food industry (Jaeger et al., 2020; Karlovi´c et al., 2020; Thiago et al., 2014).

Brewer's spent yeast (BSY) is a valuable source of various saccharides including β-glucans and mono-, di-, and oligosaccharides like trehalose and mannans. β-glucans, known for their water-binding properties, have found successful applications in the food industry as water retention additives and thickening agents (Zechner-Krpan et al., 2010). BSY can also serve as a potential source for trehalose production, as yeasts synthesize trehalose during fermentation. Trehalose offers benefits such as improving food texture, enhancing food flavor release, and stabilizing proteins. Trehalose, due to its humectant activity, is added to various products such as confectionery, bread, ice creams, and soft drinks (Rachwał et al., 2020). Mannoproteins obtained from BSY possess emulsifying properties and stabilizing effects, making them suitable for use in mayonnaise formulations (Silva Araújo et al., 2014). Moreover, crude extracts derived from BSY have been identified as a source of invertase, an enzyme that converts sucrose and polysaccharides into fructose and glucose. Invertases find applications in the food industry, particularly in confectionery, as catalysts in the production of artificial sweeteners (De León-González et al., 2016; Veana et al., 2018).

Arabinoxylan can be used in the food industry, as it can influence the water-holding capacity of food and dough starch retrogradation and can improve the quality and properties of bread (Cui et al., 2013).

Beer Waste Components and Note by Note Cooking

Considering the challenges encountered in the production of tapioca starch bread, as discussed earlier, the utilization of beer waste components presents a vast array of possibilities for further exploration and improvement of the presented tapioca starch bread. The incorporation of beer waste components into bread production not only offers a sustainable approach to utilizing by-products but also introduces unique characteristics and potential functional properties to the final product.

Tapioca starch bread production faced the issue of being too chewy and forming a ball shape. BSG's high fiber content, including cellulose, hemicellulose, and lignin, enhances the overall texture and structure of the bread (Sudha et al., 2007) , and potentially resulting in a more traditional bread-like texture and minimizing the ball shape formation. In addition, BSG proteins, despite being insoluble, can be hydrolyzed to create protein hydrolysates. These hydrolysates have shown various functional properties in the food industry, such as emulsifying, antimicrobial, anti-inflammatory, and immunomodulatory activities (Celus et al., 2007) . While their direct impact on gluten formation in tapioca starch bread may not be well-documented, incorporating BSG protein hydrolysates into the bread dough could potentially offer additional functional benefits. Furthermore, BSG contains mannoproteins that act as emulsifiers and stabilizers, which showed comparable effects to the commercial emulsifiers gum arabic and lecithin (Dikit et al., 2010; Li and Karboune, 2019) . These components could contribute to enhancing the texture and stability of the bread, possibly resulting in improved gluten formation and a more desirable structure.

Enzymes present in BSY, such as invertase, superoxide dismutase, nucleases, and phosphotransferase, could play a role in improving the fermentation process and dough characteristics. For example, it has been shown that invertase showed that invertase activity and specificity can be used to modulate the fructan content in bread, allowing the production of low FODMAP breads, or alternatively, breads with a higher soluble dietary fibre content (Laurent et al., 2020).

The saccharides present in BSY, such as β-glucans, trehalose, and mannans, offer additional benefits to bread production. These saccharides serve as water-holding agents, thickening agents, and emulsifying stabilizers (Thammakiti et al., 2004), thereby improving the texture and quality of the bread. Moreover, BSY contains arabinoxylan, a component that influences the water-holding capacity of the dough and starch retrogradation. Incorporating arabinoxylan into the bread formulation further enhances the quality and properties of the bread, including its texture and moisture retention (Stojceska and Ainsworth, 2008).

Incorporating BSG and BSY into the bread production process also enhances the flavor profile of the final product naturally. BSG and BSY are rich in flavor-enhancing compounds such as 5-nucleotides, peptides, and amino acids like glutamic acid.

By utilizing BSG and BSY its components, including proteins, fibers, saccharides, and enzymes, it could be possible to address the challenges faced in tapioca starch bread production. These ingredients could contribute to improved texture, structure, gluten formation, moisture control, flavor enhancement, and overall quality of the bread, offering a more sustainable and functional approach to bread production.

Conclusion

During the production of tapioca starch bread, several challenges were encountered, including the formation of a ball shape and a chewy texture. These issues can be attributed to the unique properties of tapioca starch, such as its high amylopectin content and low gluten formation. To address these challenges, various theoretical solutions were explored, including the use of enzymes like transglutaminase and amylase to improve the dough structure and achieve a more traditional bread-like texture. Hydrocolloids, such as xanthan gum, sodium alginate, and guar gum, were also suggested to enhance the viscosity and elasticity of the dough. Additionally, incorporating proteins from sources like egg white powder and serum milk proteins, as well as utilizing different beer yeast strains, were proposed to strengthen the gluten network and improve the overall structure and texture of the bread.

Furthermore, the incorporation of beer waste components, such as brewer's spent grain (BSG) and beer yeast (BSY), into the bread production process offers numerous benefits. BSG's high fiber content, including cellulose, hemicellulose, and lignin, can improve the texture and structure of the bread, while BSG proteins and hydrolysates can contribute functional properties and enhance gluten formation. Enzymes and saccharides present in BSY can improve the fermentation process and dough characteristics, while flavor-enhancing compounds in both BSG and BSY can naturally enhance the flavor profile of the bread.

Overall, the utilization of beer waste components could present a sustainable and functional approach to bread production, offering opportunities for improved texture, structure, gluten formation, moisture control, flavor enhancement, and overall quality. By exploring and harnessing the potential of these waste components, not only unique and visually captivating dishes could be created but also contribute to a more sustainable and responsible food industry.

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Appendences

Element	Ingredient	Producer	
Bread	Tapioca Starch	COCK	
	Gluten	Bio-Bäckerei Spiegelhauer	
	Egg White Powder	Louis François	
	Serum Milk Proteins	Sports Supplements Limited t/a Bulk™	
	Ale Yeast	Fermentis	
	Water	/	
	Salt	/	

<table>
<tr><td rowspan="6">Spent Grain</td><td>Agar-Agar</td><td>SOSA</td><td>
</td></tr>
<tr><td>Nutritional Yeast</td><td>Marigold Engevita</td><td>
</td></tr>
<tr><td>Maltodextrin</td><td>SOSA</td><td>
</td></tr>
<tr><td>Coconut Oil</td><td>KTC</td><td>
</td></tr>
<tr><td>Water</td><td>/</td><td></td></tr>
<tr><td>Barley Malt Extract</td><td>Meridian Foods</td><td>
</td></tr>
</table>

Spent Hops	Maltodextrin	SOSA	
	Green And Yellow Coloring	II Punto Italiana	 
	Water	/	

Spent Yeast	Agar-Agar	SOSA	
	Nutritional Yeast	Marigold Engevita	
	Maltodextrin	SOSA	
	Coconut Oil	KTC	
	Water	/	

Foam	Water	/	
	Egg White Powder	Louis François	
	Lecithin	SOSA	
	Lemon Flavoring	MSK Ingredients Ltd	

Equipment	
	Electrolux Modular Cooking Range Line 2-Burner
	Electrolux Skyline Premium
	Robot Coupe Stick Blender MP450 Ultra
	Robot Coupe Cutter Mixer R2

Logbooks

MODULE CODE: TFPD9022

MODULE TITLE: Molecular Gastronomy

STUDENT NAME: Iris Starcevic

FOOD PRODUCT:

WEEK NO.: 1 **DATE:20/03/2023**

Weekly Aims and Objectives:

Aim: To evaluate and select the most suitable option between "Note by Note Grissini" and "Note by Note Bread" for further product development, based on their texture and visual appearance.
Objectives:

- to make “Note by Note Grissini” using the ingredients and process from Molecular Gastronomy Handbook.
- to make “Note by Note Flour” mixture
- to make “Note by Note Bread” with the ingredients given in the Handbook
- to come up with “Note by Note Bread” process
- to use tree different colorants (blue, red, green) for the both option
- evaluate and compare the texture and visual appearance of "Note by Note Grissini" and "Note by Note Bread" and select the most suitable option for further product development.

Materials and Method (Ingredients, Equipment and Method)

Ingredients:

	INGREDIENTS
250g	*water*
41g	*egg white proteins*
3g	*xanthan gum*
9g	*isomalt*
1,5g	*salt*
0,6%	*white vinegar/acetic acid solution in water of 4,5%*
0,3%	*odorant solution Bread crust*
760g	*wheat starch*
120g	*gluten*
8g	*egg white powder*
5g	*serum milk proteins*
27g	*cellulose*
1x portion	*Note by Note flour*
8g	*yeast*
20g	*salt*
720g	*water*
3g	*lipids*
10g	*serum milk proteins*
0,4g	*monosodium glutamate*
30ml	*sunflower oil*

Equipment:

	EQUIPMENT
1x	*hand blender*
1x	*kitchenaid -mixer*
1x	*piping bag*
3x	*bowl*
1x	*scale*

Method:

“Note by Note Grissini

- Blend all the ingredients except the odorant solution “Bread crust”.
- When all is blended well with a hand blender, put the mixture in a Kitchenaid bowl with the whisk attachment and whip the mixture until very light and fluffy; it should be like a meringue.
- At this point, add the odorant solution drop by drop on the medium- low speed.
- Put the mixture in a piping bag and form grissini shapes in a dehydrator tray covered with baking paper.
- Dehydrate at 60°C for 12 hours or overnight.
- Before drying, sprinkle with any kind of seeds if you wish, but this is optional.

Results and discussion

During the first week of the project, the aim was to follow the recipes for Note by Note grissini and Note by Note bread as described in the Molecular Gastronomy Handbook. The objective was to choose the more suitable option for further product development, considering texture and visual appearance. Due to time constraints, only the Note by Note grissini were prepared and evaluated. After a 12-hour drying period, the grissini was observed and the texture was harder than desired, and lacked the desired level of softness. These results suggest that further modifications to the recipe and cooking process are necessary to achieve the desired texture and visual appearance. Additional experimentation with different ratios and cooking times may be necessary to optimize the recipe and achieve the desired results. Additionally, the colorants used in the grissini did not contribute to a visually appealing product. Furthermore, In preparation for the

Figure 14: Note by Note Grissini prior to drying

following week's development of the note by note bread, the note by note flour mixture was also prepared using the appropriate ingredients and process.

Conclusion&Recommendations

In conclusion, the first week's experiment provided valuable insights into the challenges and opportunities associated with using Note by Note techniques in bread-making. Although the Note by Note grissini did not exhibit the desired properties, it provided a basis for further development of the Note by Note bread recipe, which will be improved and adopted in the coming weeks. The aims and objectives for the first week were successfully achieved, as "Note by Note Grissini" was made, "Note by Note Flour" mixture was prepared, and valuable information was gained about the texture and visual appearance of the product. The next step will be to compare and evaluate the texture and visual appearance of the "Note by Note Bread" and the "Note by Note Grissini" and select the most suitable option for further product development. Overall, this first week's experiment provided a solid foundation for future development in the project.

MODULE CODE: TFPD9022

MODULE TITLE: Molecular Gastronomy

STUDENT NAME: Iris Starcevic

FOOD PRODUCT:

WEEK NO.: 2 **DATE:27/03/2023**

Weekly Aims and Objectives:

Aim: To produce two different breads made from beer waste, namely "Lager Bread" using lager yeast and "Ale Bread" using ale yeast, and evaluate their texture and overall appearance for further development.

Objectives:

- to come up with Note by Note Bread process
- to make Note by Note Breads
- to make one lager Note by Note Bread by using lager yeast
- to make ale Note by Note Bread by using ale yeast
- to compare the texture and overall appearance of the lager and ale Note by Note Breads with the Note by Note Grissini from the previous week's experiment.

Materials and Method (Ingredients, Equipment and Method)

amount [g]	***ingredient***
Corn starch bread	
190	*corn starch*
30	*gluten*
70	*egg white powder*
50	*serum milk proteins*
Tapioca starch bread	
200g	*tapioca starch*
60	*gluten*
70	*egg white powder*
50	*serum milk proteins*
Note by note flour	
2	*yeast (lager and yeast)*
5	*salt*
180	*water*
2.5	*serum milk proteins*
7.5	*sunflower oil*
Equipment	
1x	*oven*
1x	*oven tray*
4x	*bowl*
1x	*scale*

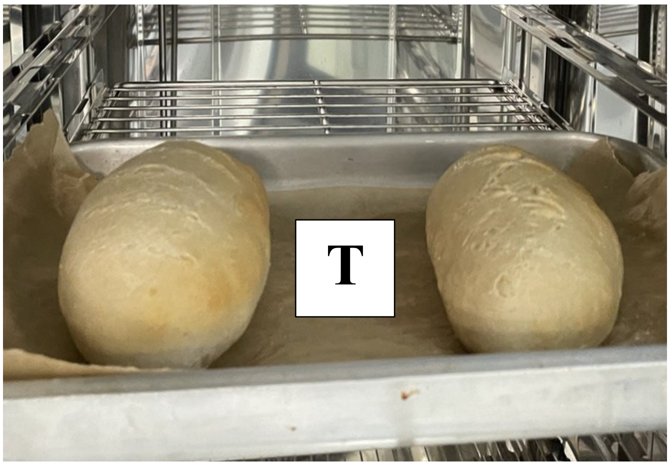
Method:

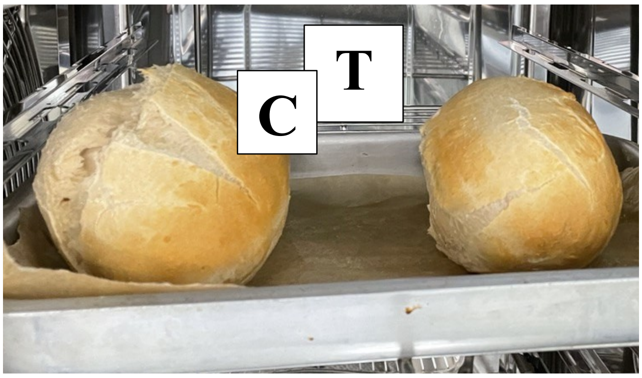
- Preheat the oven to 180°C.
- In two separate bowls, combine the dry ingredients for each bread (corn starch and gluten for the corn starch bread, tapioca starch and gluten for the tapioca starch bread).
- Add egg white powder and serum milk proteins to each bowl and mix well.
- In a separate bowl, prepare the Note by note flour by combining the yeast, salt, water, serum milk proteins, and sunflower oil. Mix well.
- Divide the Note by note flour mixture into two equal portions, and add each portion to the respective bowl containing the dry ingredients for each bread.
- Mix the ingredients together until a dough forms.
- Divide each dough into two equal portions, and add the lager yeast to one portion and ale yeast to the other portion.
- Knead each portion of dough until it becomes smooth and elastic.
- Place the dough portions in separate greased bread pans and cover them with a damp cloth.
- Let the dough rest for about 20 minutes in a warm place to allow it to rise.
- Form the desired shape of the breads.
- Bake the bread in the preheated oven for about 10 minutes or until the crust is golden brown.
- Remove the bread from the oven and let it cool before slicing and serving.

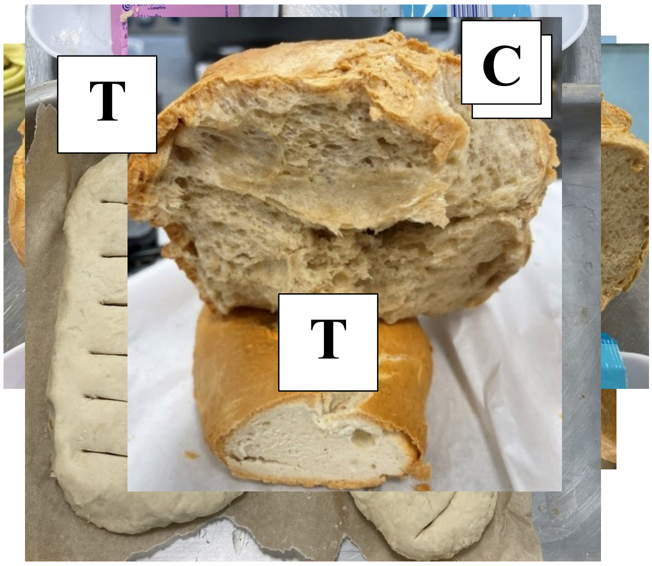
Results and discussion

In this study, the original Note by Note recipe was not used as a reference due to the absence of a crucial ingredient, wheat starch. Instead, two new breads were developed using corn and tapioca starch with two different yeast strains, lager and ale yeast. A total of four breads were baked and evaluated. The bread made with corn starch did not rise well and had a dry texture, making it unsuitable for the desired final product. In contrast, the bread made with tapioca starch using both lager and ale yeast showed better characteristics, although during baking, the dough started to form a ball shape instead of the intended bread shape. These observations could be seen on the pictures below (T – tapioca starch bread; C- corn starch bread, pink sachet is lager and blue one is ale yeast).

There could be several reasons why tapioca starch bread formed a ball shape after a few minutes of baking. Tapioca starch has a high amylopectin content and low amylose content, which contributes to its unique properties such as high viscosity, chewiness, and translucent appearance. When heated, the starch granules in tapioca starch absorb water and swell, resulting in a gel-like texture. This gel-like texture can become more pronounced when baked, causing the bread to form a ball shape as it loses its ability to hold its shape. Additionally, tapioca starch has a high water-absorbing capacity, which can lead to a rapid expansion of the dough during baking, causing the bread to rise and then collapse into a ball shape. It is also possible that the tapioca starch bread lacked sufficient gluten formation, which can result in a weak bread structure that is prone to collapse. It is important to note that the baking temperature and time may also play a role in the final outcome, and further investigation may be necessary to determine the exact cause of this issue.







Conclusions

In conclusion, the aim of producing two different breads made from beer waste, namely "Lager Bread" using lager yeast and "Ale Bread" using ale yeast, and evaluating their texture and overall appearance for further development was successfully achieved. However, due to the unavailability of a key ingredient, wheat starch, the original Note by Note recipe was not utilized as a reference. Instead, the two novel breads were developed using corn and tapioca starch in combination with the two different yeast strains. The texture and overall appearance of the resulting breads were compared with the Note by Note Grissini from the previous week's experiment. The corn starch bread did not rise properly and had a dry texture, while the tapioca starch bread with both lager and ale yeast showed better characteristics, but still had issues with collapsing into a ball shape during baking. Further investigation is needed to address this issue. Based on the observation of the Note by Note Grissini from the previous experiment and the texture and overall appearance of the newly developed breads, it was determined that the tapioca starch bread with both lager and ale yeast showed better characteristics.

Therefore, this bread was chosen as the preferred option for further development.

Recommendations for following week.

Based on the results, it is recommended to further optimize the baking conditions for the tapioca starch bread to prevent it from forming a ball shape. This could involve adjusting the baking temperature or time, or adding more gluten-forming ingredients to improve the bread structure. Additionally, further experimentation could be done with different yeast strains to determine which is most suitable for producing tapioca bread.

MODULE CODE: TFPD9022

MODULE TITLE: Molecular Gastronomy

STUDENT NAME: Iris Starcevic

FOOD PRODUCT:

WEEK NO.: 3 **DATE:17/04/2023**

Weekly Aims and Objectives:

Aim: The aim for week 3 is to enhance the visual appeal of the dish by incorporating elements that represent the beer-making process. Specifically, in addition to the bread, the plate will feature hops, grains, and yeast as complementary components. The goal is to create a cohesive and visually striking presentation that not only showcases the bread but also evokes the essence of beer. Additionally, the objective is to explore different plating techniques and arrangements to achieve an optimal and aesthetically pleasing outcome.

Objectives:

- To produce Note by note brewers spent yeast.
- To produce Note by note brewers spent grains.
- To produce Note by note brewers spent hops.
- To produce a beer-like foam that can visually represent beer for plating.
- To creatively present the dish with the bread, hops, grains, yeast and foam in a visually appealing way that effectively represents the concept of beer.

Materials and Method (Ingredients, Equipment and Method)

	SPENT GRAIN		***BEER FOAM***
20g	*agar-agar*	*100ml*	*water*
20g	*nutritional yeast*	*1g*	*maltodextrin*
10g	*maltodextrin*	*0.5g*	*iota carrageenan*
10g	*coconut oil*	*0.5g*	*kappa carrageenan*
300 ml	*water*		
	SPENT HOPS		***SPENT YEAST***
1g	*agar-agar*	*20g*	*agar-agar*
1g	*xanthan gum*	*20g*	*nutritional yeast*
2g	*maltodextrin*	*10g*	*yeast extract*
2g	*rice flour*	*5g*	*salt*
	green coloring	*300ml*	*water*
1L	*water*	*20g*	*barley malt extract*
5g	*sodium alginate*		
5g	*calcium lactate*		
	EQUIPMENT		
3x	*saucepans*		
1x	*robot coupe*		
5x	*bowls*		
2x	*plates*		

Method:

“Beer foam” [1]

- In a saucepan, combine 100ml of water with 1g of maltodextrin. Heat the mixture on medium heat, stirring constantly, until it dissolves.
- Reduce the heat to low, and add 0.5g of iota carrageenan and 0.5g of kappa carrageenan to the mixture. Whisk the ingredients together until the carrageenan has dissolved.
- Continue to heat the mixture on low heat, stirring frequently, until it thickens.
- Remove the mixture from the heat and allow it to cool to room temperature.
- Using an immersion blender, blend the mixture until it becomes frothy and forms a stable foam.
- Let the foam sit for a few minutes to allow any large bubbles to dissipate.
- Using a spoon or a piping bag, carefully spoon or pipe the foam on top of your desired dish.
- Serve immediately to maintain the stability of the foam.

“Brewers spent hops”

- In a small bowl, mix 1 g of agar-agar with 100 ml of water. Heat the mixture over low heat, stirring constantly, until the agar-agar is completely dissolved.
- In a separate bowl, mix 1 g of xanthan gum with 100 ml of water. Use a hand blender to blend the mixture until it is completely smooth.
- Add the agar-agar mixture to the xanthan gum mixture and blend again until fully combined. The mixture will become thick and sticky.
- Add a few drops of green food coloring to the mixture and stir until the color is evenly distributed.
- Using a dropper or syringe, drop small droplets of the mixture into a bowl of the sodium alginate bath. The droplets should form into small spheres as they solidify in the bath.
- Let the spheres sit in the bath for 2-3 minutes, then remove them with a slotted spoon and rinse them with water to remove any excess sodium alginate.
- Mix 2 g of maltodextrin with a small amount of green food coloring until it forms a powder that resembles hop dust.
- Mix 2 g of rice flour with water to create a paste that can be shaped into small cones or pellets that resemble hop cones.
- To serve, arrange the spheres on a plate and sprinkle the maltodextrin hop dust around them. Add a few of the rice flour hop cones or pellets as garnish.

“Brewers spent yeast” [3]

- In a saucepan, mix together 300ml of water and 20g of agar agar. Bring to a boil, then reduce heat and simmer for about 5 minutes, stirring constantly, until the agar agar has dissolved.
- Add 20g of nutritional yeast, 10g of yeast extract, and 5g of salt to the saucepan. Whisk until fully incorporated.

- Remove the mixture from heat and pour it into a container. Allow it to cool and solidify for about 30 minutes at room temperature.
- Once the mixture has solidified, use a fork or food processor to break it into small pieces that resemble spent yeast.
- To serve, arrange the spent yeast pieces on a plate or in a bowl, and serve as a garnish or side dish to your main dish.

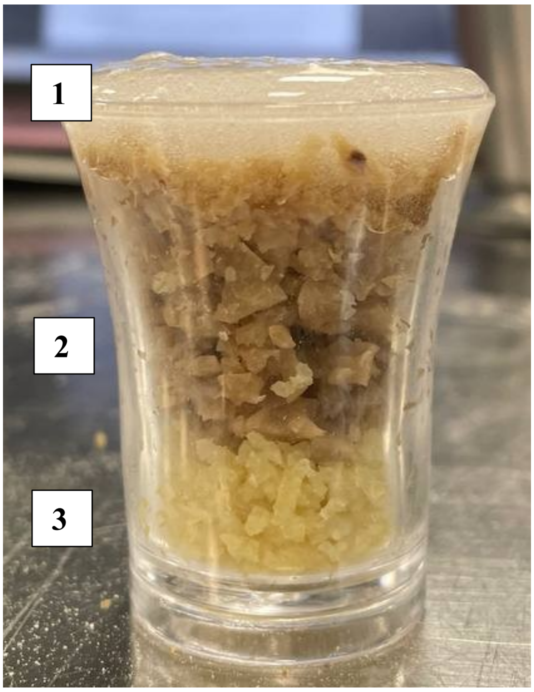
“Brewers spent grain” [2] – the method is same as for brewers spent yeast, with addition of barley malt extract for the color.

Results and discussion

Upon evaluation of the results, it was determined that the beer foam (1) requires further improvement to achieve the desired texture. The texture was observed to be too gel-like, whereas the desired texture was more akin to foamy, such as that of egg whites. Further experimentation with foam stabilizers or alternative ingredients may be necessary to achieve the desired result.

The brewers spent yeast and grains displayed desirable characteristics and were successfully prepared and stored in the freezer for use in the subsequent week's experimentation. However, the spherification of the brewers spent hops was not successful. This could possibly be attributed to the size of the spheres, as attempts were made to create smaller spheres, which may have resulted in issues with spherification. The hops will be further experimented with during the final week of experimentation.

Overall, while progress has been made towards achieving the goal of visually representing beer in the dish, further experimentation and optimization is required to achieve the desired results.



Conclusions

In conclusion, the objectives set for week 3 have been met to a certain extent. The Note by note brewers spent yeast and grains were successfully produced and are now ready for use in future experimentation. However, the spherification of hops was not successful, and further experimentation is required to achieve the desired results. The beer-like foam was created but lacked the desired texture, and further improvements are needed to achieve the desired foamy consistency. Despite these setbacks, the plating techniques and arrangements were explored, leading to the creation of a visually striking presentation that effectively represents the concept of beer. Moving forward, the experimentation will focus on improving the foam texture and spherification of hops while continuing to explore creative plating techniques to enhance the visual appeal of the dish.

Recommendations for following week

- For the beer-like foam, consider experimenting with different ingredients and ratios to achieve a more desired texture that resembles a foamy consistency rather than a gel-like one.
- For the hops spherification, it is important to ensure that the droplets are of the appropriate size to ensure successful spherification. Experiment with the droplet size and the amount of sodium alginate used in the bath.
- Consider exploring different plating techniques and arrangements to achieve an optimal and aesthetically pleasing outcome for the dish.

MODULE CODE: TFPD9022

MODULE TITLE: Molecular Gastronomy

STUDENT NAME: Iris Starcevic

FOOD PRODUCT:

WEEK NO.: 4 **DATE:24/04/2023**

Weekly Aims and Objectives:

Aim: The aim for the final week is to bring together all the components developed over the previous weeks into a cohesive and visually appealing dish that effectively represents the concept of beer. This includes the bread as the main component, along with the complementary elements of yeast, grain, and hops presented in visually creative ways that evoke the essence of beer. Additionally, the aim is to develop a sauce or trace on the plate that adds a beer-like flavor to the dish.

Objectives:

- Develop a balanced bread recipe (with increased gluten content) that complements the visual representation of beer ingredients on the plate.
- Produce brewers spent hops using note-by-note cuisine techniques and incorporate them into the visual representation of beer ingredients on the plate.
- Create a visually striking and cohesive representation of beer ingredients on the plate.
- Experiment with techniques to create a subtle beer-like trace on the plate that enhances the sensory experience without overpowering the flavors.

Materials and Method (Ingredients, Equipment and Method)

BEER FOAM	
100g	*water*
10g	*egg white powder*
2g	*lecithin*
	lemon flavoring
SPENT HOPS	
10g	*maltodextrin*
	green coloring
	water
BREAD	
200g	*tapioca starch*
100g	*gluten*
70g	*egg white powder*
50g	*serum milk proteins*
Note by note flour	
2g	*yeast (lager and yeast)*
3g	*salt*
180g	*water*
2.5g	*serum milk proteins*
BEER TRACE	
5g	*barley malt extract*
10g	*sunflower oil*

	xanthan gum

Method:

“Note by note bread”

- In a bowl, mix together the tapioca starch, gluten, egg white powder, serum milk proteins, and Note by Note flour.
- In a separate bowl, dissolve the yeast in a small amount of warm water.
- Add the dissolved yeast to the dry mixture and stir well.
- Gradually add the remaining water to the mixture, stirring constantly until it forms a smooth dough.
- Add the salt and continue to knead the dough until it becomes elastic and smooth.
- Cover the dough and let it rest in a warm place for 15 minutes.
- Preheat the oven to 220°C.
- Divide the dough into small pieces and shape them into desired shapes.
- Brush the bread with serum milk proteins and sunflower oil.
- Place the bread in the oven and bake for 10-15 minutes or until golden brown.
- Remove from the oven and let it cool.

“Brewers spent hops”

- Place 10 g of maltodextrin in a bowl.
- Add a few drops of green food coloring to the maltodextrin. The amount of food coloring will depend on the intensity of green color, so adjust to your preference.
- Using a fork or a whisk, mix the maltodextrin and green food coloring together until the maltodextrin absorbs the liquid and forms a powder with the desired color. The mixture should resemble hop powder in appearance.
- If the mixture is too dry, add a few drops of water at a time and continue mixing until achieve the desired consistency. Be careful not to add too much water as it can cause the maltodextrin to clump.

“Beer foam”

- In a bowl, combine 10g of egg white powder with 100g of water. Mix well until the egg white powder is fully dissolved.
- Transfer the mixture to a blender or a mixing container suitable for an immersion blender.
- Add 2g of lecithin powder to the mixture. Lecithin acts as a stabilizer and helps to create a stable foam.
- Add lemon flavoring to the mixture, to taste. Start with a small amount and adjust to your desired level of lemon flavor.
- Use a blender or immersion blender to blend the mixture on high speed for about 1-2 minutes, until a thick and foamy texture is formed.
- Allow the foam to rest for a few minutes to allow any bubbles to settle.

- Skim off any excess foam from the top, leaving behind the stabilized foam.

Beer-flavored oil

- In a small bowl, whisk together the neutral oil and malt extract until well combined.
- Add a few drops of yellow food coloring to the mixture and whisk until the desired yellow color is achieved.
- Taste the beer-flavored oil and adjust the flavors as needed with more malt extract to achieve the desired beer-like flavor.
- Use the beer-flavored oil as a drizzle, spread, or dressing on the plate to add a beer-like flavor and yellow color to your dish without using actual beer.
- Add xanthan gum to adjust thickness.

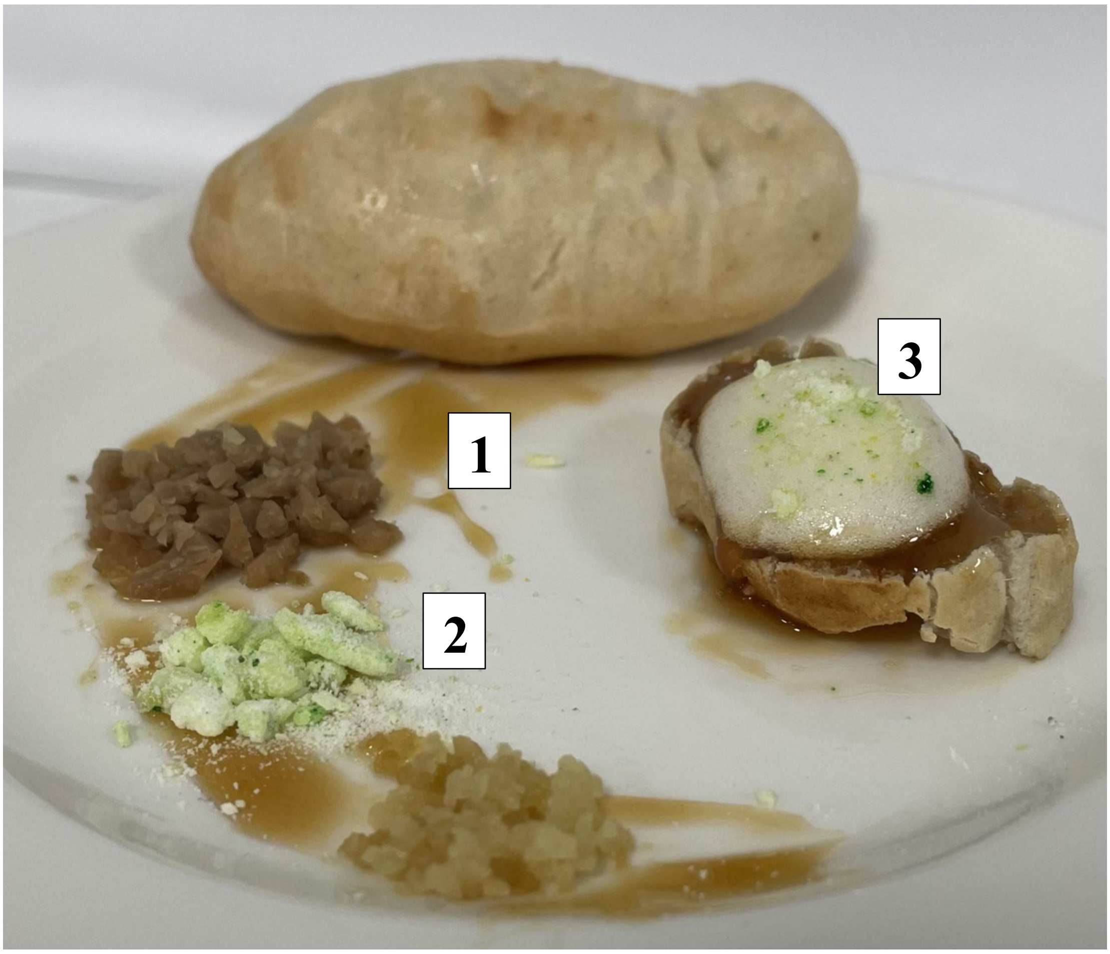
Results and discussion

The experiment with the beer trace using neutral oil and malt extract did not produce the desired result. The mixture did not achieve a strong enough beer-like flavor and the yellow color was not vibrant. Adjusting the flavors with more malt extract did not significantly improve the taste. Adding xanthan gum to adjust the thickness also did not improve the texture. Therefore, an alternative method was employed. The alternative method involved using barley malt extract as a direct drizzle on the plate (Picture 3, number 1). This was found to provide a malty component that complemented the other beer ingredients on the plate. The malt extract also provided a subtle sweetness and rich color that enhanced the overall sensory experience of the dish. This method eliminated the need for a complex mixture of neutral oil, malt extract, and food coloring that did not produce the desired result.

During the experimentation with brewer hops, it was found that the recipe used in the previous week did not produce the desired appearance. As a result, a different recipe was tried, which involved mixing maltodextrin with green food coloring to achieve a powder that resembled hop powder in appearance. However, it was observed that achieving the desired texture was challenging as adding too much water caused the maltodextrin to become too wet and lose its sand-like texture. Additionally, the green food coloring was too thick and had to be mixed with water separately before adding it to the maltodextrin mixture, making it difficult to obtain the desired texture. Despite these challenges, the final product was deemed satisfactory in terms of appearance and was successfully used in the dish (Picture 3, number 2).

In terms of the bread, challenges were encountered in achieving the desired shape and texture. Despite increasing the gluten content in the recipe, the first batch resulted in a ball-shaped bread (Picture 1). Attempts were made to vary the shape and reduce the baking time in subsequent batches, however, the bread had a tough texture (Picture 2). Ultimately, changes were made to the recipe that resulted in a grissini-like texture, although the bread ended up being harder than intended (Picture 3). While the texture was not optimal, the final product did have an improved visual appeal.

The new beer foam recipe produced satisfactory results, although there is still room for improvement in achieving a more realistic beer-like appearance (Picture 3, number 3).



Conclusions

In conclusion, the experimentation process showed that there is potential for further improvement in both the bread and beer spent grain and spent yeast recipes. The bread recipe could benefit from additional modifications, and incorporating real beer waste into the recipe could be a promising avenue for future exploration. While the final products' appearance was satisfactory, there is still room for improvement in terms of texture and taste. The texture of the beer spent grain and spent yeast could be enhanced with more time and experimentation. Overall, this project has provided valuable insights and opportunities for further development in the use of beer by products in culinary applications.