Low Food Lab:

grass

Low Food Lab Grass delved into the potential of grass (protein) for human use and consumption.

About Low Food

Low Food aims to change Dutch gastronomy. Low Food was founded in 2018 by a group of chefs, political scientists, and producers. Since then, the movement has grown and so have its ambitions of changing Dutch gastronomy, putting Dutch food culture firmly in first place in the fields of sustainability, inclusion, etc. In a world where food security, food sustainability, and sustainable agricultural practices are three of the biggest issues, our food movement can have a major impact on food patterns. Accordingly, Low Food's purpose is to serve as a networking agent and platform where new ideas are created and implemented.

The Low Food Lab brings culinary knowledge, agricultural knowledge, and product development together. The Labs are the places where chefs develop new products, preparation methods, and techniques that contribute to fairer, more diverse, healthier, and/or more sustainable eating habits. In the Labs, we work on food issues for which a culinary solution must be found, such as smarter ways to valorize residual streams or the development of applications that make certain ingredients accessible to a wider audience.

See www.lowfood.nl for more information.

About Flevo Campus

Flevo Campus Knowledge Institute is a joint initiative between the town of Almere, the Province of Flevoland, Wageningen University & Research and Aeres University of Applied Sciences. Guus Nelissen, project manager at Flevo Campus: "At Flevo Campus, we address a variety of food chain issues through research, innovation, and experimentation. We take an interdisciplinary approach, which means that we link up with various parties to come up with new, creative solutions. We don't just leave the research to the scientist; we also bring in food entrepreneurs or professional chefs. Flevo Campus sees a lot of potential in Low Food Lab's experimental research that investigates food issues from a gastronomic perspective regarding what tastes good, what works, and what doesn't. Historically, these questions have been the source of most of today's culinary knowledge and food innovations – all driven by the ambition and willingness of chefs and small food entrepreneurs to look at food in a different way.

The alliance with the province of Flevoland is also key. Flevoland is one of the main food-producing provinces in the Netherlands. Food security and improving the sustainability of the food and agricultural system are hot topics at the moment. This region in particular is facing a number of challenges in these areas, for which Low Food Labs could provide a solution."

See www.flevocampus.nl for more information.

Index

Introduction by Ivana Mik, Head of Lab

I ALWAYS THOUGHT WE NEEDED MULTIPLE STOMACHS TO DIGEST GRASS. Little did I know that a part of grass is actually edible as it is! Together with a bunch of creative and culinary minds, we looked for ways to prepare this tiny plant. We found a dietician, two (plant-based) cheese experts, an artist, three chefs, two food scientists, and an herbalist. For three months, they tried, tested, and tasted. The result: a collection of recipes, processes, and preparations to get you grazing.

It does not stop there either. The potential of grass expands past this lab's timeline. Grass sugars could be used to feed microbes that can produce microbial oils (I hear you thinking: grass butter!). Next level: It can be fed to genetically modified microbes that directly produce milk protein. The options are grand and as long as we produce grass to feed cows, we might as well use it as efficiently as possible.

meet the team

From left to right: Lenno Munnikes, Rianne Oudejans, Berbele van den Bos, Guus Nelissen, Joris Bijdendijk, Sebastiaan Aalst, Polona Kuzman, Kim Jantzen, Tessa van der Geer, Ivana Mik, Rieks Smook, Liv van de Ven, Bram Koopmans, Akash Kumar, Steven Broere, Marjolein Triesscheijn, Nina Olsson, Hazel Htun.

About grass

What human (food) applications can we find for grass?

Grass is a topic that not many people will quickly associate with humans. Grassland already serves a clear purpose in the Netherlands, namely as feed for cows. However, grass has a great potential: It contains a lot of proteins. To get an idea of how much protein that is: per year, one hectare of grass produces twice as much protein as soy: 2.5 tons of protein each year.

You would think that the cow needs this protein, but they currently are usually fed too much of it. Instead of utilizing it, they excrete this in the form of greenhouse gases. The innovative Dutch company Grassa-BV developed a technology to “open up” grass; meaning the grass is split into different fractions by pressing out the juice. The protein-rich fibers are fed to the cow, which reduces the amount of ammonia and phosphate that they emit. The protein rich juice can be further split into pure protein, which can even be decolorized, sugar-rich FOS-extract, and minerals. These fractions can be fed to monogastric animals like chickens but also to humans. How fantastic would it be if we could further valorize these other fractions instead of feeding them to animals? Therefore, the research question of this Low Food Lab is: *What human (food) applications can we find for grass?*

RIEKS SMOOK (LEFT),
MANAGING DIRECTOR GRASSA

"Our company Grassa-BV developed a technology to extract protein from grass. The grass protein is suitable for consumption by humans and animals. The application of grass protein in animal feed is already fully developed. It is the perfect alternative to soy. Still, the application of grass protein in human food needs further development. Flevo Campus, through the organization of the Low Food Lab, offers a wonderful opportunity to let a number of food virtuosos work with protein from grass and other biomass. This way, several applications for grass protein are immediately put into practice and tested. This greatly assists Grassa in scaling up the technology and in its mission to make grass a new protein crop."

The role of proteins

Proteins are important nutrients in building and maintaining muscle in the human body. To feed the growing world population in 2050, protein production must increase by approximately 50% from around 200 million tons to around 300 million tons. Currently, the Dutch protein diet consists of 60% animal proteins (dairy, meat, fish, and egg) and 40% vegetable proteins (legumes, grains, and nuts). The aim is to reverse these protein percentages by 2030. The demand for plant-based protein alternatives is increasing. Why should we get soy from the other side of the world if we have efficient local alternatives? Grass has the same protein structure as soy. Further research into the possible (food) applications of grass will speed up the process.

Methodology

The lab was led by Ivana Mik (Head of Lab) and Tessa van der Geer (Project Lead), and they both participated in the lab as well. Twelve participants took on the challenge of creating innovative grass products for human consumption or use. Grassa-BV provided them with the needed grass fractions.

DISCLAIMER

Before we share the experiments and recipes, we would like to give a disclaimer about the usage of grass. Grass protein does not have the Novel Food Status yet, which means it is not approved to be commercially sold in food products for human consumption. Grassa-BV is working on this. Therefore, the use of grass-protein is at your own risk. For safety reasons, some of the experiments were conducted using spinach protein, which has similar characteristics.

Bram Koopmans

Simple homemade grass (or spinach) protein

RECIPE BY GRASSA

It is easy to replicate the Grassa process. Using common kitchen tools, it is possible to make a green protein concentrate from grass and other green leaf materials (spinach, for example) in a few steps. The result is a green paste consisting of 50% protein. The methods for grass and spinach are the same.

INGREDIENTS

- Grass or spinach
- A good slow juicer
- Microwave
- Cheesecloth
- Citric acid (optional)
- Centrifuge, 1500 g
- pH meter

METHOD 1

Extract the juice from the grass by using a slow juicer. Heat the green juice in the microwave to a minimum of 80°C. It should be stirred regularly during heating to obtain a firm protein flake. Filter the heated juice through a cheesecloth. Then, hang it for an hour to allow the moisture to drain out by itself, and squeeze more moisture out by hand. This way, the cloth does not clog.

METHOD 2

Because protein that is coagulated by heating (method 1) has a somewhat granular texture, protein can also be obtained in another way. An additional advantage using this method is that the color is better preserved, the protein is better preserved, and the product has a creamy texture. However, the obtained protein is so fine that it can no longer be filtered with cheesecloth. First, make a solution of 20 g of citric acid in 80 g of water. Then, make green juice the same way as in method 1.

Carefully, drip citric acid into the cold juice while stirring. When the pH drops to 4.5, the protein is coagulated. This is not yet visible to the naked eye. Separate the liquid from the protein in a centrifuge. This liquid is an FOS extract and contains sugars. Pour the liquid off and scoop the protein from the bottom of the centrifuge.

Ivana Mik

Ivana wanted to test if the FOS-extract can be used as a growth medium for bacteria and mushrooms

Ivana Mik is a fermentation expert and food creative who develops food products and processes with a main focus on fermentation technology. She combines a background in food technology and culinary experience in her Fou Food Lab company and restaurant kitchens, where she develops products for start-ups, SMEs, and multinationals.

The study and results

When you remove the protein from the grass juice (see page 8), what remains is a sugar-rich liquid: FOS extract. Ivana wanted to test if this FOS-extract can be used as a growth medium for bacteria and mushrooms. If this would work, then the extract would probably also be usable for feeding other microbes. It turned out that both shiitake and oyster mushrooms grew on the extract. It was striking to see that the shiitake grew in a perfectly round shape, and the oyster mushroom simply goes everywhere.

Grass growth medium for mushrooms

RECIPE BY IVANA MIK

INGREDIENTS

- 500 ml FOS-extract (see page 8 for the recipe)
- 7.5 g agar agar
- 1.5 g nutritional yeast
- A mushroom (shiitake or oyster mushroom)

METHOD

This method needs to be performed sterile. For those who are unfamiliar with this technique, look up "sterile pouring agar" or ask a friend who works in microbiology.

1. Make FOS agar agar by mixing the FOS, agar, and nutritional yeast. Microwave the mix at the highest setting for 1 minute. Give it a good stir.
2. Put the mix in a bottle. Close it, but not completely.
3. Sterilize the bottle with its contents for 45 minutes using a pressure cooker.
4. Let the bottles cool down, but no cooler than 60 degrees Celsius.
5. Pour the agar in the Petri dishes.
6. Let the plates solidify completely before continuing to the next step. Ideally wait a day.
7. Spray the mushrooms with 70% alcohol.

8. Pull the mushroom so that the inside is exposed. Take a very sharp knife and put it in a flame for 5-10 seconds. Spray some alcohol on it to cool it down and briefly put it in the flame again to get rid of any excess alcohol.
9. Cut a small 5x5 mm piece of mushroom out of the center.
10. Put the piece in the middle of an agar plate.
11. Close the plate and let the mushroom grow at room temperature for a few weeks.

Liv van de Ven

Liv van de Ven (left)

Liv van de Ven is a food enthusiast and scientist who alternates between freelance (company name: Foodconstruct) and contract work. She was educated at Wageningen University and specializes in fermentation and dairy science. Liv worked together with Ivana Mik (see page 9) to conduct the experiments.

The research

Liv and Ivana's initial idea was to create a product that utilized the most out of grass (or spinach) protein. They wanted to incorporate the absolute maximum amount of protein in a blue cheese without the addition of other protein sources. It had to be scalable, low in cost, and, of course, tasty.

They started with a control experiment and changed only one parameter per cheese. In the first tests, they made blue cheese from spinach protein, fat from the Time Traveling Milkman (see page 33, blue cheese starter (Saint Agur), salt, sugar, and lactic acid bacteria. They varied, for example, in the protein base (decolorized/green), fermentation time (5 or 8 weeks), and fat or no fat. The first cheeses became very dry as they could not retain the fat properly and lost water during fermentation. This resulted in their new goal to entrap the water and fat in the cheese. They chose starch. In this stage, Ivana and Liv tried to play with the addition of transglutaminase (food glue) and different types of cheeses (camembert/blue cheese).

The results

The end results are very promising. They managed to make a blue cheese with 26% grass protein on a dry weight basis. The recipe could be further optimized and tweaked. For example, the optimal fermentation settings need to be established. In follow-up experiments, it would be possible to play with different temperatures, humidity in the climate chamber and fermentation time. Or play with different blue cheese molds to optimize the taste.


normal
trans

Blue grass cheese

RECIPE BY LIV VAN DE VEN & IVANA MIK

INGREDIENTS

- 110 g water
- 57 g odorless coconut fat
- 36 g decolorized grass or spinach protein
- 22.5 g blue cheese
- 13.5 g maizena corn starch
- 10 g sugar
- 0.225 g lactic acid bacteria (1/4 tsp)
- Salt, enough to coat the outside of the cheese (approximately 2% of the total weight)

METHOD

Create the paste

- Wash the protein thoroughly with water. Drain the rinsed protein by using a cheesecloth.
- Mix the protein, water, sugar, fat, and Maizena cornstarch together. Heat this while stirring until the mixture becomes a paste.
- Wait for the mixture to cool below 30 degrees Celsius and add the blue cheese and lactic acid bacteria.
- Use a high shear blender (for example, a stick blender) until the added ingredients are completely incorporated.
- Transfer the paste to a cheese mold lined with cheesecloth. The cheesecloth has to be big enough to cover the top of the paste completely. Completely cover the paste.

Fermentation

- Put the mold in a fermentation chamber with the following settings:
  - Temperature: 30 degrees Celsius
  - Humidity: 50%
- After 24 hours, carefully take the cheese out (preferably with disposable latex gloves) and salt the outer layer (top, bottom, and sides). Put the cheese back into the fermentation chamber. If the cheese seems a little moist on the outside, keep the humidity at 80% and 16 degrees Celsius for a while. When the outside looks dry, you can ferment using the following settings:
  - Temperature: 16 degrees Celsius
  - Humidity: 90%

  Flip the cheese every day.
- After 14 days, the cheese should be a bit firmer and completely covered in blue mold. Using disposable latex gloves, crumble the cheese in a large bowl. Next, repack the crumbs, without pressing too much back again into a cheese shape. Place the cheese back into a clean cheesecloth into the cheese mold and back in the chamber with the same settings as step 7. Keep it there for 1-2 days. Then, take out the cheese from the mold again and flip the cheese every day.
- After a total of 5 weeks of fermentation, the cheese will be ready to eat. Before doing so, please check if there are signs of spoilage: pink/black mold or no growth of blue cheese mold. If you see this, discard the cheese. The same goes for cheeses that do not smell like blue cheese (rotten greens/eggs). For a sharper, richer blue cheese taste and runnier inside, ferment the cheeses longer.

Steven Broere & Tessa van der Geer

Steven and Tessa came to the idea of a local shoyu (soy sauce)

Steven is an economist by education, chef by choice, mostly spending time running Restaurant Foer in Amsterdam. He is always interested in sustainability, especially when it converges social sustainability and the sustainability of products or production chains.

For this lab, Steven teamed up with Tessa van der Geer (Project Lead Low Food Lab), chef and food transition consultant. From chef de parti at Foer to researching transition topics like protein transition and food waste issues. She combines a unique perspective of a finance background and a culinary education.

The study

At Foer, Steven and Tessa often work with fermentation, and so they make their own miso, shoyu, and many other flavor makers. As grass could be an interesting local substitute for soy, Steven and Tessa came to the idea of a local shoyu (soy sauce). Over the timeline of the lab, they researched the flavor

development of grass shoyu. To start with, they set up two shoyus using spinach (1) and grass protein (2) with toasted hay broth as a flavor enhancer. After the mid-tasting, the opened fiber provided by Grassa came to the fore leading to shoyus using grass protein and grass fibers (3) and just grass protein (4) as a flavor control shoyu. Normally shoyu takes up to 24 months to fully develop its flavor. The limited timeline and the difference in starting point (due to protein availability) made them rely on tasting notes comparing the results head to head.

Next to that, they researched an enzymatic breakdown of hay broth (5, little residual protein) and a broth of dried grass fibers (6, with more residual protein), comparing flavors to the shoyus. With the use of enzymes, you can speed up the flavor development. They used four different enzymes in four stages to end up with a sort of hay or grass "elixir". This method takes roughly two hours instead of a shoyu process that develops over months. However, the result was underwhelming in comparison to the rich flavor of the shoyu.

THE EXPERIMENTS

1 - Spinach protein and hay broth - shoyu*
2 - Grass protein and hay broth - shoyu
3 - Grass protein and grass fiber - shoyu
4 - Grass protein - shoyu
5 - Hay elixir
6 - Grass fiber elixir

* Shoyus use a base of koji (aspergillus oryzae) grown on pearled barley and salt.

The results

Steven and Tessa prefer version 2 over 1, as it has a slightly more rounded grass/hay flavor, but both were really tasty and usable. Options 3 and 4 were too immature in their process to say that they hold enough flavor substance without the addition of a toasted hay broth, time will tell. Their expectation is that they will still develop but might not be as appealing as version 1 or 2 that have an accepted hay nostalgia.

One of the enzymes used in 5 and 6 was specifically for breaking down cellulose (about 30% of grass) that partially converted into sugar. However, there was probably too little accessible protein to have the full effect of the other three enzymes breaking it up in desirable smaller protein chains having a umami flavor outcome. It lacked depth in flavor as a whole, even when using the grass fibers with residue protein. Although less time consuming, the elixirs are not a suiting alternative method.

Grass protein and hay broth shoyu

RECIPE BY STEVEN BROERE & TESSA VAN DER GEER

INGREDIENTS

- 500 g grass protein
- 500 g karley koji (500 gr barley, koji spores)
- 700 g water
- (50 g toasted hay)
- 140 g salt (8% of total weight)

METHOD

Make koji

1. Rinse the barley under cold water.
2. Soak the barley for 4 hours.
3. Steam the barley until tender but not falling apart (20-30 min.).
4. Let the barley cool (to at least 30°C).
5. Inoculate the barley with koji spores.
6. Keep at 30°C. After 24 hours, you will see the beginnings of mycelial growth. Wait until fully covered.
7. Cool to stop the growth of the fungus.

Make the shoyu

1. Make sure your surfaces and props are sterilized.
2. Weigh your produce.
3. Put the grass protein, koji. and the toasted hay in a big jar.
4. Measure 700 g of water and dissolve the salt.
5. Add the salted water.
6. Shake the pot & open to aerate every day.
7. Let the fermentation stand for a minimum of 3 months (up to 24 months) and taste it frequently.

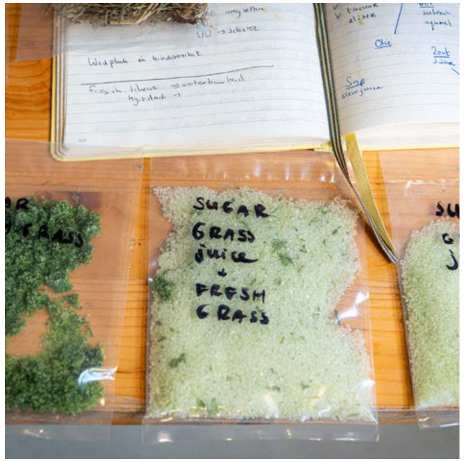
Marjolein Triesscheijn

Marjolein is a culinary herbalist, food creative, food educator, and designer. For about 12 years, she had a company - now called School of Food - in creative and sustainable food education at elementary and high schools. As a vegan and vegetarian chef as well as a culinary herbalist, she has been developing botanical cocktails and mocktails with food pairing over the past two years.

The study

Marjolein decided to focus on a (dried) grass cocktail and mocktail. She started experimenting with the different components of a cocktail, such as syrups, hydrosols, tinctures, shrubs, sugars, and liqueurs. Every component of a cocktail can be "designed". The "rim", syrup, liqueur, and soda: For each part, there is something unique that can be developed botanically.

She used fresh grass or the dried variant in all of her experiments. While producing the hydrosol, Marjolein was curious to see if there would be a difference in taste/fragrance when using



various types of spring water and tap water. In addition, she explored whether a distillation kettle made of copper or stainless steel would make a difference. Spoiler: A copper distillation kettle imparts a deeper aroma and taste! In the production of liqueurs, she experimented with different alcohol percentages. The higher the alcohol percentage, the stronger the flavor, but it can sometimes result in excessive bitterness. For making the shrubs, various vinegars were used.

The results

The dried grass yielded the best result. The scents of the hydrosol transition to vanilla and honey truly captured the aroma of hay encapsulated in floral water. The flavors of honey and vanilla, occasionally with a hint of cardamom, can be found in the syrup that she made using glycerol.

Dried grass cocktail

RECIPE BY MARJOLEIN TRIESSCHEIJN

INGREDIENTS

- 6 parts dried grass hydrosol [1]
- 1 part dried grass shrub [2]
- 3 parts dried grass glycerite [3]
- 1 part light gin
- Top up with soda water and ice

METHOD

1. Mix the hydrosol, shrub, glycerite, and gin in a glass or cocktail shaker with some ice.
2. Pour it into a glass if using a cocktail shaker.
3. Top up with soda water and some extra ice cubes.
4. Decorate with, for example: a grass spike, yarrow, violet, nettle, marigold, or wild roses.

1. Hydrosol

INGREDIENTS

- 800 ml water
- 70 g dried grass

METHOD

1. Use a distillation kettle. Place the water in the kettle.
2. Use an iron steam basket and place it above the water; make sure it doesn't touch the water. Put the dried grass in the steam basket and turn on the kettle.
3. Collect the grass water. This yields 600 ml of hydrosol.

2. Shrub

INGREDIENTS

For 600 ml shrub.

- 300 ml apple cider vinegar
- 300 g cane sugar
- 100 g dried grass

METHOD

1. Mix everything well in a glass jar.
2. Shake or stir regularly for the first few days until the sugar completely dissolves.

After 5 days, the shrub is ready.

3. Glycerite

INGREDIENTS

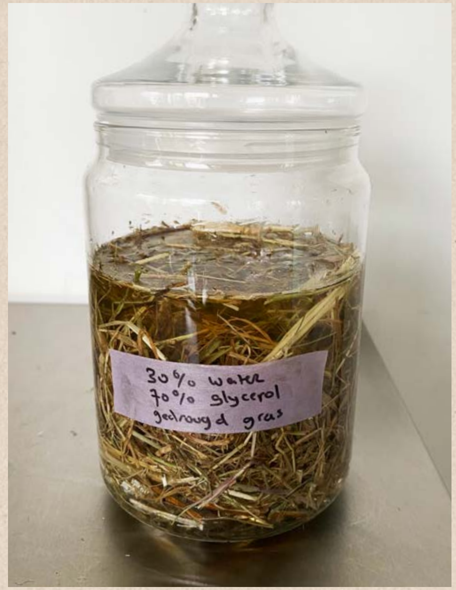
Use food-safe vegetable glycerin.

For 1 liter of glycerite:

- 700 ml glycerol
- 300 ml water
- 30 g dried grass

METHOD

Mix everything together and let it sit for at least 3 weeks.




SHRUB
DRIED
GRASS

Nina Olsson

Nina is a chef, writer, artist, and culinary entrepreneur. She is the owner of restaurant Chez Nina in Amsterdam and wrote several bestselling cookbooks. She expresses herself through food and shares plant-based food and inspiration with the world. Nina enjoys the process of developing culinary concepts and exploring the potential of her ideas as a culinary entrepreneur. The idea of goodness and better sustainable food cultures are the driving force behind her work.

The study & results

Nina used a tried and tested method for making "mozzarella" with grass. Therefore, her tests focused more on how the grass flavor would work in the final product. The first recipe was tasty, but when she moved into the second testing, adding fermentation, the product really benefited from it.

The grazzarella is easy to produce. She managed to make a delicious product with grass protein. From a flavor perspective, Nina says it is impressive to discover that grass protein can be easily incorporated and masked. When the notes of grass come through in the recipe, it adds to the character. Therefore, it was her intent not to hide it. Given that it is so nutritious and sustainable, it means that it would function in more similar foods. The subtle grass flavor turned out to be not displeasing at all.

Grazzarella

RECIPE BY NINA OLSSON

INGREDIENTS

- 18.7 psyllium husk
- In 200 g liquid (Nina used 150 g water and 50 g of fermented beans from Steven and Tessa)
- 200 g fermented beans
  - 200 g white beans
  - Lacto-fermentation starter – two tablespoons of unpasteurized yogurt, buttermilk, or sauerkraut juice
- 100 g cooked beans
- 15 g shoyu (with grass) from Tessa and Steven (see page 16)
- 15 g nutritional yeast
- 20 g grass protein
- 70 g olive oil

METHOD

1. Make the fermented beans. Cook 200 grams of white beans until they are al dente, and then let them cool down. Add a lacto-fermentation starter and let them sit in a vacuum-sealed bag for a few days until they are sour.
2. Mix the psyllium husk with the liquid and leave it to absorb for 20 minutes.
3. Add the rest of the ingredients to a high speed blender, minimum 1200, as it needs to be the most powerful fast blender like a Vitamix to make the bean mixture turn into a ball that holds together and has elasticity.
4. Blend for 5-10 minutes on the highest speed and then stop to scrape down on the sides. Shake the blender if it gets stuck.
5. When the grazzarela texture is stretchy and naturally holds together it is done.
6. Remove it from the blender, form little balls with your hands. Store the balls in cling film or in a food container drizzled with extra virgin olive oil and salt flakes if you like.
7. Serve in cold or warm dishes.

Polona Kuzman

Polona is originally from Slovenia, where she studied Graphic Arts Technology. Driven by personal interest, she began studying and experimenting with plant-based alternatives. She is now actively involved in the test kitchen at Restaurant De Nieuwe Winkel, where she focuses on the development of plant-based cheese. For this lab, Polona partnered up with Hazel Htun (see page27).

The study

Polona's initial inspiration was from the idea of creating grass jelly and green tofu. However, upon delving into the research, it became evident that neither grass jelly nor green tofu actually would involve pure grass in their production. Instead, they are derived from plants rich in pectin, a substance crucial for achieving the desired jellification in the final product. Exploring these products led to the discovery of various Asian items that employ diverse starch-based thickening agents. Hazel Htun possesses knowledge about many of these products, and they started working together. They applied their findings to preparations using grass (spinach) juice and protein as a foundational base.

The results

The outcomes resembled familiar foods like green tofu, mochi, boba, gnocchi, and others. To address the flavor aspect, they conducted a series of experiments involving various fermentation techniques. Polona's specific focus was on incorporating these findings into staple foods like pasta. The recipe for Grass Ravioli is a compilation of their experiments.

Grass ravioli

RECIPE BY POLONA KUZMAN

Grass pasta dough

INGREDIENTS

- 60 g fresh grass juice
- 4.2 g cornstarch
- 60 g semolina
- 60 g flour “00”
- 1 tbsp olive oil
- Pinch of salt

METHOD

1. Make the green “egg”: mix 60 g fresh grass juice with 4.2 grams of cornstarch, bring it to the boil and then remove it from the heat before the proteins start curdling. Let it cool down.
2. Make a pasta dough with 60 g of semolina and 60 g of flour “00” and the “egg”.
3. Let it rest for at least 30 min. (or overnight), wrapped in plastic foil to prevent it from drying out.

Green tofu

INGREDIENTS

- 258 g fresh grass juice
- 2.55 g calcium chloride

METHOD

1. Stir the calcium chloride into the juice until it dissolves, and then let sit for 30 min.
2. After 30 min., bring it to the boil until you see the curds separating from the liquid. Take it off the heat, cover it, and let sit for 15 min.
3. Then, pour the mixture into a tofu press covered with cheesecloth and press it into a block of tofu. Allow it to cool.

Decolorized grass protein

INGREDIENTS

- Fresh grass juice

METHOD

1. Bring the grass juice to the boil.
2. When the proteins start curdling, take it off the heat, cover it, and let it sit for 15 min.
3. Then, strain it to separate the protein from the liquid.
4. Use a Soxhlet extractor to remove the chlorophyll from the protein.

Grass ravioli filling

INGREDIENTS

- 50 g green tofu
- 24 g decolorized grass protein
- 10 g nutritional yeast flakes
- 25 g fermented nut paste (or thick plant-based yogurt)
- 1 tbsp crushed walnuts
- 1 tsp grass amino sauce (see page 27)
- 1 tsp sunflower seed paste
- 1 tsp grass protein miso (or shiro miso)
- Salt and pepper to taste

METHOD

For the ravioli filling, mix together all of the ingredients. Taste and add salt and pepper to taste, if necessary.

Grass ravioli

RECIPE BY POLONA KUZMAN

Final dish: Grass ravioli
4 persons

INGREDIENTS

- 1 recipe grass ravioli
- 400 ml vegetable broth
- 1-2 tsp grass shoyu (see page 16)
- 1/2 tbsp nutritional yeast flakes
- 1 tsp fermented grass juice (or kimchi juice)
- Vegan parmesan (rasped)
- White pepper

METHOD

1. Make Grass Ravioli with Grass Pasta Dough and Grass Ravioli Filling.
2. Warm up the vegetable broth, add 1 or 2 tsp grass amino sauce, ½ tbsp of nutritional yeast flakes, and 1 tsp of fermented grass juice. Taste and adjust, if needed.
3. Cook the ravioli in boiling water until they float - about 2-3 minutes.
4. Serve the ravioli with a dash of vegetable broth, flavored with a bit of grass amino sauce. Dot with pumpkin oil and sprinkle with vegan parmesan and freshly ground white pepper.

Hazel Htun

Hazel presents the potential of fermentation on the grass with two types of pickling methods common in Asia

Hazel was born in Yangon and raised in Bangkok. Her life has been all about food and flavors. She did her studies in the Netherlands about Food Technology, majoring in Food Quality Management. On the side, she loves involving herself with food innovation and solutions, introducing and applying Asian traditional methods. Currently, Hazel is enjoying her full-time projects as a Quality Control Engineer at Joannusmolen.

The study

Hazel worked together with Polona and was inspired to use the waste stream "fiber" to conduct fermentation experiments on real grass. Unfortunately, due to seasonality, holidays, and personal time constraints, she focused on a representable substitution with the available raw materials; carrot leaves (earthy & grassy) and water spinach (for visual & discoloring behavior). This way, her ideas could be conveyed through using carrot leaves/greens to replicate the earthiness and grassiness of the greens and water spinach to vividly portray oxidation and fermentation behavior and color.

The results

Hazel presents the potential of fermentation on the grass with two types of pickling methods common in Asia. A heavily spiced and oil pickling version (carrot leaves pickle) and a simple fermented version (water spinach pickle). The carrot version was her favorite one.

Carrot leaves pickle

RECIPE BY HAZEL HTUN

INGREDIENTS

- 200 g carrot greens
- 3 g fresh bird's eye chili (or 15 g chili flakes to substitute, see step 7)
- 20 g garlic cloves
- 1/2 tsp turmeric powder
- 1/2 tsp fenugreek powder
- 1 tsp asafoetida
- 3 tsp fermented tamarind (mix with ¼ cup water to extract the paste)
- 1 tsp mustard seeds
- ¼ tsp salt
- 50 ml sunflower oil
- 1 tsp white sesame seeds powdered (optional)

METHOD

1. Wash the greens and separate them from the stalks. Retain the tender stalks and throw the rest away *(or use everything to avoid waste).*
2. Cut the carrot greens to a length of 2-3 cm.
3. Heat 2-3 tbsp oil in a pan and sauté the chopped carrot greens. Cook the greens until they wilt completely and set them aside *(this step aims to break the cellulose down and remove a lot of water).*
4. Dice the garlic finely together with the fresh bird's eye chili.
5. Heat the rest of the oil in a pan.
6. Add the mustard seeds and let it splutter. After this, add the diced garlic & chili, sauté until they are golden brown.
7. Add asafoetida, turmeric powder, fenugreek powder, and salt. Sauté over low flame until the raw smell of the ingredients goes away *(add chili flakes here).*
8. Now, add the cooked carrot green. Cook it in the spices for 3-5 minutes.
9. Add tamarind extract and taste the pickle. *(Check to see if you need more salt, tamarind or chili. This varies from person to person.)*
10. Once the spices and salt levels are corrected, sauté the pickle until the oil comes to the surface of the pickle.
11. Take it off the flame five minutes after this and when it cools, store it in a sterilized airtight container (*make sure to press everything down to the bottom).*
12. (18°C-20°C) and enjoy. (*You can already enjoy this after 2 days of fermentation as well.)*

Akash Kumar

Akash is a product designer who focuses on sustainable design. He draws inspiration from the natural world and is constantly experimenting with all kinds of materials to solve real-life problems responsibly. His focus on responsible design involves problem-solving that aligns with nature.

The study

In his research, Akash conducted several experiments to turn grass into materials. In his research method, he made sure that he did not have any waste in the making process. His initial research idea was to weave textile samples using grass. He discovered that the grass fibers were too small to be woven together. The grass fibers that are usually used in grass mat weaving are longer. For example, Cattail leaves and Kauna Grass. He also discovered if the grass needs to be woven it should be fully matured and dried straight.

The results

He extracted natural dyes from grass and explored the idea of making grass leather once the papermaking was successful. He had the idea to grow mycelium on top of it since it is just like cellulose material for the mycelium to feed on and then to stop that growth and that would eventually give a leather-like material made of grass and mycelium. The research opens many more possibilities for exploring grass as a vegan leather option. Eventually, the outcomes of the grass paper were the most promising. The stability and strength of the paper surprised him a lot.


ALUM
COPPER
SODA ASH
PLAIN

Grass paper

RECIPE BY AKASH KUMAR

INGREDIENTS & SUPPLIES

- Grass
- Water
- Blender
- Fine mesh screen or sieve
- Plastic basin or shallow container
- Sponge
- Towels or cloths
- Rolling pin or flat object

METHOD

1. Collect and prepare the grass: Break it into small pieces and remove any big items like pebbles or twigs. Place the grass pieces in a plastic basin or shallow container.
2. Cover the grass with water and let it soak for a few hours or overnight. This helps break down the cellulose fibers.
3. After soaking, blend the grass and water in a blender until you get a pulp-like consistency. Add more water, if needed.
4. Set up your work area with towels or cloths to absorb the excess water. Pour the blended grass mixture into another basin or large container. Add more water to achieve a soupy consistency.
5. Place the fine mesh screen or sieve over the basin with the grass mixture. This will be your mold. Dip the mold into the grass mixture, ensuring that an even layer of pulp covers the screen. Lift the mold slowly, allowing the water to drain.
6. Use a sponge to press out the excess water from the grass on the screen. Flip the screen upside down onto a flat surface.
7. Use a rolling pin or flat object to press the grass onto the surface, removing more water and creating a uniform thickness.
8. Carefully peel the grass paper off the screen and place it on a dry towel or cloth. Allow the paper to air-dry completely. Once the grass paper is dry, you can further press it with a heavy book to flatten it and improve its smoothness.

Berbele van den Bos & Saskia Tersteeg

Berbele and Saskia experimented with making yogurt and cream cheese with Time Traveling Milkman Cream

Berbele is a food technology master student, currently completing her final Research & Development internship at Time-Travelling Milkman (TTM): a B2B company that works on producing plant-based fat ingredients for sustainable and appetizing dairy alternatives. The main product is a dairy cream alternative made from only sunflower seeds and water. Berbele conducted her experiments together with Saskia Tersteeg, co-founder of Time-Travelling Milkman.

The study

Berbele and Saskia experimented with making yogurt and cream cheese with Time Traveling Milkman Cream. They used grass protein instead of the proteins that they normally use in their original recipes (a protein-starch mixture with 0.9% protein). The initial goal was to replace the proteins used in existing model recipes for yogurt and cream cheese that were previously developed by TTM. Many recipes have been tried to achieve the yogurt and cream cheese recipe that are used by TTM. Because the development of these recipes is quite a complicated process, the aim was to not adjust the recipes too much as they wanted to maintain the same structure and mouthfeel while adding the grass protein.

The results

The first trials were not successful, unfortunately. The yogurt did not set and remained very liquid. To explain the differences between the “original proteins” and the grass protein, they compared the two in terms of functional properties and composition. As it turned out, due to the current extraction process of the grass protein, the proteins become denatured. In addition, the protein was much lower than the original protein.

Therefore, a large amount of water and other compounds were also added to the recipes, disturbing the networks that would normally form. The fact that the grass protein is denatured means that it is not functional anymore. This resulted in a lack of firmness in both the yogurt as well as the grass. Therefore, a different approach had to be tried. The grass protein was added to the samples at 4%, alongside the protein that is also added in the original recipe. With this formulation, the yogurt remained liquid. This indicates that the grass protein somehow interferes with the network formation of the yogurt. Further research is required to understand why.

Because the yogurt experiments failed, Berbele and Saskia decided to focus on cream cheese. Because the grass protein could only be used in relatively low amounts, the effect on the taste was hard to measure. At this concentration, it added a nice and light green fresh color and very mild grassy flavor, even in the initial recipes that did not contain any herbs or garlic.

Cream cheese with garlic, herbs and grass

RECIPE BY BERBELE VAN DEN BOS
& SASKIA TERSTEEG

INGREDIENTS

- 89.51% Time Travelling Milkman cream
- 7.5% potato protein-starch mixture (of which 0.9% protein)
- 4% grass protein
- 0.35% lactic acid
- 0.9% salt
- 0.4% garlic powder
- 0.1% dry oregano
- 0.1% dry basil
- 0.1% dry chives
- 0.1% dry parsley

METHOD

1. Add the lactic acid to TTM cream to obtain a pH value of 4.65-4.7.
2. Transfer TTM cream-lactic acid mixture from step 1 to Thermomix and incorporate Perfectasol, salt, garlic, and the herbs to the TTM cream and mix for 5 minutes on speed 3. Heat (in total) for 8 minutes at 90°C.
3. When T is around 60-65°C, add the grass protein to the cream. Stir for 1 minute on speed 2.5.
4. Save it in a container and store it for at least 24 hours in the fridge to set.

Kim Jantzen

Kim is a food nutritionist with a bachelor's degree in nutrition and dietetics. She likes to combine her knowledge about nutrition and product development to create tasty and healthy food. She has been working freelance as a product developer and cook, and she recently started working for a food startup as a part of the culinary team.

The study

Kim's goal was to create a sports nutrition product that is high in protein. She was very surprised by the quality of the grass protein. This can be determined by looking at the amino acid profile and comparing this to the amount of amino acids humans need. Grass protein was also relatively high in BCAAs, the main amino acids responsible for muscle growth, which makes it a good option for sports nutrition.

She decided on a convenient portion size for a protein bar or a drink, and also decided how much protein this particular product should contain. For the protein bar, the amount of grass protein she would need to add was quite high compared to the total weight and, therefore, it was difficult to create a tasty product with the right texture. That is why Kim changed her focus to a protein drink. Since the taste of the protein is similar to matcha tea, she decided to test the options of adding it to a matcha latte. Kim started by making a normal matcha latte recipe and slowly added more of the protein until both the taste and nutritional value were good.

The results

The texture of the first few tests of the drink was not desirable. It became gritty and the protein would slowly sink to the bottom. Kim was able to resolve this by adding xanthan gum, which she later replaced with pectin because it gave a better and less gritty structure.

Protein drink

RECIPE BY KIM JANTZEN

INGREDIENTS

- 160 g grass protein (citric acid coagulation, method 2 on page 8)
- 820 ml coconut milk
- 188 g water
- 20 ml vanilla syrup (2 parts sugar, 1 part water infused with vanilla beans)
- 6 g matcha powder
- 0.6 g pectin

METHOD

1. Start by making a pectin solution in water; do this by blending the pectin with 70 grams of the water.
2. Blend the coconut milk together with the grass protein and vanilla syrup.
3. Heat up the remaining 118 grams of water until it is 80°C. Add the matcha and whisk until it becomes foamy.
4. Add the matcha and pectin solution to the coconut milk and protein mixture and mix well.
5. Cool before serving or add some ice.


DRIED GRASS
FRESH GRASS
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Low Food Grass Organization
Ivana Mik (Head of Lab)
Tessa van der Geer (Project Lead)
Sebastiaan Aalst
Guus Nelissen

Participants
Ivana Mik
Liv van de Ven
Steven Broere
Tessa van der Geer
Marjolein Triesscheijn
Nina Olsson
Polona Kuzman
Hazel Htun
Akash Kumar
Berbele van den Bos
Saskia Tersteeg
Kim Jantzen

Editor
Laura Emous

Design
Krista Stofberg

Photography
Paulus van Dorsten

Partner
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