



LAB low food

Low Food Lab:

Okara

LOW FOOD LAB:

OKARA

When soybeans are pureed and filtered to make products like soy milk and tofu, the soy pulp remains. This pulp, also known as okara in Japanese, is mostly treated as waste in The Netherlands. In Japan okara is seen as a nutritious and valuable product. Why are we using okara mostly as feed for livestock? How can we safely use okara in our own diets? And what culinary properties does it have?

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.

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SOYBEANS ARE SPECIAL. They have high-quality protein and excellent nutritional values. But only a small percentage of that makes its way into the soy milk after producing. The rest remains in the okara, which we throw out or feed to livestock. You could compare it to cooking potatoes, using the boiling water and throwing out the potatoes themselves. That doesn't make much sense, right?

If you try to imagine okara, close your eyes and picture a fresh young cheese that is pretty neutral, slightly nutty, with a creamy mouthfeel. Okara is like a blank canvas, and extremely versatile. So when I think of this I see a lot of options and that is, from my perspective as a product developer, very exciting. The way I see it is that okara is already very close to being a product on its own that just needs some tweaking and adjusting, and then it's ready to be used in all kinds of applications or even to be sold in stores.

That's why we felt the necessity to do this Low Food Lab. Over the past years there has been an increasing awareness about the shadowside of soy production, since it can be linked to deforestation, for example (but not exclusively) of the Amazon rainforest. Luckily we have our own soy producers right here in the Netherlands. For this Low Food Lab we are working with Bart and Tom Grobben, the first all-Dutch soy milk producers. Since 2016 they have been producing soy in Twente and since 2020 their soy milk is on the market. They are left with this nutrient-rich soy pulp that doesn't seem to have a real purpose yet. With this Low Food Lab we aim to discover the culinary properties of okara and find new ways to use it in our diets.

Spoiler alert:
okara exceeded all
of our expectations.

meet the researchers

SASKER SCHEERDER

Sasker is the founder of Manenwolfs foodlab. At Manenwolfs, they turn old preservation techniques such as smoking, drying, pickling, infusing and fermenting upside down and inside out, with the aim to create modern-day food products and innovative concepts. As Sasker knows his fair share about food processes, he gets especially excited when there's microbes and fungi involved. Together with his companion and research assistant Steevy-Jo Schipper and sparring partners Sanne Zwart and Bart Smit, he took a deep dive into the world of okara.

MANENWOLFS.NL AND @MANENWOLFS

LOTTE SMELIK

Lotte Smelik is the founder of Das Brot, a sourdough bakery in Rotterdam. She makes real bread from scratch with mostly Dutch and organic ingredients. Taste always comes first for Lotte, and she is very interested in using waste streams in her products. That's why she is the perfect addition to the okara team.

DASBROT.NL AND @DASBROTNL

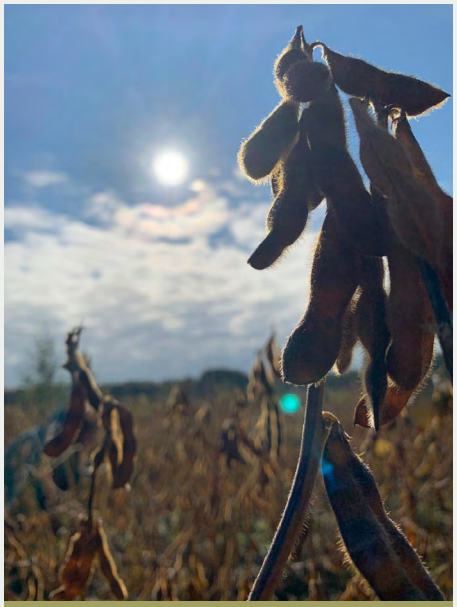
GILBERT KOLFF

Gilbert Kolff is the founder of Fond and provides tailored dining experiences on location. He's worked as a chef in multiple countries and loves cooking with seasonal products and developing new products and dishes. Gilbert is involved in this Low Food Lab to experiment with the practical uses of okara in the kitchen.

FONDROTTERDAM.NL AND @GILBERTKOLFF

from soybeans to okara

In this Low Food Lab we've done extensive research on okara. But how is okara made in the first place? Easy. Tom and Bart from De Nieuwe Melkboer grow the soy on their farm in Twente. Traditionally, soy grows in tropical or subtropical climates, but because of crop breeding it can now also be grown in colder climates. In September or October the soybeans are harvested and immediately dried so they can be stored for up to a year. This way they can be used whenever they're needed. To make soy milk, the beans are soaked in water, finely ground into a 'soy slurry' and then strained.
The pulp that remains is okara. For this Low Food Lab, the okara was pasteurized, packaged, frozen and sent to the researchers. And that's where the experimenting begins.



VALUABLE FOOD WASTE

Apart from small-scale home use and incidental industrial applications, most of the okara worldwide goes into cattle fodder, biogas, or is simply thrown out. But that is such a pity: only part of the nutritional value of the soy bean goes into the soymilk or tofu. Okara contains a decent amount of fibers, fats, carbs and proteins, as well as most of the minerals and vitamins from the original soybean: potassium, calcium, niacin, isoflavones, linoleic acid, vitamins B and D. Valuable stuff, from a nutritional viewpoint. Therefore, and because okara has a moisture content of 80%, it can be seen as 'water with benefits' when used in product development.

July

miso

okara 60%
koji 40%
sea salt 10%

koji fermented
like miso (HIGH TEMP)

shoyu

TRADITIONAL USES OF SOY

MISO - SHOYU - AMINO PASTE

We started our tests with some traditional uses of soybeans, by making miso and shoyu. Traditionally, miso and shoyu are made by using either just soybeans or a mixture with grains and mixing them with koji, water and salt. We used okara instead of the whole soybeans, for obvious reasons. This is where we ran into our first problem: the okara oxidized very quickly which led to moldy miso and shoyu. With soy milk production, the okara is exposed to a lot of oxygen. This makes it prone to spoilage and makes it a challenging product to work with. We tried again, with a workaround this time: the 'miso' and 'shoyu' were put in vacuumed bags and kept in a controlled environment at a temperature of 60 degrees Celsius for several weeks. At this temperature the enzymes work at a record speed. We made different variations: high and low sodium, with and without lacto fermentation, different times and different temperature trajectories.

The outcome did not compare to anything like the miso or shoyu they were inspired by: they lack the funky fruitiness and depth of flavor that the cocktail of fungi, lactobacilli and yeasts create in their original counterparts. We would rather call them 'amino pastes', because it's all about the conversion of amino acids. However, in many cases a very stable, intense bouillon-like paste came out that balances sour, umami, caramellization and saltiness, sometimes even resembling a very deep salty liquorice.

OKARA AS A RESOURCE: CULTURAL HISTORY AND KNOWN USES

Okara has been around since the history of tofu- and soymilk making. Okara is the Japanese word for it, in Korea it is called biji, the Chinese know it as douzha. In Indonesia, where a lot of okara is made, the Japanese term is adapted. All of these cultures have found many inventive ways to incorporate the by-product into daily food preparation, from stews (for example Japanese unohana) to the Sundanese people of Java making a beloved type of tempeh with it called oncom. The challenge of making upscaled products with okara lies in maintaining the quality, as the earlier process of making tofu or soy milk involves boiling and grinding the beans to a pulp where they oxidize quickly over time, making it difficult to use in other processes without the risk of cross-contamination. Another reason is economical: even in Indonesia for instance, there are no industrial producers of oncom tempeh, because the market is not willing to pay the same price for oncom as for a tempeh with virgin soybeans.

TEMPEH

In the Sundanese region on the island of Java, Indonesia they make a tempeh out of okara called Oncom. Indonesian people make this tempeh themselves, at home. Since it is a byproduct, it's very cheap. Next to the price, oncom tempeh is highly appreciated for its taste. It's a very nutritious product full of fibre, protein, fats, carbohydrates, vitamins and minerals. Moreover, the Neurospora culture that makes oncom creates a golden orange fungus on the surface. Great, we said, let's do this!

Our first thought though was: the okara as we know it is cottage cheese-like, how do we turn that into tempeh? Let's start off by noting that the okara in Indonesia is very different from the okara in the Netherlands. The soybeans coming from an industrial process are very finely ground so we can extract more nutrients from them, whereas the soybeans in Indonesia are mashed by hand. That results in okara with way more lumps of soybean and visible fibers, which is ideal for making tempeh. There's still room for the oxygen to go through so the fungus can spread and ferment the soybeans. Our okara is very finely ground and leaves no room for oxygen to go through, so the fungus can only grow on the surface. Conclusion: making tempeh out of Dutch okara is a no go.

bacillus subtilis
(low tray)

binding with nigari, just like tofu-process?
(probably won't bind enough)
different binder
-> Birmese tofu?

NATTO AND TOFU

After we tried making tempeh, we continued with natto: a traditional Japanese product consisting of fermented soybeans and characterized by a slimy, sticky and stringy texture. Natto is one of very few food products that contain big quantities of vitamin K2, so that makes it a very interesting product. To the western palate, its ammonia-like odour combined with its texture makes it pretty challenging to appreciate. Unfortunately the natto failed as well, for the same reason as the tempeh: not enough room for oxygen for *Bacillus subtilis* to grow.

Tofu is made from the coagulated proteins in soy milk. Most of these proteins remain in the soy milk after production, and not in the okara. So technically it doesn't make sense to try and make tofu from okara, but that didn't stop our curiosity. Will the okara proteins bind when you use nigari salt, the tofu-making culture, on them? No they don't, this experiment failed as well.

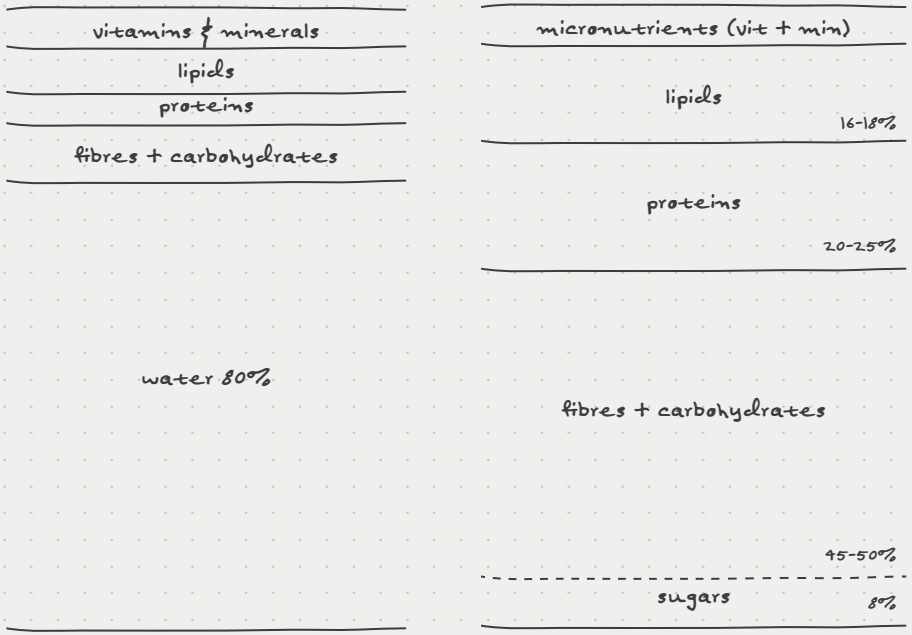
NUTRITION - ANTINUTRITION

One of the challenges that comes with finding good use for okara is the digestibility of the proteins. Soybean -and therefore okara- contains some antinutritional factors: lectins, phytic acids, trypsin inhibitors, phytoestrogens, saponins, and soybean agglutinins amongst others, which make soybean hard to digest. Some, but not all of these factors are neutralized in the cooking process. Not a big deal when sipping soy milk, but an underexposed topic when it comes to the use of soy in today's generation of meat replacement products, we would say.

LACTO FERMENTATION

This is where microorganisms come in: fermentation by proper species of bacteria or fungi is known to break down soybean's antinutrients; as is the case in most traditional soybean products like tempeh, miso, natto, douchi, gochujang and such. Fermenting the beans doesn't only lift off the bean's negative aspects, it even improves their nutritional value: it can synthesize minerals and increase the amount of edible fiber, free amino acids, sugars, fatty acids and B-vitamins, amongst which the much sought-after B12.

With Low Food Lab: Okara, we tried many different lactobacillic cultures until we found one that performed stable results, preserving the okara better and improving its digestibility. Wherever we could, we applied this version of lacto fermented okara in our tests. Lacto fermented okara has a more pronounced, slightly sour taste, and contains salt. It does take away some of the soft, creamy and nutty aspects of the okara. In the tests where this effect -or the addition of salt- was unwanted, we used the untreated okara.



August

mushrooms -> duxelle?
pickle vegetables
okara
spices

duxelle

mayo-like

CHARCUTERIE

DUXELLE

Since okara is soft cheese-like, it would probably lend itself well to make spreads with, we figured. So we made a duxelle from mushrooms, onion, garlic and butter, and used this as a base for okara-sandwich spread. The mushrooms really helped with achieving an umami flavour. Our taste panel enjoyed it too: a bit on the culinary side. Something you would expect in a restaurant, but not in the supermarket.

RECIPE OKARA 'DUXELLE' SPREAD: PAGE 12

FILET AMÉRICAIN

Next up: a vegetarian Filet Américain with roasted peppers and paprika powder. Although we had high expectations, they were not fulfilled. The fat binding failed. It turned out to be a pretty good veggie spread, but it just couldn't be called a Filet Américain. It was just peppers, okara with added spices, oil and some other ingredients. Also, the added value of the okara was minimal and that was not what we had set out for.

filet américan

finely chopped onion

préparé
mayo
mustard
english sauce
capers
pepper/salt
finely minced beef

hot sauce?

tartex

with bite / chunks?
umami
mushroom
rapeseed oil

thicken / texture

SAUSAGES AND FALAFEL

What happens when you try to make meat-like products with okara? We tried to make different types of 'sausages', which was a lot of fun but hard to achieve. It turned out to be difficult to create a meaty texture with okara. The consistency remained crumbly and the sausage wouldn't really bind together without using a lot of binding agents.

On the other hand: okara lends itself very well to making falafel. The okara-falafel had a good texture and flavour. Okara also has very good baking properties, which led to falafel with a nice brown, crunchy outside and a moist inside. Just a bit of chickpea flour was needed to create the perfect falafel-batter. All in all: okara-falafel is a success.

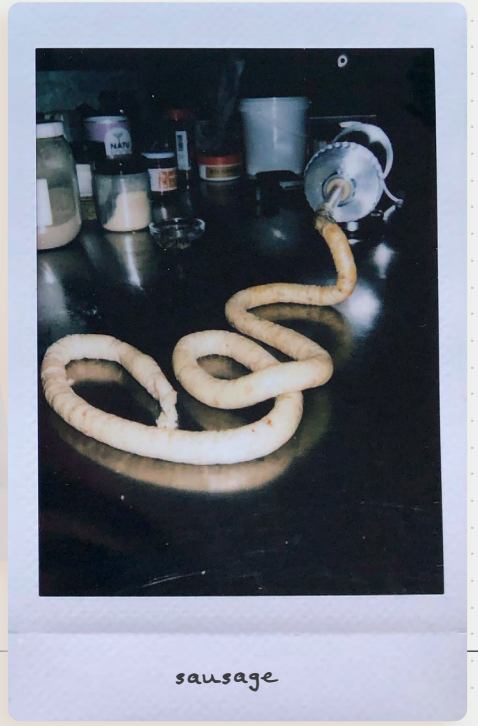
RECIPE OKARA FALAFAL: PAGE 12

frankfurter

PÂTÉ AND CHORIZO-SPREAD

A big win was a pâté-like spread that we duped after the iconic vegan spread 'Tartex'. It was even better than Tartex, if we may say so. Both taste and texture were great with a good, spreadable consistency. We used lacto fermented okara, mushroom, spices and a binding agent. This pâté is extra interesting because it has a long potential shelf life.

Lastly, we made a chorizo-like spread using the okara-tempeh as a base and fermented it with chorizo spices. After mixing it became a pâté-like consistency. Very successful!



sausage

sausage

okara in casing

okara + flavour (salt, yeast extract, spices)

sausage
- naturelle
- tomato-harissa / merguez
- grain
- chorizo

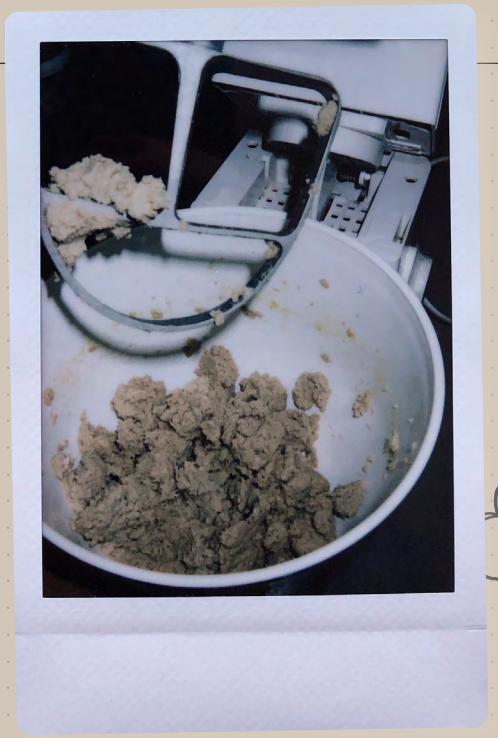
OKARA 'DUXELLE' SPREAD

INGREDIENTS

- 120 GR OYSTER MUSHROOM, CHOPPED
- 50 GR OYSTER MUSHROOM, TORN
- 50 GR SHALLOT, CHOPPED
- UNREFINED OIL (OLIVE, RAPESEED)
- YOUR BOYFRIEND'S BEST WHISKEY
- 1 TSP GROUND BLACK PEPPER
- 2 TSP FRESH THYME
- 1 TSP GROUND LAUREL
- 2 TSP DRIED GROUND SHIITAKE
- 200 GR LACTO FERMENTED OKARA

METHOD

Slowly bake the chopped and torn oyster mushroom and shallot in the oil and deglaze with the whiskey. While cooling down, add the black pepper, thyme, laurel and shiitake powder. Mix in the okara and put the mixture in the fridge.



OKARA FALAFEL

INGREDIENTS

- 200 GR OKARA
- 50 GR GRAM (CHICKPEA) FLOUR
- 1 MEDIUM-SIZED ONION, FINELY CHOPPED
- 2 TBSP PARSLEY, FINELY CHOPPED
- 1 TSP GROUND CORIANDER SEED
- ½ TSP GROUND CUMIN SEED
- PINCH OF CAYENNE PEPPER
- REFINED OIL FOR FRYING

METHOD

Mix all the ingredients together and let it stiffen up in the fridge for at least one hour. Take the mixture out of the fridge and roll it into balls. Coat the falafels in some of the gram flour and fry in hot oil.

September

10%
20%
30%

GRAIN PRODUCTS

BREAD

To experiment with using okara as an ingredient for bread, we've tried different percentages of okara: 10%, 20% and 50%. 10% was, in our taste, the sweet spot. The bread was airy and you couldn't really taste any okara. 20% made a bread that was a bit more dense, but still pretty good. Also, with adding okara we can imagine the bread having a longer shelf life, since you're adding a porridge-like consistency to the dough which will keep it moist for a longer period of time. 50% was definitely too much okara: the end result was way too wet.

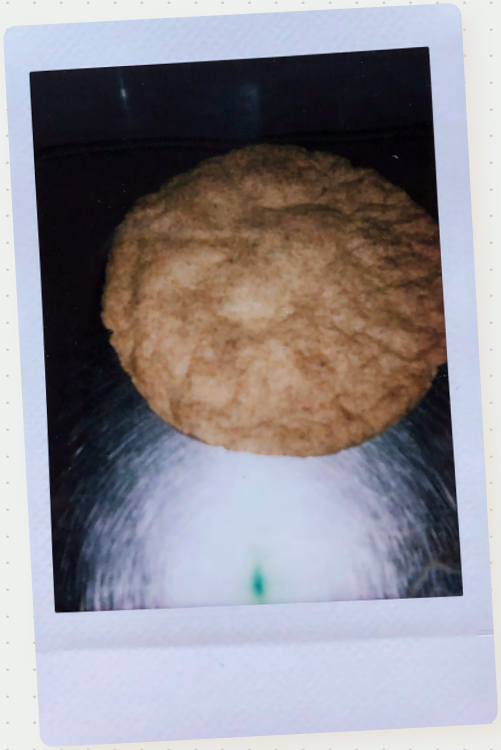
CRACKERS

We continued with the use of okara in crackers. Okara on it's own doesn't contain any gluten, but in a cracker dough we do need some form of gluten so it'll stick together. That's why we added a small amount of flour. The ratio of okara and flour was about 7/3. The rest of the ingredients consisted of flax seeds, sesame seeds, oil and sea salt. The result? Really tasty and crunchy crackers! This is in our opinion a really good use of okara since it is the main ingredient in this recipe, and crackers is a product that has a very good shelf life

RECIPE CRACKERS: PAGE 15

PIZZA DOUGH

Later on we also tried to make pizza dough. In this dough we didn't add any flour since we wanted to see if we could make it gluten free. We did use psyllium fibers since they absorb a lot of moisture. With adding the psyllium it became a nice dough right away. Then we added some yogurt, salt and olive oil to finish it off. After baking, the pizza base dried out really quickly and it turned into a kind of cracker, which wasn't the desired effect. However, this might be an interesting way to make gluten free crackers!



GNOCCHI

Gnocchi normally consists of potato, flour and egg. But what if we swap out the potato for okara? You get a firm gnocchi with a good taste. It's an interesting application, since a substantial part of the recipe consists of okara. After boiling and frying you get a nice and crispy gnocchi. The outside is a bit less brown than 'normal' gnocchi, that's because the okara-gnocchi contains less starch. All in all a very successful and easy recipe.

RECIPE GNOCCHI: PAGE 15

nibb-it like snack

NIBB-ITS

On to a snack: nibb-it-like crisps. Initially we tried making them with 100% okara and 0% flour, but these nibb-its fell apart. Then we tried a dough with 70% okara and 30% flour, sea salt, some seasonings and oil. It was a similar dough as the crackers, but then a different shape and deep-fried instead of baked. The end result: very crunchy and tasty crisps!

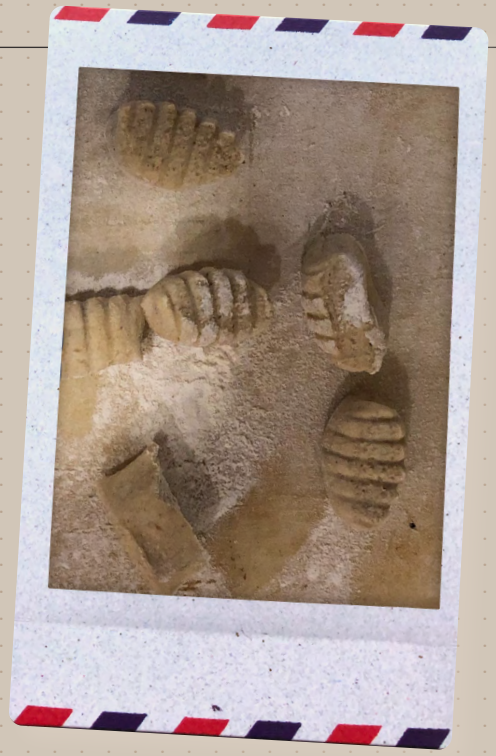
OKARA CRACKERS

INGREDIENTS

- 200 GR OKARA
- 75 GR FLOUR
- 25 GR FLAX SEED
- 20 GR SESAME SEED
- 2 TSP COARSE SEA SALT
- 1 TBSP OIL

METHOD

Mix all ingredients, except the salt, together for 5 minutes. Add some water if necessary and let the dough rest at room temperature. Roll out the dough to 3 mm thickness and transfer to a baking sheet. Brush lightly with oil, sprinkle with salt and some more sesame seeds. Cut into square shapes (3x3 cm, for example) and bake for 25-35 minutes at 160 degrees Celsius.



OKARA GNOCCHI

INGREDIENTS

- 250 GR OKARA
- 5 GR SALT
- 200 GR WHEAT FLOUR
- 1 EGG YOLK

METHOD

Mix the okara and salt together. Sieve the flour and knead, together with the egg yolk and okara. Shape the dough into little 'pillows' using a gnocchi board or a fork. Blanch the gnocchi in boiling (salted) water. When the gnocchi starts floating, take them out and rinse with cold water. The gnocchi is now ready for further use. Please note that they will take longer to brown when frying or baking.


macarons

October

mooncake

macarons

gevulde koek

THE SWEET STUFF

PASTRIES

MOONCAKES

Mooncakes are a typical Chinese pastry that can be sweet or savory. It's an acquired taste, in our opinion. Usually the outside of a mooncake consists mostly of flour. We replaced a big part of the flour with okara and we had to add psyllium fibers to make it into a good dough. For the filling we made a sweetened okara. This gave a very different texture and flavour than the filling of a traditional mooncake (which are typically filled with bean puree). We tried adding some almond flavourings to see if we could match the traditional flavour a bit more, but this didn't help too much. The mooncakes turned out nice, but they were nowhere close to a 'real' mooncake.

MACARONS

To use okara in baked goods, you can also dehydrate it in the oven and then blitz it into okara meal. That's what we did to make okara macarons. We replaced the almond meal in the original recipe one on one with okara meal. Almond meal has a more delicate taste, so the okara macarons tasted way less like almond. On the other hand, the batter had the same properties and consistency as 'normal' macaron batter. Also interesting: this would be a good way to make nut-free macarons.

GEVULDE KOEK

We also tried to make a typical Dutch pastry: 'gevulde koek', which translates to 'filled cookie'. It's a big, soft pastry filled with a sweet almond paste. For the dough we used an okara-flour ratio of 66/33, which led to a beautiful dough with good baking properties. The almond filling consisted of 50% okara and 50% sugar.

GRANOLA

Another surprising use of okara: in a granola! Mix the same volume of okara and oats together with all of your favourite ingredients (like honey, salt, cinnamon, vanilla, seeds, nuts or raisins), put the mixture on a baking tray and bake it on a low temperature. What you're left with is this yummy, crispy granola that's perfect for your sweet breakfast.

GRANITA

We mixed two parts of okara with one part of sugar and the shredded inside of two whole lemons. We put it in the freezer, breaking the mass every half hour until completely frozen with the texture of beach sand. The taste and texture were excellent, making it great to use in desserts. This can be done with any fruit juice or pulp.

RECIPE GRANITA: RIGHT SIDE

BROWNIES

If you like a nice and dense brownie, you should try one with okara. A percentage of flour is needed for the batter to have the right consistency. We used a ratio of 40% okara and 60% flour, but a higher percentage of okara might be possible too. The okara didn't alter the flavour at all, it just tasted like a good brownie. What did change, was the density. The brownie is a little heavier on the stomach, which might be correlated with the digestibility of the proteins in okara. We did use unfermented okara after all.

RECIPE BROWNIES: RIGHT SIDE

OKARA BROWNIES

INGREDIENTS

- 130 GR FLOUR
- 150 GR CASTER SUGAR
- 25 GR CACAO POWDER
- 1,5 TSP BAKING POWDER
- ¼ TSP SALT
- 90 GR OKARA
- 180 ML SOY MILK
- 1 TSP VANILLA EXTRACT

METHOD

Mix the dry ingredients together. Mix in the wet ingredients (including the okara) one by one. Transfer the batter to a baking pan lined with baking paper and bake for 25-30 minutes at 180 degrees Celsius.

OKARA LEMON GRANITA

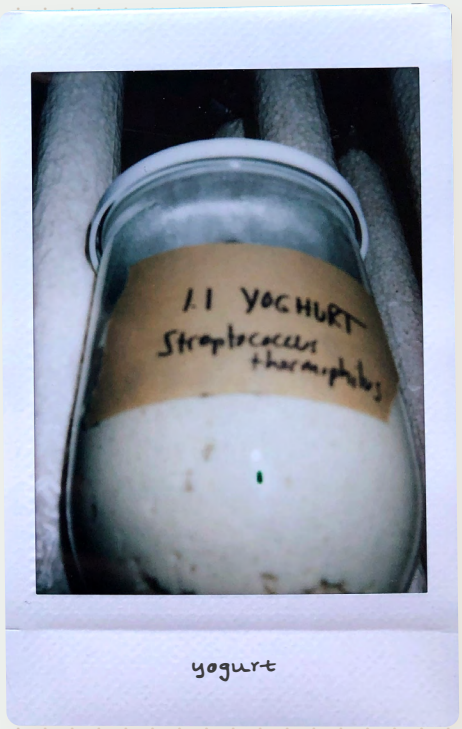
INGREDIENTS

- 2 LEMONS
- 200 GR OKARA
- 100 GR SUGAR (OR LESS, TO TASTE)

METHOD

Zest the skin and shred the inside of the lemons. Mix the okara with the sugar, the zest and shredded lemon. Put the mixture in the freezer and break the mass every half hour using two forks until completely frozen with the texture of beach sand.

November



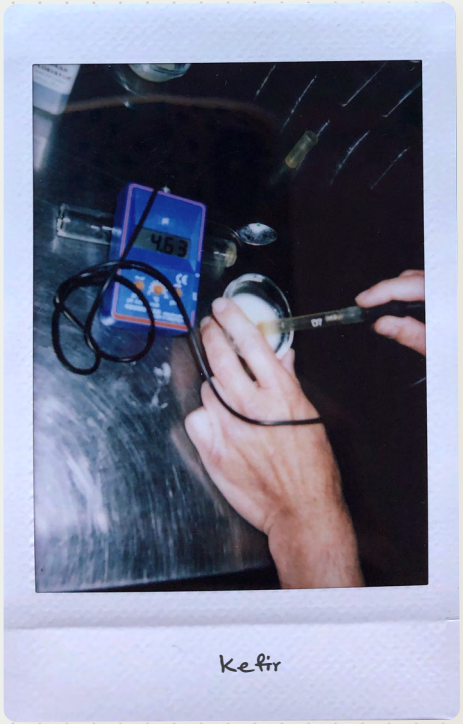
yogurt

soy yogurt starter
vegan lactobacillus acidophilus
beany taste

DAIRY

YOGURT AND KEFIR

Why not try and make yogurt and kefir out of okara? We added several yogurt cultures to the okara and wired up our yogurt machine. The process worked well for both yogurt and kefir. The 'beany' taste of soybean (created by the aldehyde Hexonal) disappeared but the mouth-feel of the products remained grainy.
A half-succes.

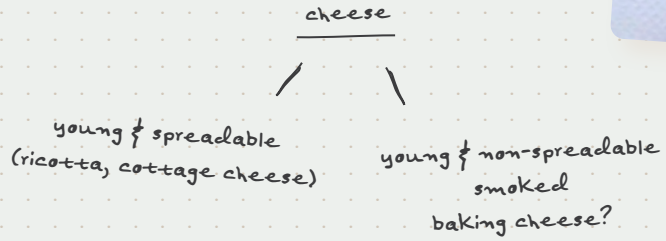


vegan
milk kefir
starter culture

Kefir

CHEESE

Together with fermentation centipede Sanne Zwart (from Keukenboeren and RotPot) we ran some tests with making plant based cheeses from okara. Can you call it a cheese if there is no dairy involved? We would say you can, as long as there is culturing. These cheeses consisted of almost 100% okara and we experimented with different cheese cultures. The tests were very promising! We made a dry cheese, a softer cheese and one with kale powder, making it green and adding some more vegetable protein. The cheeses had a strong mycelium crust, a very good taste and nice mouthfeel. The version with kale powder had a bit of an overpowering kale flavour, but we were very excited about these first experiments.



conclusion

SO, after five months of testing and well over a hundred experiments that couldn't all make it into this publication, can conclusions be drawn?

As mentioned in the introduction, it is pretty safe to say that okara exceeded our expectations. Who would have thought that anything, let alone so many seemingly promising things would come out of this inconspicuous yellowish-beige puree that was sent to us in a plastic bag? To make a confession: we didn't.

There's no way we can declare one experiment the winner. Some experiments were simply too short, one-off or not developed enough to say much conclusive about its potential.

But in the top few of the most interesting ways of using okara, 'baking' in general should not be omitted. Be it in pancakes, crackers, brownies or as an addition in bread: okara appears to have some excellent baking properties that deserve to be further examined. Cheese should be there. Gnocchi. Falafel. Plant based pâté. Amino paste.

We have added some recipes knowing very well that you, dear reader, very likely don't have access to okara as a resource, so that may seem a bit crude.

But who knows, one day it will be the case. Maybe in the future our supermarkets will be supplied with okara(products).

okara lab,
signing out.

“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.

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