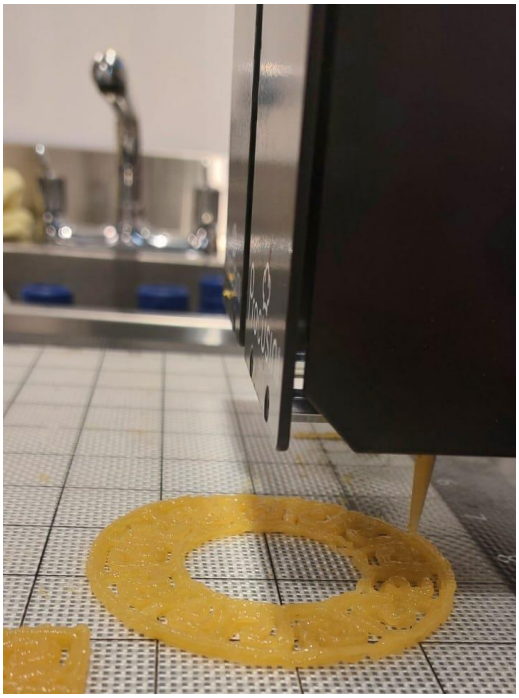
Molecular Gastronomy (TFCS9025)



Theme: Food Waste

Concept: *"Live in a Maze"*, with 3D printer

MAY 8

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Executive summary

For this year's Note by Note cooking, I chose to combine food with 3D printer, as I believe 3D Printing of food is the future of food. I believe that combining technology in our food system will help us in reduction of food waste of our product. Food waste reduction, molecular gastronomy, and 3D printing can all be used to develop novel and sustainable culinary solutions. Molecular gastronomy, 3D printing, and food waste reduction have the power to transform the culinary world and advance a more sustainable future. To take deeper understanding of molecular gastronomy, mango powder in combination with water, flavor and food color was used to test the textural property parameter for the 3D printing of the dish.

Introduction

Molecular gastronomy is an interdisciplinary approach with a heavy emphasis on physics and chemistry. It is an area of food science which studies how foods are prepared. This, H. (2002). Molecular gastronomy is applied in Note by Note cookery where all ingredients in dishes are pure compounds or pure compound mixes.(This., 2013). The concept of Note by Note was first proposed in the year 1994 by Herve This, a french physical Chemist and Co-Founder of Molecular Gastronomy.

According to Herve, the potential for the development of novel meals, by the application of Molecular Gastronomy is considerable. Hervé calculated that it is conceivable to produce something about 1,000 to the power of 10. (or 10^{30}) new recipes, and that's before taking chemical concentrations into account. The goal of Note by Note is to produce new dishes, possibly with novel flavors, rather than to replicate already-existing foods. For the module of Molecular gastronomy we were asked to prepare for Note by Note contest with the theme of "Food Waste". I chose to work with 3D printing by applying my knowledge of Molecular Gastronomy to create a dish, "Living in a maze".

3D printer uses Layer-by-layer material deposition technique, also known as additive manufacturing, is based on a pre-designed file (Pinna et al., 2016; Rayna & Striukova, 2016). Through more straightforward procedures, food 3D printing technology enables the creation of delicacies with unique designs and textures. 3DFood Printing (3DFP) includes digital gastronomy, which is accomplished by building up beautiful designs layer by layer. Due to its ability to use 3D printing technology to produce food items that are individualized in both content and design, 3DFP has recently attracted a lot of attention from both the commercial and research communities.

Food waste is a huge issue that threatens food security, the economy, and the environment owing to resource depletion and increased greenhouse gas emissions. Food waste is produced across the entire food supply chain, with a global average of one third of it ending up in landfills (Jagadiswaran et al., 2021). Food waste has an impact on resources as well as recycling, causes odors, and creates issues

with vector breeding. The Table -1 the average food waste in countries, which is a clear indication that the food waste is a global issue and innovative measures needs to be taken to tackle with the problem. So, I chose 3D food Printing as a way to resolve the issue by the application of molecular gastronomy.

3D Food Printing can be a beneficial technology to minimize food waste as it reduces the transport food print and also allows reuse of the material. By recycling certain food waste streams, 3DFP can reduce the production of food waste. The quantity of the ingredients used can also be monitored beforehand when a 3D printer is used.

Table - 1: Average food waste (kg/capita/year) by World Bank income classification, averaging medium and high confidence estimates for countries

Income group	Average Food waste (kg/capita/year)		
	Household	Food Service	Retail
High-Income countries	**79**	**26**	**13**
Upper middle-income countries	**76**	**Insufficient data**	
Lower middle-income countries	**91**	**Insufficient data**	
Low-income countries	**Insufficient data**		

Source: World bank Income classification

Fig 1: Mango balls

Aims and Objective

The aim of this assignments includes:

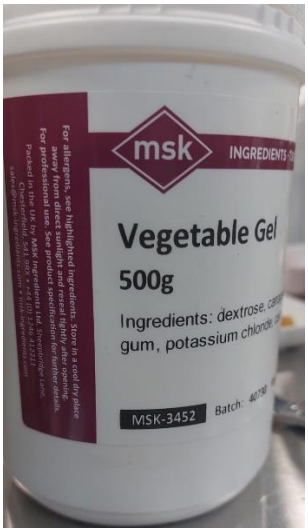
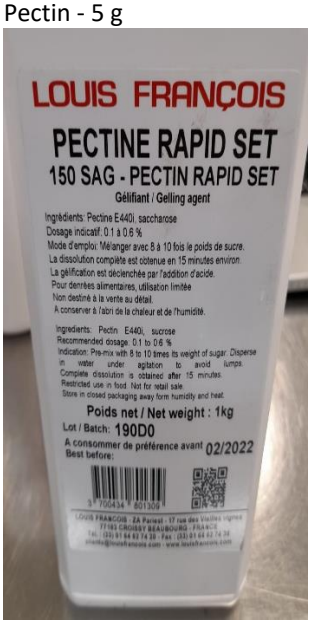
1. To make us students aware about the concept and importance of molecular gastronomy.
2. To enable our understanding of food waste and how to incorporate the knowledge in molecular gastronomy syllabus.
3. To aware us about the Note by Note contest and role that the compounds make in creating new and undiscovered products with molecular gastronomy.
4. To educate us about the importance of minimal usage of ingredient to create an edible product.

Methods and Materials

Fig 2: Final Product Demonstration

Table 1: Picture and quantity of the Ingredient

A	B	C	D
Beet- Root powder - 20 g	Potato Starch - 85 g	Vegetable Gel - 20 g	Mango powder - 50 g

			
Lecithin - 2 g	Water - 200 g	Green colorant- 1 drop 	Pectin - 5 g 

Castor Sugar - 5 g		Flavoring (Lemon)- 1 drop 	Mango flavor – 1 drop 
Water - 100 g		Water – 100g	Color 
			Water – 150 g
			Castor Sugar – 10 g

Materials required

1. Weighing balance
2. Hand blender
3. Stove

4. Non-sticky paper.
5. Microwave oven
6. 3D Printer (Procusini)
7. Blast freezer

Preparation of the Ingredient

For A

1. Weigh all the materials.
2. Mix Beet root, lecithin and Castor sugar together.
3. Use Hand blender to mix if they are not mixed properly.
4. See the formation of foam and keep them apart.
5. Decorate them in a plate, according to your desire.

For B

1. Weigh the ingredient.
2. Mix the ingredients.
3. Heat the mixture in a stove for about 1-2 min until thick.
4. Spread the mixture in a non sticky - microwave friendly paper and form the desirable shape.
5. Microwave it in an oven for about 1 hour.
6. Keep checking in the oven and take them out when you see the shape formation.

For C

1. Weigh vegetable gel, sugar and water and mix them together.
2. Heat them in a stove with continuous mixing until it thickens.
3. Add color and flavor using a dropper. (Be very careful)
4. In a non-sticky paper, create a desirable shape from your hands.
5. Keep them cool until the structure sets.

For D

1. Weigh mango powder, water, sugar and pectin and mix them together.
2. Heat them in low flame in a stove with continuous mixing.
3. Add flavor and check the thickening of the product.
4. When it thickens, remove them from the flame and create desirable shape.
5. For the 3D printing, you need to keep the product in a 3D printer tube, make sure that there is no air-bags as this will hamper the printing process. The tube for the printing presented in fig 5.

Result and Discussion

Concept Behind Product

My representation for the dish is that we as human are all living in a maze, following the trajectory that has been told to us. For my dish, Maze represents the way we are currently living inside the box.

For - A

The aim of using Beet-root powder and lecithin was to create foam and air bubbles with liquids. The sugar was added in this to give sweet flavor profile to the product. Lecithin, which is a naturally occurring emulsifier can be used to create foam or air bubbles in liquids. When mixed with beetroot powder syrup and water, it can be used to create a foamy, airy texture in a dessert or other dish. For my "Live in a Maze" dish, I used this combination to represent the food resources which are found outside of the maze if we are to explore them.

For - B

Product B was created using potato starch and water which represents rocks and other resources which are abundant on earth.

For – C

Vegetable gel, sugar, Green color and lemon flavor were all added to give the concept of greenery on earth. I added green color and shaped them to make them look like tree. This represents the untouched Molecular Gastronomy if we do not think outside the box which is maze.

For – D

I used maze for my product to represent us, humans who are constantly living inside the box and are following what has been told to us since long. Through this creation, I would like to give the message that we will have to come outside the box and explore the vast world of Molecular Gastronomy which is represented by my Product A, C and C.

Discussion for 3D printing

3D printed maze was made with the composition of Product D. This had smooth printability while printing through the printer. There was layer by layer deposition of the product without any obstacle and hindrance while printing. 3D printer was used to create 3 mazes, one squared and two circle ones (See fig 4). The square maze was done very successfully, but while printing the circle ones, due to the small air bubbles, it skipped few layering process time and again. At the last print of circle, due to the volume of the product in the tube, the circle could not be properly formed. Still, the printing of the mazes was very successful.

It took around 15 minutes to print all the three mazes. The product had a shiny and smooth appearance at a glance. Because of the texture, the product was kept in blast freezer along with the print mat to solidify. This was done to preserve structural integrity of the product. Also, by keeping the product cool it was expected to come out easily from the printing material so the presentation of the product could be done. The blast freeze 3D sample can be seen in the fig 3.

As in the picture, the product after freeze lost it's glossy property. Still, it was difficult to take the sample out from the print paper. To check the product's structural integrity the oval shaped using the same ingredient was also made during the molecular gastronomy lab work (see fig 1). The shape of the product during this lab work seem to be holding together and it was easy to take them out without losing the structure of product.

Carefully, one print from the material was take out to take the picture of the product in overall. After, the result I believe that the best way to obtain the structure both for the 3D printing and the texture is to optimize the process and ingredient to give proper result.

Fig 3: Blast Freeze 3D Printed sample

Fig 4: 3D print of two circle & square maze

Fig 5: 3D print tube

Conclusion

By enabling accurate portioning and food product customization, 3D food printing has the potential to drastically lower food waste. Following are some methods in which 3D food printing can aid in minimizing food waste:

1. **Portion Management**

Food waste resulting from overproduction or overconsumption can be reduced by using 3D food printing to portion food products in precise amounts.

2. **Customization**

Custom food products can be created using 3D food printing to meet dietary needs and personal tastes. By just creating what is necessary and lowering the amount of food that is discarded because it is unsuitable for some consumers, this can help reduce food waste.

3. **Preservation of Freshness**

By printing food goods as needed and cutting down on the time they spend in storage or on the shelf, 3D food printing can be utilized to keep food products as fresh as possible.

To conclude, I believe by combining 3D food printing and molecular gastronomy, chefs and food scientists can push the boundaries of culinary creativity and innovation to develop new and exciting dishes using repurposed food waste. Overall, the Note by Note Cooking contest was a huge learning opportunity for me as I got to discover the new perspective of cooking which I never thought was possible. After gaining knowledge, I believe that there is more to pure compounds and ingredients. This

course helped me to rethink all my learnings and understand the new concept of designing a product using just compounds.

Recommendation

To improve the 3D printed product I would give following recommendation.

1. Structural integrity of the product can be improved by studying the characteristics of all the ingredients used for printing.
2. Even though, the texture of the product was good for the printing and flow ability for the 3D print of the material, the detail study on the textural property of the 3D printed product can also be performed.

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Logbooks

Logbook Week -1

MODULE CODE: TFCS9025
MODULE TITLE: Molecular Gastronomy
STUDENT NAME: _Prakriti Khanal
FOOD PRODUCT: Molecular gastronomy
WEEK NO.:_1 DATE:_20th March, 2023

Weekly Aims and Objectives
To understand the concept of Molecular Gastronomy.
To create a product using pure compounds.
To make a foam using beet root powder

Materials and Method (Ingredients, Equipment, and Method)

S.N	Ingredient	Quantity (g)
1.	Water	100
2.	Beet-root powder	20
3.	Sugar	5
4.	Lecithin	2

Equipment

- Hand blender
- Weighing balance

Method

1. Weigh all the materials.
2. Mix Beet root, lecithin and Castor sugar together.
3. Use Hand blender to mix if they are not mixed properly.
4. See the formation of foam and keep them apart.
5. Decorate them in a plate, according to your desire.

Results and discussion

Beetroot foam was successfully created in a laboratory using beet root powder, Lecithin and water. The foam created from this was stable and stayed in the structure for more than 30 minutes for the

final demonstration to the audience. The concept of molecular gastronomy was clearly understood. However, the foam which was created was not large, they were small size.

Conclusions

A product for molecular gastronomy was created with huge success.

Recommendations for the following week.

Try to look more into textural property of the product by incorporating other ingredients like mango powder in the mix. To check if the structure and texture of the product is good enough to be used for 3D printing.

Ingredients required for the following 2 weeks.

Mango powder.

Logbook Week – 2

MODULE CODE: TFCS9025
MODULE TITLE: Molecular Gastronomy
STUDENT NAME: _Prakriti Khanal
FOOD PRODUCT: Molecular gastronomy
WEEK NO.:_2 **DATE:_**27th March, 2023

Weekly Aims and Objectives

- To understand the concept of Molecular Gastronomy.
- To use mango powder and evaluation for the 3D printing.
- To evaluate the color.

Materials and Method (Ingredients, Equipment, and Method)

S.N	Ingredient	Quantity (g)
1.	Water	150
2.	Mango powder	50
3.	Sugar	20
4.	Pectin	5
5.	flavor	1 drop

Equipment

- Hand blender
- Weighing balance
- Stove

- Blast freezer

Method

1. Weigh mango powder, water, sugar and pectin and mix them together.
2. Heat them in low flame in a stove with continuous mixing.
3. Add flavor and check the thickening of the product.
4. When it thickens, remove them from the flame and create desirable shape.
5. Keep them in blast freezer to give them defined shape.

Results and discussion

Mango balls was created using mango powder, water, pectin and sugar. The color was not added to the product so it didn't look desirable.

Fig: Mango balls without addition of the color.

Conclusion

Try to focus on improving the color of the product as it dosen't look appealing to the eyes.

Recommendation

Use Yellow color for the improvement in the color of the product.

Logbook Week – 3

MODULE CODE: TFCS9025
MODULE TITLE: Molecular Gastronomy
STUDENT NAME: _Prakriti Khanal
FOOD PRODUCT: Molecular gastronomy

WEEK NO.:_3 **DATE:**_17th April, 2023.

Weekly Aims and Objectives

- To create a mango balls using the ingredients presented on the list.
- To evaluate the color of the product using Colormeter App from your phone.
- To evaluate the printability of the product for the 3D printer.

Materials and Method (Ingredients, Equipment, and Method)

S.N	Ingredient	Quantity (g)
1.	Water	150
2.	Mango powder	50
3.	Sugar	20
4.	Pectin	5
5.	flavor	1 drop
6.	Yellow color	1 drop

Equipment

- Stove
- Weighing balance
- Blast freezer
- Cell phone with Colormeter App.

Method

1. Weigh mango powder, water, sugar and pectin and mix them together.
2. Heat them in low flame in a stove with continuous mixing.
3. Add flavor and check the thickening of the product.
4. When it thickens, remove them from the flame and create desirable shape.
5. Keep them in blast freezer to give them defined shape.

Results and discussion

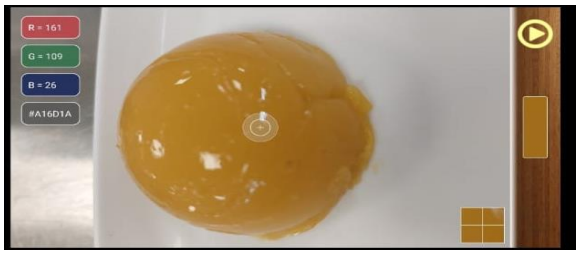

Fig: Color Evaluation of the product.

Mango balls were crated in laboratory for the molecular gastronomy module. With the addition of color, the product looked more desirable as can been seen in the picture above. The product created was also analyzed for the texture property to be printed in the Procusini printer. The sample was well preserved in the laboratory for the 3D printing the following day.

Conclusions

Mango powder was created in the laboratory for the 3D printing with success.

Recommendations for the following week.

Use 3D printing to create a design to check the flow ability of the product.

Ingredients required for the following 2 weeks.

Final product showcase.