LAB low food

Low Food Lab:

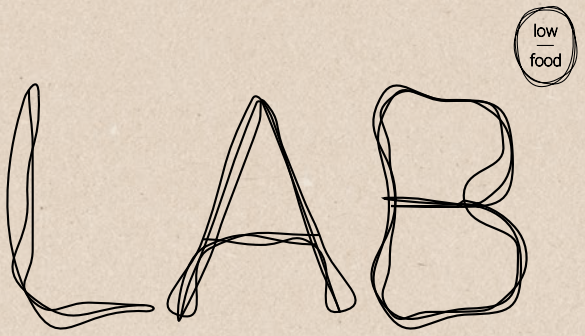
broth

LOW FOOD LAB:

broth

Low Food Lab focuses on three themes: biodiversity, waste and the protein transition. In this lab, the researchers delve into the theme of waste, and waste in the catering industry in particular. Because the catering industry is responsible for around 14% of all food waste in the Netherlands, which adds up to a 2 billion kilos of waste annually! In this lab we examine how we can tackle this by turning residual streams into a new, tasty and valuable product in restaurant kitchens: broth.

By making smart use of all your kitchen leftovers, you can get more flavour and productivity out of the same ingredients that would normally be thrown away. Elzelinde van Doleweerd (Upprinting Food), Joris Bijdendijk (RIJKS and Wils) and Friso van Amerongen (Wils) take a deep-dive into this subject, exploring how you can create the tastiest umami broth imaginable from waste streams.



ABOUT LOW FOOD LAB

The Low Food Movement has set the goal to change Dutch gastronomy. The Low Food Movement was founded by a group of chefs, political scientists and producers in 2018. The movement since then has grown and the goal is to change Dutch Gastronomy and to make Dutch food culture leading when it comes to forward thinking on subjects such as sustainability and inclusion. In a world where food security and the sustainability of the food and agricultural system are two of the world's biggest issues, we believe that the food movement has an important role in changing food culture. Low Food will therefore act as a networking agent and platform where new ideas are created and implemented.

See www.lowfood.nl for more information.

In the first step of the study, Elzelinde, Friso and Joris set out to define the perfect broth. To this end, they tasted twelve different commercial types of broth and evaluated them according to their looks, aroma and taste.

After the initial broth tasting sessions, Elzelinde, Joris and Friso started with the next phase: finding a way to bring out the umami flavours from vegetables. The researchers conducted a number of experiments with supermarket waste streams to see if they could use enzymes or fermentation techniques to bring out the umami flavour. In doing so, they mainly focused on achieving the depth of flavour they felt was lacking in the broths made from shop-bought stock in the initial tasting session.

The researchers then started experimenting with different waste streams. As enzymes produced promising results in step 2, their use was examined in more detail in the next phase of the study. In addition, the researchers tested flavourings known for their umami: miso, dawadawa and garum.

The researchers ultimate aim is to create a product that can be used to season soups, sauces, marinades and the like, as an alternative to stock cubes. We will look at a variety of experiments, as the different seasonings created in the experiments can complement each other in terms of taste, layering and complexity.

introduction by Elzelinde van Doleweerd

AS A DESIGNER, I PREFER TO WORK WITH CHEFS, each with expertise in a different field. I believe that we can together bring restaurants to a new level, in terms of the food, the experience and the story we want to convey to our guests. With a view to the future of our food system, issues like food waste are becoming increasingly important and there is a need for chefs to become aware of this and take steps to tackle this. Not only to reduce residual streams from restaurants, but also to use residual streams as valuable ingredients. The next step is the story: how are we going to communicate the choices we make in the kitchen to our guests? Do we use residual streams as ingredients without anyone noticing? It is my hope that chefs, as role models in the kitchen, will share the story and thereby inspire guests to be creative with leftovers at home.

The challenge for us in this Low Food Lab was to develop a vegetable broth from residual streams. With this challenge, we also tried to find solutions for the protein transition: how can we get that strong umami taste, that depth of flavour of a meat broth, into a vegetable broth? We set a number of prerequisites for the broth we were looking for. First, chefs needed to be able to create it from their vegetable leftovers in their kitchen. Second, we wanted a broth with depth of flavour, a layered taste and rich in umami; we wanted a broth low in salt. We defined this taste in more detail in the first phase by conducting market research. Through additional literature research on umami, experiments with fermentation methods and many tasting sessions, we eventually found the recipe for the perfect plant-based umami-rich seasoning.

meet the researchers

ELZELINDE VAN DOLEWEERD

Elzelinde graduated from Eindhoven University of Technology with a Master's in Industrial Design, after completing a minor in Food Technology at Wageningen University & Research during her Bachelor's in Industrial Design. While doing her Master's degree, she founded Upprinting Food, a company focused on research and development in gastronomy. She combines traditional techniques with new technology such as 3D printing and works with chefs to transform restaurants' waste streams into unique dining experiences. She has also worked for the Alchemist restaurant in Copenhagen.

ELZELINDE.COM

JORIS BIJDENDIJK

Joris is one of the founders of Low Food, chef of the RIJKS and Wils restaurants, a columnist for the Parool newspaper and the author of several cookbooks. He started out in the kitchen of the Ron Blaauw restaurant when he was 19, and later worked in the Michelin star restaurant Le Jardin des Sens in Montpellier. In 2012, he returned to the Netherlands to start working as the chef of the Bridges restaurant and was hailed as Young Talent of the Year by Gault & Millau. After 10 months at Bridges, Joris received his first star in the 2014 Michelin Guide. At the end of 2014, he started as Executive Chef at RIJKS, the restaurant of the Rijksmuseum. The restaurant was awarded a star in the 2017 Michelin Guide. In the same year, Bijdendijk was awarded the title of Master Chef by SVH, the professional standards organisation for the Dutch hospitality industry.

JORISBIJDENDIJK.NL

FRISO VAN AMERONGEN

Friso grew up in The Hague and has loved cooking since childhood. After spending a year abroad (travelling from Argentina to Costa Rica, with a focus on food and fishing) he came to Amsterdam in 2010, where he started studying social geography (University of Amsterdam) and then business administration (VU Amsterdam). But his passion for cooking never left him, and after deciding to embark on a career in catering, Friso was able to start as a breakfast cook in The Dylan Amsterdam hotel. At the hotel's Vinkeles restaurant, he learned the profession from Michelin star chef Dennis Kuipers and Jurgen van der Zalm. Subsequently, he set up the Wils restaurant together with Joris Bijdendijk and Erwin Oudijk, where he is now Chef de Cuisine.

@FRISO.VAN.AMERONGEN

STEP 1

Defining the perfect broth

The study

In the first step of the study, Elzelinde, Friso and Joris set out to define the perfect broth. To this end, they tasted twelve different commercial types of broth and evaluated them according to their looks, aroma and taste.

ANALYSIS

Broth without added salt had little flavour, but adding too much salt did not enhance the depth of flavour. A salt content of around 0.5% helped to enhance the flavour. In most broths, monosodium glutamate (MSG) or yeast extract is added, which did give an extra dimension compared to broths without these additives. We also found that vegetables, especially onion, carrot and leek, are essential flavourings in a vegetable broth. Vegetable broths made from dried stock were rated lower than those made from liquid vegetable stock or vegetable fond. Broths made from powdered stock or stock cubes often also contain small pieces of dried vegetables, which add little to the taste and texture. In fact, we found that their structure was quite tough. In addition, these broths tended to be watery and salty and often left behind a coloured fat rim in the bowl. They often had an artificially bright yellow or orange colour. With the broths made from liquid vegetable stock, the flavours were often better balanced, and their production method is often closer to the preparation method for a traditional broth, i.e. they consist of a reduction of vegetables seasoned with spices.

CONCLUSION AND FOLLOW-UP

Based on the first step of our study, we concluded that our broth would need to have a salt content of around 0.5%. We concluded that both herbs and vegetables are needed for a tasty broth. The follow-up step was to find a way to more emphatically bring out the umami flavours from vegetables and to combine them into a tasty broth, together with added vegetables, herbs and a pinch of salt. In addition, we found differences between broths made from dried stock and those made from liquid stock. In the broths made from liquid stock, the flavours were more pronounced and the ingredients dissolved better.

UMAMI

Umami is a Japanese word that was coined by combining the words umai (delicious) and mi (taste), in other words: a delicious taste. One of the additives commonly used in flavourings to create this taste is monosodium glutamate (MSG). MSG is a glutamate, a type of an amino acid that is naturally present in various foods, especially in protein-rich foods like meat and fish, but also in tomatoes, mushrooms and other vegetables. Proteins are made up of amino acids and can also be broken down into amino acids. The protein chains are then first broken down into shorter chains, peptides, which in turn are broken down into amino acids, including glutamates. This breakdown can be brought about by preparing food (e.g. frying meat), ripening it (e.g. tomatoes or cheese), or through fermentation. So the breakdown of proteins is reflected in what food tastes like, making it more umami!

STEP 2

Umami from supermarket waste streams

After the initial broth tasting sessions, Elzelinde, Joris and Friso started with the next phase: finding a way to bring out the umami flavours from vegetables. The researchers conducted a number of experiments with supermarket waste streams to see if they could use enzymes or fermentation techniques to bring out the umami flavour. In doing so, they mainly focused on achieving the depth of flavour they felt was lacking in the broths made from shop-bought stock in the initial tasting session.

ENZYMES

The first technique we explored was the use of enzymes. Working with enzymes offers a way to bring out umami flavours. Enzymes are proteins of which there are thousands of different types in your body alone. Each enzyme works in a specific way and is unique in the actions it performs, like a key that only fits a particular lock. They can put together or break down substances. There are also enzymes that break down proteins. Our body cannot absorb an entire protein molecule, but it can absorb the individual amino acids of which it is made up. Papain is one of the enzymes that can split protein molecules. This enzyme is available over the counter at chemists and is obtained from papaya. Enzymes have a specific temperature and acidity at which they are most active; for papain this is at around 60 degrees Celsius and a pH of 5-6.

We bought the papain at a chemist, it can be bought over the counter. This is a less pure form of the enzyme, but good enough to establish if it has an effect. We added 24 grams of papain to two different waste streams (separately): 150 grams of mushrooms and 150 grams of tomatoes. We put these in a thermomixer. This device is well suited for working with enzymes, as it enables you to set the temperature and time and the vegetables are finely ground. Constant stirring ensures that as much of the vegetables as possible comes into contact with the enzymes. We let this process continue for 3 hours.

As a control experiment, we compared the products of these experiments with the same vegetables we put in the thermomixer at the same temperature for the same length of time, without the enzymes. We saw a clear difference in colour and the products from the experiments with the enzymes had a richer flavour. Therefore, we decided to experiment further with the use of enzymes. Read more about this at step 3.

LACTO-FERMENTATION

The second technique we explored to break down vegetables and bring out umami was lacto-fermentation. This involves adding salt to the vegetables, which are shielded from oxygen (e.g. in a preserving jar or in vacuum seal bags). Many bacteria cannot tolerate salt. But Lactobacillus bacteria, which are naturally present on the peels of vegetables (and also on our hands) are salt-tolerant. By adding salt (2%) to the vegetables, the Lactobacillus bacteria eventually get the upper hand. In the process, they convert the sugars in the vegetables into lactic acid, which creates a sour taste.
We did an experiment with (combinations of) different residual streams from supermarkets. This resulted in complex flavours, but all were acidic. This method did generate value by recycling residual streams. However, it was not the flavour we wanted to achieve for the broth, so we did not take it to the next phase.

STEP 3

Experimenting with different flavourings and residual streams

The researchers then started experimenting with different waste streams. As enzymes produced promising results in step 2, their use was examined in more detail in the next phase of the study. In addition, the researchers tested flavourings known for their umami: miso, dawadawa and garum.

Enzymes

Enzymes break down the molecular structure of vegetables: the proteins are, as it were, broken down into smaller chains: amino acids. Umami is one such amino acid. In our first enzyme experiments (in step 2) we worked with papain, it can be bought over the counter. For the next step we used purer enzymes specifically developed for the food industry, which we bought from the company Novozymes. These were three different enzymes: Protamex to break down the proteins in the peptide chains; ProtanaUboost to further break down the peptide chains into amino acids; and ProtanaPrime to then convert the amino acid glutamine into the amino acid glutamate, which increases the umami taste.

Method

We tested the enzymes with tomatoes, mushrooms and cauliflower, which we first puréed. For each test, we also did a baseline test without the addition of enzymes. We followed the protocol of Novozymes for the test. Accordingly, in each test Protamex was added at a ratio of 2g/kg (pH optimum 6-8), followed after half an hour at 55 degrees by ProtanaUboost and ProtanaPrime, both at 1g/kg (pH optimum 6-7). We let this process continue at 55 degrees (in thermomixers and a water bath) for 3 hours to let the enzymes do their work, and then at 95 degrees for 15 minutes to deactivate the enzymes.

Conclusion

INGREDIENTS	TASTE	PH
875 g tomatoes, 125 g water, 5 g baking soda (to raise the pH to 6.7, instead of around 4-5)	Very strong difference: a clearer broth with a darker colour, sweeter and more umami. Promising!	6.7
925 g mushrooms, 75 g water	Without the enzymes it is not a very nice broth, but with the enzymes it is sweeter and has a fuller texture. Promising!	6.4
800 g cauliflower, 200 g water	Not much difference, but a little less bitter and sweeter.	7.1

The mushroom and tomato mixtures were promising. We were able to create a clear base for the broth by filtering these purées. We concluded that the mushrooms with enzymes version was our favourite, as it had more flavour than the tomatoes with enzymes.


Soybean
21/9
Soybean
Natto
21/9
Soybean
21/9
Soybean
21/9
Soybean
21/9

Recipe: mushrooms with enzymes

INGREDIENTS

- 925 GRAMS OF MUSHROOMS (CHESTNUT MUSHROOMS ARE GOOD; YOU CAN USE A MIXTURE OR THE MUSHROOM STEMS, PREFERABLY LEFTOVERS)
- 75 G WATER

ENZYMES

- 2 G PROTAMEX
- 1 G PROTANAUBOOST
- 1 G PROTANAPRIME

PREPARATION METHOD

1. Cut the mushrooms into smaller pieces so they can be easily puréed.
2. Add the mushrooms to the thermomixer, together with the water.
3. Blend the mixture until it is smooth.
4. Heat the mixer to 55 degrees Celsius, set the mixer to speed 2 (low-speed mixing) and add the Protamex, then set a timer to 30 minutes.
5. After 30 minutes, add the ProtanaUboost and ProtanaPrime, still at 55 degrees Celsius, and set the mixer to speed 2 and the timer to 3 hours.
6. After 3 hours, the mixture should be heated to 95 degrees for 15 minutes to deactivate the enzymes.
7. Pour the contents of the preserving jar through a fine sieve lined with cheesecloth. You are then left with a dark brown thin sauce. The residue can be dried and ground, resulting in a tasty powder.

.

Miso

Miso is a fermented paste, originating from Japanese cuisine and traditionally made from a mixture of soybeans (often with the addition of rice or barley), salt and koji, a Chinese fungus. Miso is used as a seasoning in broths and marinades, but in recent years also increasingly in sweet dishes, such as biscuits. It is known for its umami-rich properties. Koji (Aspergilles Oryzae), the fungus needed to make Miso, is grown in a warm, humid environment on a suitable nutrient medium, such as cereals. We grew the koji on pearl barley, rice and stale bread, resulting in a tightly bound white mat of grains and hyphal threads. The fungus releases enzymes that convert starch into sugars, proteins into amino acids and fats into fatty acids.

We made one version of the miso with a half-and-half mixture of stale bread and pearl barley, and one entirely with stale bread, as bread is a major waste stream in restaurants. The ratio for the half-and-half version was: 635 grams of pearl barley and 635 grams of stale bread covered with koji, 63.5 grams of salt (5%), and 285 grams of salt solution (5%). And the ratio for the other version was: 1,270 grams of bread covered with koji, 63.5 grams of salt (5%), and 5% salt solution to dilute the mixture to the desired consistency. We left the jars with the mixture to ferment at room temperature. In both mixtures, this resulted in the first complex umami notes. However, the miso will need to ripen for a few months to develop its flavour. Only then will we be able to evaluate which method produces better results. For the comparison with dawadawa, we used shop-bougt miso. Read more on page 12.

Dawadawa

Dawadawa's are African fermented bean pastes. These are often used as a base for soups and sauces and according to research have an extremely high content of glutamate, an amino acid known for its umami taste. Dawadawa is currently rarely used in the Netherlands. We obtained a number of fermented African pastes to test from various African food shops and from contacts with knowledge of these ingredients. We compared these pastes in their pure form with other seasonings, including miso, and also when dissolved in boiling water.

TASTING SESSION WITH CURRENTLY AVAILABLE DAWADAWA

In the tasting session, we found that the tested dawadawa differed in terms of their taste, texture, odour, solubility and colour. Some dawadawa were dried and ground, but others still consisted of visible beans and were wet. The moist pastes came from the freezer and were still 'fresh', while others were gritty. Most of them had a very stale taste and smell: they smelled and tasted a bit like manure. One of the fresh pastes smelt slightly more sour; this dawadawa gave off the most flavour when we dissolved it. We concluded from this that the pastes give a rich flavour and are promising products for further research.

DAWADAWA COMPARED TO MISO

Dawadawa is used in African cuisine as a seasoning, for example as a base for soup. Miso is also used as a base for soup in Japanese cuisine. To compare dawadawa with miso, we made a broth from 20 grams of shop-bought miso and 400 grams of water, and one from 20 grams of dawadawa and 400 grams of water. We also added equal amounts of vegetables to both broths and let them simmer. We then found that the dawadawa imparted more depth of flavour to the broth. However, this combination still had a manure smell and also a slight manure flavour. The broth with miso was saltier and had less depth of flavour, so we decided not to continue with miso, opting instead for dawadawa.

DUTCH DAWADAWA

In Africa, dawadawa is usually made from locust beans. To make a Dutch version, we started testing which Dutch beans would be suitable. In addition, the beans are normally wrapped in banana leaves. For the Dutch version made from residual streams, we set up tests with corn husk, fig leaves and cauliflower leaves. Dawadawa is fermented with the Bacillus subtilis bacteria. These bacteria are naturally present in the beans and even survive the cooking process. The bacteria can also be added to the beans: in powdered form, for example, or by adding a little amount of dawadawa or natto (Japanese fermented soybeans, which are also fermented with Bacillus subtilis bacteria).

DAWADAWA EXPERIMENT 1

Method

To make our own dawadawa, we let the soybeans soak overnight and then peeled off the skins. We cooked them for about two hours until they were good to eat. We divided the soybeans in batches that were each fermented in a different way, including without the addition of Bacillus subtilis, with a little dawadawa, and with natto, added in a ratio of 1:6. We wrapped some in fig leaves and some in corn husk. We followed the following process: soaking - peeling - cooking - adding Bacillus subtilis / natto / dawadawa (as applicable) - rolling in leaves - fermenting for 36 hours at 38 degrees - unpacking and drying at 38 degrees.

Conclusion

The experiments with fig leaves produced few visible changes, but the fig leaves had clearly imparted flavour and some of the beans had become a bit stickier. The experiments with corn husk produced more visible changes: the beans fermented with the natto starter culture were very slimy. The beans that had been fermented without adding anything likewise had a slightly stronger flavour and were sticky. The beans to which some dawadawa had been added had not changed greatly. The beans were then further dried and ground to a powder. There was a clear colour difference between the powders. The soybeans fermented with the natto starter culture in corn husk had the darkest yellow colour.

For the tasting session, we heated a tablespoon of each powder in a pan and then dissolved it in 200 ml of water, which we brought to the boil. The soybeans with the natto starter culture wrapped in corn husk tasted best. We decided that we could subsequently try this with other Dutch beans.

BEAN & LEAF COMBINATIONS	TASTE
Soybeans in corn husk	A bit sour.
Soybeans in fig leaves	Tastes very much like the version in corn husks.
Soybeans with natto in corn husk	Has a very strong flavour and could be a nice layer in the broth; tastes like natto, with umami flavour and mouthfeel (infuses the palate), and coffee flavour.
Soybeans with natto in fig leaves	The fig leaves give off a fruity flavour that does not combine well with the natto flavours; therefore not tasty.
Soybeans with dawadawa in corn husk	The corn husk give off a nutty flavour, not very strong but tasty.
Soybeans with dawadawa in fig leaves	Not so tasty.

DAWADAWA EXPERIMENT 2

Method for Dutch dawadawa

For the second experiment we made dawadawa with Dutch beans, wrapped in corn husks. We repeated the method used for Dawadawa experiment 1, but with the addition of Bacillus subtilis

and various types of Dutch beans instead of soybeans. We also did tests using cauliflower leaves next to corn husks, to see if we could recycle a further waste stream. We put the bean packets into a food dehydrator to ferment for 36 hours at 38 degrees.

The beans stank very badly afterwards. Fermentation had clearly occurred and we also saw big differences between the beans. After further drying, we were able to grind the beans to powders. We dissolved these powders in boiling water. This created a more complex taste, but there was still little difference between the various beans. The addition of 0.5% salt had a positive effect in enhancing the taste. Because we still tasted little difference between the beans, we were curious to see the effect of the Maillard reaction (see the text box) on the dawadawa solutions.

Method for Dutch dawadawa with Maillard reaction

To test the Maillard reaction, we dissolved 5 grams of the powders (from experiment 2) in 195 grams of water, with 1 gram of sugar and 1 gram of salt. We added the 0.5% salt as the necessary amount to enhance the taste, and the 0.5% sugar to induce the Maillard reaction. We put the packets in vacuum seal bags, which we placed in rice cookers (with the garums) set to the keep warm setting (60 degrees) and left there for a fortnight. In this way, we facilitated a slow Maillard reaction at 60 degrees. As we had four different types of each powder, we had 20 solutions in total.

Conclusion

All dawadawa solutions had become much more acidic, which is also reflected in a decrease of pH (Dawadawa is the product of alkaline fermentation, and before the Maillard reaction the solutions had a pH of around 8). It is not known what caused the solutions to become much more acidic. Possibly lacto-fermentation took place in addition to a Maillard reaction. The taste was also more complex, with distinct differences. Our favourite dawadawa was the version with navy beans, followed by the version with field peas, which was also very tasty. We repeated this experiment several times, which included preparing the dawadawa in corn husk and putting them through the Maillard reaction in vacuum seal bags at 60 degrees, each time with the same effect. Below are the most interesting and striking results:

MAILLARD REACTION

The crusts of most bread are (golden-)brown as a result of the Maillard reaction. The Maillard reaction is a chemical reaction between amino acids and sugars that changes the colour of food and creates flavour.

The amino acid glutamate gives the umami flavour. However, there are more umami peptides (a peptide is a chain of amino acids) which may have a variety of flavours or may act as umami-enhancing agents, capable of intensifying sweetness, sourness, umaminess and saltiness. Maillard reaction could facilitate the yield of umami/umami-enhancing peptides. In fermented products, the Maillard reaction occurs even at an ambient temperature.

BEAN & LEAF COMBINATIONS	LOOKS	AROMA	TASTE	PH
Dutch brown beans, cauliflower	Murky, slightly reddish brown, beige.	Slightly stale and toasty.	More taste, sour. Aroma is a little musty and toasty.	4.8
Navy beans, sweet corn	Clearer than with Dutch brown beans, light yellow, but still murky and thicker.	Musty, a little nutty and sour.	Better taste, tasty and complex. Aroma is a little nutty and smells like beans. Not as sour as the navy beans with cauliflower leaves (this one had pH 4.7), fairly salty, complex umami, a bit mealy with many bits in it.	6.7
Field peas, cauliflower	Beige, brown, grey. Light in colour.	Sour, sweet, complex.	Complex, richer than with Dutch brown beans. Seaweed and citrus tones, smells sour and sweet at the same time. Complex, seaweed. Slightly salty, umami, layered. Slightly sour.	5.6
Chick peas, corn husks or cauliflower leaves	Slightly murky, white/yellow, small bits in it; light in colour.	Toasted sunflower seed.	Toasted, strong taste and smell of toasted sunflower seed. The version with cauliflower leaves is the most acidic. Toasted seeds. Slightly sweet, layered.	5.17

Recipe: dawadawa Maillard experiment

INGREDIENTS

- 5 G NAVY BEAN DAWADAWA POWDER
- 195 G WATER
- 1 G SALT (0.5%)
- 1 G SUGAR (0,5%)

PREPARATION METHOD

1. Mix 5 grams of powder with 195 grams of water, add salt and sugar (pH 8).
2. Fill a vacuum seal bag or clean preserving jar with the mixture.
3. Place the mixture in a rice cooker set to 60 degrees (e.g. together with the garums, see page 19) and leave it there for a fortnight; result: pH 6-7).

.

Garum

Garum is a fish sauce used in Roman cuisine in which the fish is broken down completely by enzymes that are naturally present in the intestines of fish. This process involves proteins being broken down into amino acids, which creates umami flavours. So the fish eventually breaks down naturally without anything having to be added other than salt, which acts as a preservative.

For this study, we made vegetable garums. Inspired by the book The Noma Guide to Fermentation, we used koji for this. Koji is a fungus that produces the enzymes that convert proteins into amino acids, fats into fatty acids and starches into sugars. We grew the koji on various types of nutrient media, to which we added the vegetable residues, along with water and salt. We then put all this in a preserving jar and kept it warm in a rice cooker for 5 weeks (at around 60 degrees). This increases enzyme activity and stops the growth of various pathogens.

GARUM EXPERIMENT 1: VEGETABLES

Method

The first garums were made from different vegetable residues. These sauces were kept in a rice cooker for 5 weeks at 60 degrees. We used a recipe from The Noma Guide to Fermentation, but we halved the amount of water because we were using vegetables instead of meat. We added the ingredients together, puréed the mixture and put it into clean preserving jars.

We covered the mixture with foil to create an air seal and closed the preserving jar without inserting the rubber seal band. We then put everything into the rice cooker.

The following residual flows were tested, in combination with 112.5 grams of koji (Aspergilles Oryzae grown on pearl barley), 200 grams of water and 98 grams of salt (12%):

- 500 g mushrooms
- 500 g tomatoes
- 250 g tomatoes, 250 g mushrooms
- 450 g tomatoes, 50 g celery
- 250 g kale, 250 g mushrooms

GARUM EXPERIMENT 2: BEET PEEL, CAULIFLOWER LEAVES AND COFFEE GROUNDS

Method

The koji we used for these garums was a different species, Aspergilles Luchuensis, grown on rice. As in experiment 1, the koji was

added to a mixture of vegetables, water and salt to make new garums. Tthis time, we used other residual streams, residual streams from the restaurant. Also, we used less salt because during an intervening tasting session we had found that the previous garums tasted quite salty. However, we were unsure whether we could prepare the garum with even less salt, or whether that would be dangerous. What bacteria and fungi might then start to grow in the garums? We made three different kinds of garums, which we kept at 60 degrees for 5 weeks. These garums consisted of 500 grams of leftovers (beet peels, cauliflower leaves or coffee grounds), 112.5 grams of koji, 200 grams of water and 65 grams of salt (8%).

Conclusions from the two experiments after 5 weeks

We filtered all garums from the first and second experiment, first through a sieve and then through a fine cloth. We tasted the filtrate and further dried the residue in the food dehydrator and ground it into tasteful powders. At a tasting

session we found that all the garums were very salty. However, they all had a rich flavour. With the coffee grounds version, almost no moisture was released in the end. Both the paste (residue) and the filtrate were tasty. The filtrates of the tomato-mushroom and kale-mushroom versions had a nice dark colour. We were not yet able to determine our favourite version. Because the salt was too overpowering, we had to find out what the garums would taste like as an addition to a basic stock. Read more about this in the next section.

STEP 4

Finding the perfect combination

After having done numerous experiments with the use of enzymes and the preparation of dawadawa and garums, the researchers added the tested ingredients to a basic stock that was made by simmering vegetables in water. Their ultimate aim is to create a product that can be used to season soups, sauces, marinades and the like, as an alternative to stock cubes. They were now able to test the effect of the various seasonings they had created by adding them to the basic stock. Would they add depth of flavour? Which ingredients would work best? And what are the right proportions? Below, we will look at a variety of these experiments, as the different seasonings created in the experiments can complement each other in terms of taste, layering and complexity.

STANDARD STOCK

As a first step, we added the ingredients from the various preceding experiments to a standard vegetable stock to test whether they would enhance its taste. To create the standard

stock, we used water and onion, garlic, carrot, blanched celery, fennel, mushrooms, tomato and leek, which we brought to the boil and let simmer for 1.5 hours to draw out the flavours. We then strained this through a fine sieve.

TASTING OF BROTHS WITH GARUMS

We added 1 tablespoon (8.5 grams) of the various garums we made to 100 ml of the standard stock and then compared the effects of the garums. The garums were made by adding 8% salt or 12% salt. With the addition of 12% salt to the garum, the total salt content of the garum comes to 10.76%. The 8.5 grams of garum therefore contain exactly 0.91 grams of salt. 0.91/ 108.5 grams (total) = 0.84% salt. And with the 8% garums, this results in 0.58% salt.

This led to salty, complex flavours, as well as sweet, sour and umami. The cauliflower leaf garum had a distinct flavour, but this can be interesting in a cauliflower dish. The tomato-mushroom garum tasted the best. It was quite sweet and had a bit more acidity than the version with just mushrooms, and was very complex. The tomatoes made it a bit more tangy. The coffee grounds did not yield enough volume and therefore had no effect. The beet garum was bright pink, resulting in a pink soup, without much complexity. The kale garum was tasty, had a smoky flavour and was quite complex, although opinions were divided on this.

TASTING OF BROTH WITH ENZYMES

We similarly added the ingredients produced through the mushroom and tomato enzyme experiments to a standard stock, but without adding salt straight away. However, we found that adding a pinch of salt enriched the flavour and was necessary to bring out the complexity. This resulted in a broth with a lot of umami. It brought out the rich flavours of the vegetables. The flavours were very rounded and full. The addition really created an extra layer, so this is definitely a good basis!

TASTING OF BROTH WITH DAWADAWA

We tested the dawadawa (dissolved, with the maillaird reaction) in the same way, adding 1

tablespoon of it to the standard stock and without adding any salt. Fortified, umami, tingling on the tongue everywhere. The chickpea version had a strong sunflower seed flavour and the version with Dutch brown beans was the most acidic. The broth with navy bean dawadawa had superb complexity!

REDUCING SALT CONTENT OF THE GARUM

As the tomato-mushroom garum had a very high salt content, we tried to reduce this. With garums, generally a lot of salt is often added as a preservative. Because we were working with vegetable instead of animal waste, and miso (likewise made with koji and vegetable ingredients) can be made with less salt, we wanted to test to what extent we could add less salt in making the vegetable garums. To test this, we made the tomato and mushroom garum again, but this time with koji grown on stale bread

(to recycle even more waste streams), with and without a reduced salt content. Previously, we had made this garum with pearl barley, with 250 grams of tomatoes, 250 grams of mushrooms, 112.5 grams of koji, 200 grams of water, and 98 grams of salt (= 12% added salt). This time, we used koji grown on stale bread, with 12% added salt and with lower percentages of added salt (8%, 4%, 2%). After five weeks, we were able to test the garums and found that 2% was too low; it did not give a good taste and smelled wrong. From 4% upwards, the taste was good. This was an important conclusion, because at the initial tasting of the broths made from shop-bought stock we had concluded that many of them were too salty.

OPTIMISING THE PROPORTIONS

Once we had created all the seasonings (garum, dawadawa and enzyme), we tackled the challenge of optimising the proportions. We started with a ratio of 1:1:1 (one tablespoon of each flavouring) and added this to a basic stock to test how this affected its taste. Some flavours began to dominate and others disappeared. In this way, we explored which of the three flavourings we needed to increase the proportion of and which we needed to reduce. We also experimented with leaving out the dawadawa.

Determining the salt content of garum

Finally, we experimented with garums with a salt content of 4% and 8%. While both were good to use. The solution particularly requires more salt than can be provided by the 4% salt garum in the proportions we decided on in the end.

Recipe: tomato-mushroom garum

INGREDIENTS

- 250 G TOMATOES (PREFERABLY FROM RESIDUAL STREAMS, THESE MAY BE OVERRIPE TOMATOES)
- 250 G MUSHROOMS (CAN BE A COMBINATION OF DIFFERENT MUSHROOMS, MUSHROOM STEMS CAN ALSO BE USED FOR THIS)
- 200 G WATER
- 112.5 G KOJI (ASPERGILLES ORYZAE GROWN ON STALE BREAD)
- 65 G SALT (8%)

PREPARATION METHOD

1. Cut the tomatoes and mushrooms into small pieces so that they can be easily puréed.
2. Purée the tomatoes and mushrooms together with the other ingredients into a fine mass.
3. Pour the mixture into a clean jar without a rubber ring, cover the purée with cling film to create an airtight seal and close the jar.
4. Keep the preserving jar at 60 degrees for at least 5 weeks (e.g. in a rice cooker using the keep warm setting).
5. Pour the contents of the jar through a fine sieve lined with cheesecloth. This will leave you with a clear golden-brown tomato-mushroom garum. The residue can be dried and ground, resulting in a tasty powder.

Depending on one's preferences, this can be increased by simply adding salt or adding more garum. In addition, the 4% salt garum imparts a slightly bitter taste. This is not unpleasant, but clearly noticeable.

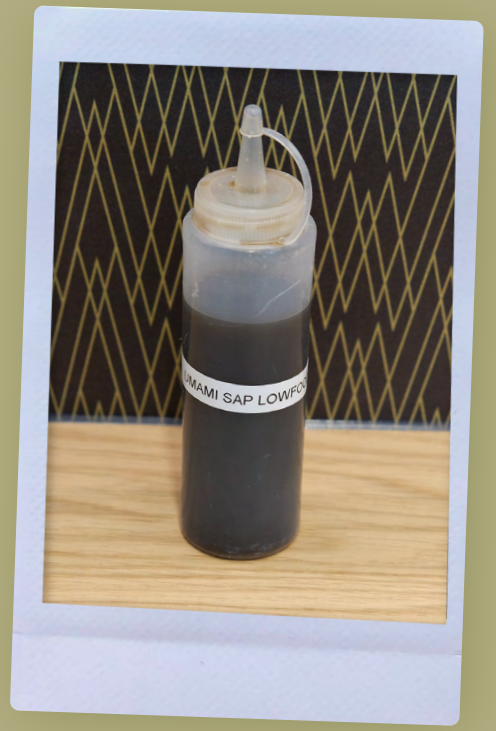
We tested a ratio of 10:10:5 for the dawadawa, enzymes and 4% salt garum, and then a ratio of 10:10:10. The latter proportions gave a complex, slightly bitter taste. We found that we could add even more garum. We then experimented with the 8% salt garum, which was powerful enough in these proportions. We found that we could leave out the dawadawa. When a high proportion of dawadawa is used, it overpowers the other flavours. When then settled on a ratio of 1:10:10 for the dawadawa, enzymes and 8% salt garum, but this did not really bring out the flavour of the dawadawa.

2:10:10: the golden ratio

In the end, 2:10:10 proved to be the golden ratio: it brought out an added hint of acidity and, above all, more complexity. This was in proportion to the 8% salt garum made from koji on stale bread. When we dissolved this combination in the broth, it clearly enriched its taste. We also experimented with reducing the broth by letting it simmer down. This mostly added a lot of overbearing sweetness, reduced the flavours, and particularly reduced the complexity and umami. The broth can be seasoned with herbs if required, but we did not want to add them to the mixture because we feel that the combination of herbs that works best may vary depending on the dish.

conclusion

The perfect seasoning, in a ratio of 2:10:10



INGREDIENTS

- 50 ML DAWADAWA MAILLARD EXPERIMENT WITH NAVY BEANS, DRIED, GROUND, DISSOLVED WITH SUGAR AND SALT, AND THEN LEFT FOR A FORTNIGHT AT 60 DEGREES. *SEE THE RECIPE*
- 250 ML GARUM OF MUSHROOMS AND TOMATOES MADE WITH KOJI GROWN ON STALE BREAD, 8% SALT, FILTERED TO OBTAIN A CLEAR DARK SAUCE. *SEE THE RECIPE*
- 250 ML MUSHROOM ENZYME EXPERIMENTS WITH TWO-STEP ADDITION OF THE VARIOUS TYPES OF ENZYMES IN A THERMO- MIXER, FILTERED TO OBTAIN A CLEAR DARK SAUCE. *SEE THE RECIPE*

PREPARATION METHOD

1. Mix all ingredients together.
2. Pour the mixture into a bottle and store in the fridge until use.
3. Can be used to season a soup, sauce or marinade to taste, or instead of a stock cube. Start with 1 teaspoon per 500 ml.

low

food

“The Low Food Movement has set the goal to change Dutch gastronomy. The Low Food Movement was founded by Joris Lohman, Joris Bijdendijk and Samuel Levie in 2018. The movement since then has grown and the goal is to change Dutch Gastronomy and to make Dutch food culture leading when it comes to forward thinking on subjects such as sustainability and inclusion. In a world where food security and the sustainability of the food and agricultural system are two of the world’s biggest issues, we believe that the food movement has an important role in changing food culture. Low Food will therefore act as a networking agent and platform where new ideas are created and implemented.”

See lowfood.nl for more information.

hello@lowfood.nl
www.lowfood.nl
Facebook
Instagram
Twitter

Participants Low Food Lab: Broth
Elzelinde van Doleweerd
Friso van Amerongen
Joris Bijdendijk

Editor
Laura Emous

Design
Krista Stofberg

Partner
This publication is a result of a collaboration between Low Food and Flevo Campus. Flevo Campus is a collaborative effort between the City of Almere, the province of Flevoland, Aeres Hogeschool Almere and Wageningen University & Research. For more information visit www.flevocampus.nl.

Special thanks to
Novozymes for the enzymes

Disclaimer
The recipes of dawadawa and the garums are the result of experimental research. We did not conduct any lab tests to verify food safety. Conducting the experiments is at your own risk. If you are conducting your own experiments, it is recommended that you heat the results for an appropriate duration and temperature to kill possible pathogens before tasting the results. During the research we heated our garums with 4% and 8% salt for 15 minutes at 95 degrees Celsius.