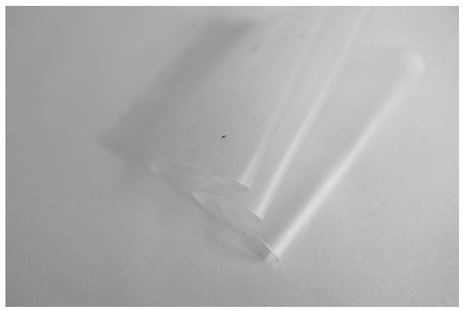
ALGINATE BIOPLASTIC

GUM POLYSACCHARIDE FOUND IN BROWN ALGAE

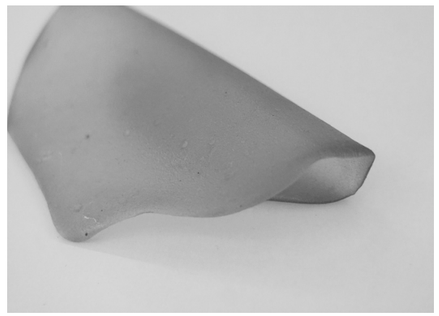


AGAR, CARRAGEENAN, AND ALGINATE ARE ***GUM POLYSACCHARIDES***. AS FOOD-SAFE BIOPOLYMERS THEY ARE USED WIDELY IN THE FOOD INDUSTRY AS THICKENERS AND STABILIZERS BUT THEY ALSO HAVE GOOD FILM-FORMING QUALITIES.

SEE ALSO: Agar bioplastic | Carrageenan bioplastic

CARRAGEENAN BIOPLASTIC

GUM POLYSACCHARIDE FOUND IN RED SEAWEED

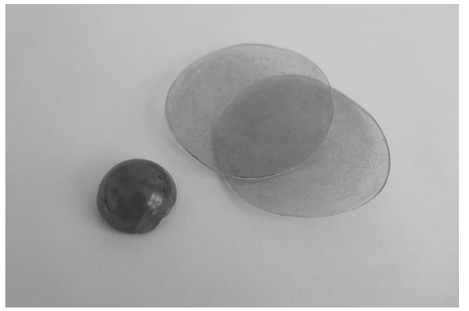


AGAR, CARRAGEENAN, AND ALGINATE ARE ***GUM POLYSACCHARIDES***. AS FOOD-SAFE BIOPOLYMERS THEY ARE USED WIDELY IN THE FOOD INDUSTRY AS THICKENERS AND STABILIZERS BUT THEY ALSO HAVE GOOD FILM-FORMING QUALITIES.

SEE ALSO: Agar bioplastic | Alginate bioplastic

GELATINE BIOPLASTIC

GELATINE IS HYDROLISED ***COLLAGEN***: A PROTEIN FOUND IN CARTILAGE, BONE AND SKIN.

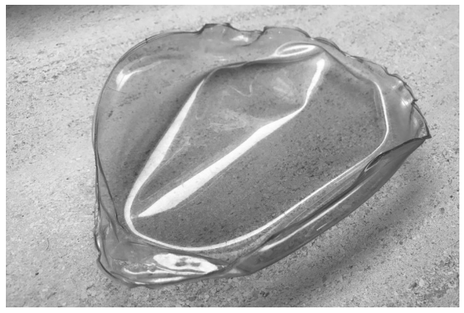


GELATIN OR HYDROLIZED COLLAGEN AND IS FOUND IN CARTILAGE, BONE AND SKIN OF ANIMALS. IT IS USED AS A GELLING AGENT IN FOOD, MEDICINE AND MICROBIOLOGY, AND IS USED IN PHOTOGRAPHY AND PAPER SIZING.

SEE ALSO: Agar bioplastic | Alginate bioplastic

CHITOSAN BIOPLASTIC

DEACETYLATED CHITIN IS FOUND IN FUNGI AND CRUSTACEAN SHELLS



CHITIN IS SUGGESTED TO BE THE SECOND MOST ABUNDANT POLYSACCHARIDE ON EARTH (AFTER CELLULOSE) AND CAN RESIST RELATIVELY HIGH HEAT AND HAS ANTIFUNGAL PROPERTIES.

SEE ALSO: Gelatine bioplastic | Agar bioplastic | Alginate bioplastic

MYCELIUM-HEMP COMPOSITE

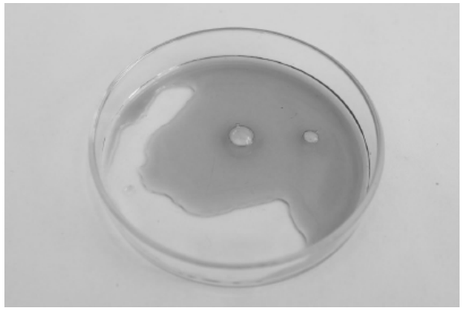
COMPOSITE OF HEMP FIBRES, ***CHITIN*** AND OTHER POLYMERS

MYCELIUM IS THE VEGETATIVE PART OF THE MUSHROOM, AND CONSISTS OF SEVERAL BIOPOLYMERS SUCH AS CHITIN, CELLULOSE AND PROTEINS. IT IS USED HERE AS A LIVING BINDER TO CREATE A COMPOSITE MATERIAL.

SEE ALSO: DIY applied mycology | Moulding and casting | Microorganisms to get to know

ONION SKIN PIGMENT EXTRACTION

PLANT-BASED PIGMENT EXTRACTED FROM ONION SKINS



THE OUTER SKINS OF ONIONS CONTAIN A PIGMENT CALLED PELARGONIDIN THAT CAN BE USED TO CREATE A MEDIUM LIGHT FAST TEXTILE DYE.

SEE ALSO: Scouring and mordanting wool fibres | Scouring and mordanting cellulose fibres.

GELATINE BIOPLASTIC

INGREDIENTS
50 g gelatine, 15 g glycerine, 250 g water

TOOLS
Scale, pot, cooker, spoon, casting surface

TASKS

Weigh the ingredients
- Bring water up to 80 degrees C
- Add glycerine and gelatine, stir gently to avoid bubbles

Allow mixture to thicken
- Keep the temperature around 80C
- Stir gently throughout for 10-20 mins
- Allow water to evaporate until liquid is like a thick syrup

Cast the bioplastic
- Cast the bioplastic slowly in the center of the mold
- When solidified: release from the mold
- Allow to dry fully for a week

REFERENCE
- Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/

CARRAGEENAN BIOPLASTIC

INGREDIENTS
16 g carrageenan kappa, 3 g glycerine, 350 g water

TOOLS
Scale, pot, cooker, spoon, casting surface

TASKS

Weigh the ingredients
- Bring water up to 80 degrees C
- Add glycerine and carrageenan, stir gently to avoid bubbles

Allow mixture to thicken
- Keep the temperature around 80C
- Stir gently throughout for 30 mins
- Allow water to evaporate until liquid is like light syrup

Cast the bioplastic
- Cast the bioplastic slowly in the center of the mold
- Allow to dry for a week without touching

Release the bioplastic
- Check that the plastic no longer feels cold to the touch
- Gently peel it off the surface

REFERENCE
- Lugae Valenti, Making Carrageenan 2021: https://vimeo.com/386012184

ALGINATE BIOPLASTIC

INGREDIENTS
For the bioplastic:
- 10 g Sodium Alginate, 20 g Glycerine, 200 g Water.

For the cross-linker:
- 10 g Calcium Chloride, an additional 100g water.

TOOLS
Scale, blender, spray bottle, glass jar, casting surface

TASKS

Prepare the bioplastic mixture
- Weigh the ingredients
- Put the glycerine and half of the water in a blender
- Turn on the blender, sprinkle in the sodium alginate ***fast!***
- When the paste is homogenous, add the remaining water
- Leave the mixture overnight in a closed jar

Prepare the cross-linker
- Put the calcium chloride in a glass jar
- Add 100 g hot water and stir to dissolve
- Allow to cool and transfer to spray bottle

Cast the bioplastic
- Cast the bioplastic slowly in the center of the mold
- Spray generously with calcium chloride solution
- Allow to dry until no longer cold to the touch

Releasing the bioplastic
- Gently peel off the casting surface

REFERENCE
- Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/

ONION SKIN PIGMENT EXTRACTION

INGREDIENTS
10-20 g Onion skins (red and yellow onions separated), 20g mordanted natural fibres, water, PH modifiers (soda solution, vinegar), iron modifier, cloves or clove oil.

TOOLS
Cooker, pot, spoon, scale, strainer, glass jar

TASKS

Separate yellow and red onion skins
- Yellow onion skins create a yellow/gold/orange hue
- Red onion skins create a greens and greenish yellow
- Pre-wet the mordanted fibres by putting them in water

Cover the onion skins with water and bring to the boil
- Extract the pigment by letting it simmer for 30-60 minutes
- Allow to cool to 30 degrees Celcius

Dyeing
- Add the pre-wetted mordanted fibres
- Slowly reheat, keep temperature below 80 degrees Celcius
- Dye for 1 hour, turn off the heat and leave overnight

Rinsing and modifying
- Rinse the fibres until the water runs clear, squeeze out excess
- Cut the fibre into 4 parts. Dip one in a jar of vinegar, dip one in a soda solution (PH9-10), and dip the last one in an iron sulphate solution to shift the colors.

Re-use or store the dye
- add new fibres to the exhaust bath, evaporate more water and add a binder such as Arabic gum to create an ink, or create a lake pigment
  (e.g. https://rebeccadesnos.com/blogs/journal/making-lake-pigments)

REFERENCE
- Biochromes week (2019) Fabricademy: https://class.textile-academy.org/classes/2019-20/week04/
- Joy Boutrup & Catherine Ellis (2019) The Art & Science of Natural Dyes: Principles, Experiments.
- Jason Logan (2018) Make Ink: A Forager's Guide to Natural Inkmaking.

MYCELIUM-HEMP COMPOSITE

INGREDIENTS
GIY kit from grown.bio, plain flour (30g per kg grow kit)

TOOLS
Scale, 70% alcohol, scissors, large bowl, scalpel, cling film, latex or nitrile gloves, moulds

TASKS

Clean all tools and surfaces with 70% alcohol

Prepare the composite mix
- Wear gloves and open the bag with clean scissors
- Add the GIY mix to the bowl and mix in the flour
- Crumble up all the lumps with your hands until even

Prepare the mold
- Desinfect the mold with alcohol
- Distribute the mycelium-hemp mix
- Cover the mold with cling film
- Punch small holes every 3 cm with a clean scalpel

Let it grow
- Put the mix in a dark place at 20-25 degrees C
- Allow the mycelium to colonize the substrate for 3-5 days
- When it is completely white, carefully take it out

Dry the composite
- Dry the composite for 2-3 hours at 40 degrees C
- Keep the door of the oven open to allow moisture to escape
- Bake for another 2 hours at 80 degrees until light and firm

REFERENCE
- Grow-It-Yourself kit via Grown.bio https://www.grown.bio

NEXT
Learn to make mycelium composites from scratch with the following resource: Kick-start your Mycoculture (2019) by Fabtextiles https://issuu.com/nat_arc/docs/myceliumfabtextiles

CHITOSAN BIOPLASTIC

INGREDIENTS
8 g chitosan, 200 ml water, vinegar or citric acid solution
* If adding glycerine, add no more than 1% of total weight.

TOOLS
pH strips, blender, acrylic or glass sheet for casting

TASKS

Weigh the ingredients
- Add vinegar or citric acid solution to the water until it reaches pH4-5
- Put water/vinegar mix in the blender, turn it on
- From the top lid, add the chitosan quickly in one movement while it blends

Allow mixture to thicken
- The mixture will thicken as the chitosan dissolves in the acid water
- Leave overnight to allow bubbles to disappear

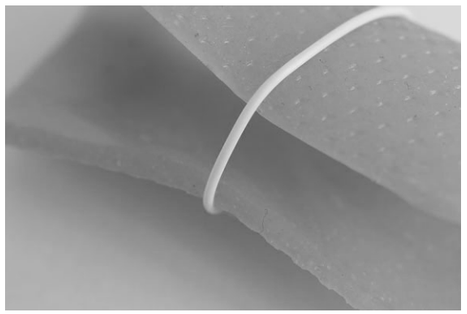
Cast the bioplastic
- Cast on walled acrylic sheet: 3-5 mm thickness (will shrink a lot)
- Allow the water and vinegar to evaporate completely over the course of a few days (optional: place in oven at 60 degrees C).
- When dry: peel the sheet off the casting surface.

Shellworks has developed interesting techniques to create other forms (see video in reference).

REFERENCE
- Shellworks (2019) https://youtu.be/QBQyMjL3yWk

STARCH BIOPLASTIC

POLYSACCHARIDE (OR POLYMERIC CARBOHYDRATE) PRODUCED BY PLANTS FOR ENERGY STORAGE



In industry, (modified) starches are used to manufacture bioplastics, alcohol and biofuel, as thickener for e.g. sauces. Non-food applications include stiffening textiles, adhesives and paper-making. Because native starch has poor processing and mechanical properties, gelatin is added here.

SEE ALSO: Better together: combining polymers | Gelatine bioplastic | Morphology of ingredients.

BIO-BASED MATERIALS

MILK COMPOSITE

MAMMAL MILK CONTAINS A PROTEIN CALLED ***CASEIN***

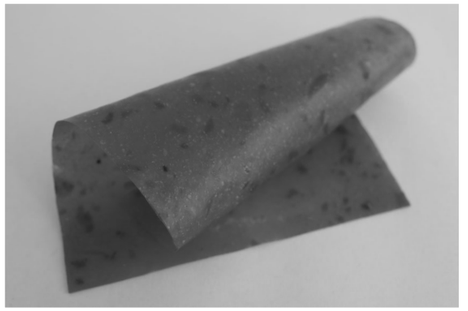
Casein was first patented in 1899 and was used to copy horn. It was commonly used for small items such as buttons, cutlery handles and knitting needles.

SEE ALSO: Better together: combining polymers | Gelatine bioplastic | Waste walk | Morphology of ingredients.

BIO-BASED MATERIALS

FRUIT LEATHER

MOST FRUITS CONTAIN THE BIOPOLYMER ***PECTIN***, A POLYSACCHARIDE



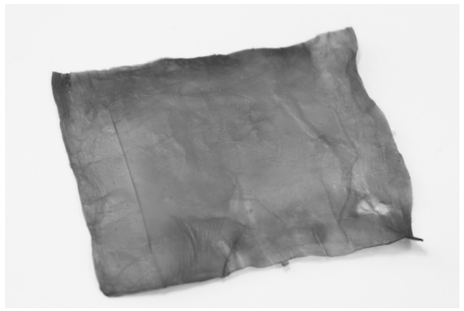
Fruit leather was originally conceived of as a way to preserve fruit to be eaten as a snack. To make fruit leather, overripe fruit is best, used with skin and all. Unsold market fruits are a big waste stream in the Netherlands.

SEE ALSO: Waste walk | Morphology of ingredients | Starch bioplastic | Better together: combining polymers

BIO-BASED MATERIALS

MICROBIAL LEATHER

ACETOBACTER XYLINUM, A BACTERIA IN KOMBUCHA PRODUCES ***NANOCELLULOSE***



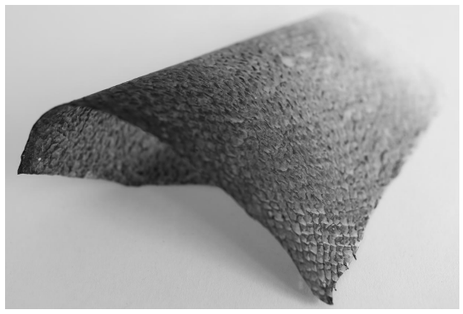
Kombucha is a fermented tea drink that can be made with living culture called a SCOBY: symbiotic culture of bacteria and yeast. By building up this culture, you can create a small cellulose factory.

SEE ALSO: DIY pH paper | Better together: combining polymers | Morphology of ingredients | Microorganisms to get to know

BIO-BASED MATERIALS

FISH LEATHER

FISH SKIN IS RICH IN THE PROTEIN ***COLLAGEN***, A BIOPOLYMER



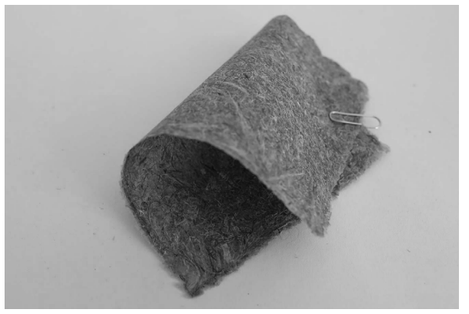
This treatment with alcohol ***DENATURES*** or damages the living cells of the fish skin, to prevent decomposition. Glycerine re-hydrates and plasticizes the skin, making it pliable and stable.

SEE ALSO: Shit, hair, d(isg)ust | Waste walk | Fruit leather

BIO-BASED MATERIALS

FLOWER PAPER

MOST PLANTS CONTAIN ***CELLULOSE***, A BIOPOLYMER



With this simple technique you can make your own paper. Stems can also be used, but need longer cooking time and result in rougher and thicker paper.

SEE ALSO: Morphology of ingredients | Fruit leather Better together: combining polymers

BIO-BASED MATERIALS

FRUIT LEATHER

INGREDIENTS
1 overripe mango with skin, 10 g potato starch, 8 g vinegar

TOOLS
Blender, walled mould, cooker, pan, spoon, scale, oven

TASKS

Prepare the mixture
- Cut the mango in smaller pieces and puree with blender
- Put the puree in a pot with some water
- Keep at low heat for 30 minutes while stirring to kill bacteria

Cook the mixture
- Dissolve the starch in a dash of cold water
- Add to the hot mango mixture and stir
- Cast the paste into the mould

Drying
- Heat the oven to 40-50 degrees C
- Dry the sheet for 16 hours in the oven
- Peel off the sheet and flip to dry the other side
- Allow to airdry for another 5-7 days

REFERENCE
- Beatriz Sandini (2018) Ephemeral Fashion Lab: https://class.textile-academy.org/2020/beatriz.sandini/projects/final-project/
- Fruit Leather, Rotterdam: https://fruitleather.nl/

MILK COMPOSITE

INGREDIENTS
65 g calcium carbonate or finely ground egg shells, 25 g calcium hydroxide, 8 g glycerine, 800 g low fat milk, 30 g white vinegar

TOOLS
Face mask, scale, bowls, grater, oven, cooker, pots, blender

TASKS

Preparing the casein
- Heat up the milk and add the vinegar, stir
- After 1 minute: strain the casein curd from the liquid
- Put in the blender and blend with glycerine
- Press into mould and dehydrate fully

Making the composite
- Wear a mask to protect airways from small particles
- Grate the dried casein plastic into a fine powder
- Dissolve the calcium hydroxide in hot water
- Dissolve the calcium carbonate in the vinegar
- Mix both with the calcium carbonate

Casting and drying
- Cast into a mould and press for 1 hour
- Dehydrate at 50 degrees C in the oven for at least 4 hrs
- Allow to air dry until fully dehydrated.

REFERENCE
- William Christmas (1924) Casein Plastic Composite patent https://bit.ly/3C7rdYF
- Tessa Silva (2016) Chalk & Cheese, and Protein project: https://www.tessasilva.com/chalk-cheese

STARCH BIOPLASTIC

INGREDIENTS
50 g potato starch, 50 g gelatin powder, 100 g glycerine, 100 g water, 15 g vinegar

TOOLS
Cooker, pot, scale, spoon, casting surface

TASKS

Prepare the gelatine mix
- Weigh the ingredients
- Bring water to the boil, add the glycerine and gelatine
- Keep temperature below 80 degrees C
- Stir slowly until gelatine is fully dissolved

Prepare the starch mix
- Put starch in a bowl and dissolve with 2 tbsp hot water
- Add the mixture to the gelatine mix and stir slowly

Casting and drying
- When it thickens but is still liquid, cast on surface
- Quickly spread out with spatula if needed
- Allow to dry at room temperature near an open window

REFERENCE
- Starch-based rubber by Loes Bogers (2020) https://class.textile-academy.org/2020/loes.bogers/files/recipes/biorubber/
- The Bioplastics Cookbook: A Catalogue of Bioplastics Recipes by Margaret Dunne for Fabtextiles (2018) https://issuu.com/hat_arc/docs/bioplastic_cook_book_3

FLOWER PAPER

INGREDIENTS
Bouquet of withered flowers, sodium carbonate (soda ash), water

TOOLS
Mortar and pestle, cooker, pot, mould & deckle or a picture frame lined with a fine mesh, strainer

TASKS

Prepare the paper slurry
- Pick the flower petals from the bouquet
- Cover them with water, add a tsp of soda ash
- Bring to the boil and cook for 30 mins or until soft
- Strain the flower leaves and pound them in the mortar
- Optional: blend them with a blender, but this cuts the fibres and results in a more brittle paper.

Distribute the slurry
- Scoop the slurry onto the mesh or mould & deckle
- Spread out evenly, about 2 mm thick
- Carefully submerge in water to help distribute the slurry

Allow to dry
- Leave to dry for about 2 days
- Carefully peel the paper off the mesh

REFERENCE
- May Babcock for Paper Slurry (2014) Hand-papermaking With Plants: https://www.paperslurry.com/2014/08/20/hand-papermaking-with-plants-illustrated-infographic/
- https://class.textile-academy.org/2020/loes.bogers/files/recipes/flowerpaper

FISH LEATHER

INGREDIENTS
Fresh uncooked fish skins, 250 ml denatured 96% alcohol, 250 ml glycerine

TOOLS
Blunt scraping tool, 1000 ml glass jar, dishwashing soap, wooden board, nails, hammer

TASKS

Clean the skins
- Scrape off fat, meat and membrane with a blunt scraping tool
- Wash the skins with cold soapy water and rinse

Prepare the tanning liquid
- Put the glycerine and alcohol in the jar
- Submerge the skins in it and shake vigourously for 1 min
- Put a little weight (like a marble) on the skin to keep it down

Tanning process
- Keep the skins in the jar for 3 days, shake daily for 1 min
- Take out the skins, massage and stretch them for 1 hr
- Nail them to the wooden board and leave outside to dry

REFERENCE
- Fish Skin Tanning from the 6-8th grade Heritage Kit Curriculum by Chugachmiut Heritage Preservation, Anchorage USA:https://chugachheritageak.org/pdf/CLO_6-12%20_FISH_SKIN_TANNING_Final.pdf
- Cecilia Raspanti (2019) Fish skin leather: https://class.textile-academy.org/classes/2019-20/week05A/
- Nienke Hoogvliet (n.d.) Re-Sea Me https://www.nienkehoogvliet.nl/portfolio/re-seame/

MICROBIAL LEATHER

INGREDIENTS
1x Yaya Kombucha starter pack (contains SCOBY), 4 g green or black tea, 40 g sugar, vinegar, 400 ml water, citric acid

TOOLS
Clean glass 1000 ml jar, dishwashing soap, pH strips, large round coffee filter or old t-shirt, rubber band

TASKS

Prepare the sugary tea
- Clean and disinfect your work area and wash all tools with very hot water and soap. Rinse well and airdry (no towels!)
- Brew 400 ml of tea, add the sugar and stir to dissolve
- Allow to cool to 30 degrees Celcius
- Strain the tea and catch the liquid in the clean glass jar

Add the living culture
- Add contents of the starter pack, add white vinegar until pH of the liquid reaches pH 5-6
- Cover the jar with a coffee filter or piece of clean t-shirt, and wrap a rubber band around it to keep bugs out.
- Put in a warm spot away from sunlight

Incubate
- Check for every few days for contamination, without moving the pot or the filter.
- If the culture is contaminated (see link below), discard! You should see a white or translucent pellicle growing on the top of the surface after a few weeks.
- Wait until the pellicle is 10 mm thick

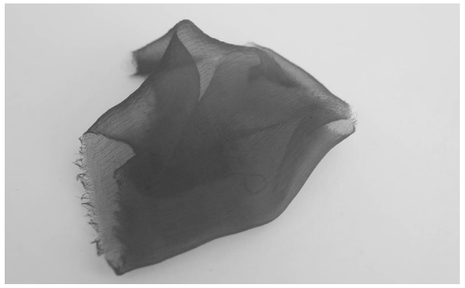
Harvesting
- Wash your hands and tools well, take out the pellicle
- Prepare a citric acid solution with pH2-3 and soak the pellicle in it overnight, this will make it more supple.
- Allow it to until fully dehydrated (e.g. oven at 50 degrees C)

Continuous culturing
- Repeat the process by adding more cold sugary tea to the liquid SCOBY in the jar and wait another few weeks. Your culture will get stronger and grow faster over time.

REFERENCE
- Suzanne Lee (2011) Grow Your Own Clothes TedTalk: https://www.ted.com/talks/suzanne_lee_grow_your_own_clothes
- Kombucha Mold! How to Identify Mold vs. No Mold and What to Do Next (n.d.) Kombucha Kamp: https://www.kombuchakamp.com/kombucha-mold-information-and-pictures

MADDER PIGMENT EXTRACTION

LIKE INDIGO (BLUE) AND WELD (YELLOW), MADDER IS A ***GRAND TEINT***: A CLASSIC DYEPLANT THAT IS COLOUR- AND LIGHTFAST.

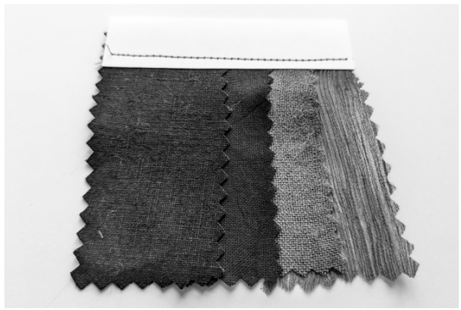


MADDER CAME FROM THE ROOTS OF ***RUBIA TINCTORUM*** PLANTS FOUND IN SOUTHERN EUROPE AND WEST-ASIA. MADDER WAS BROUGHT TO THE SOUTH OF THE NETHERLANDS AND FLANDERS AROUND 1300 WHERE THE CLAY SOIL WAS OPTIMAL FOR MADDER CULTIVATION. COMPARED TO RED PIGMENTS COMING FROM THE SYNTHETIC GARANCINE, MADDER IS LESS ECOLOGICALLY TAXING.

SEE ALSO: Scouring and mordanting wool fibres | Scouring and mordanting cellulose fibres | DIY pH paper | Onion skin pigment extraction

OAK GALL TANNIN EXTRACTION

OAK GALL EXTRACTION TO MAKE TANNIN MORDANT OR IRON GALL INK.

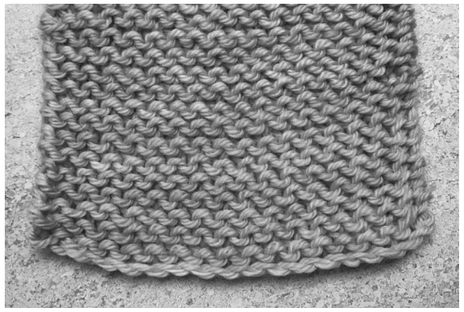


OAK GALLS FORM WHEN GALL WASPS INJECT THEIR LARVAE INTO DEVELOPING BUDS OF THE OAK TREE. AN OAK GALL FORMS AS THE LARVAE UNDERGO METAMORPHOSIS INTO ADULTS.

SEE ALSO: DIY iron acetate

FUNGAL DYE

SULPHUR TUFT MUSHROOM OR ***HYPHOLOMA FASCICULARE*** CAN BE USED AS WOOL DYE.

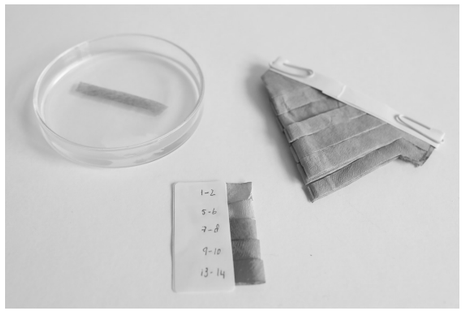


THIS MUSHROOM (NL: ZWAVELKOP) IS HIGHLY ABUNDANT IN THE NETHERLANDS AND CAN BE FOUND IN GROUPS AT THE FOOT OF DECIDUOUS AND CONIFER TREES IN PARKS AND FORESTS.
NOTE: TOXIC!

SEE ALSO: DIY Iron Acetate

DIY PH PAPER

EXTRACT OF RED CABBAGE CHANGES COLOUR WHEN EXPOSED TO SOLUTION OF VARYING PH



THE PURPLE COLOR IN RED CABBAGE COMES FROM A CLASS OF PIGMENT MOLECULES CALLED ANTHOCYANINS. THE LEVEL OF ACID OR ALKALI (I.E., LOWER OR HIGHER THAN PH 7) AROUND THE MOLECULE CHANGES THE COLOR OF THE ANTHOCYANIN.

SEE ALSO: Microbial leather | Madder pigment extraction | Chitosan bioplastic

DIY IRON ACETATE

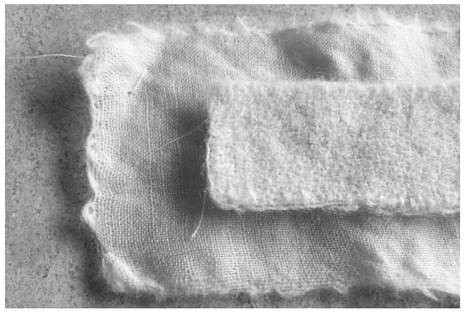
DIY IRON ACETATE (ALSO ***IRON VINEGAR*** OR ***IRON LIQUOR***) IS MADE BY LETTING VINEGAR CORRODE IRON SCRAPS.

IT IS HIGH IN IRON IONS, WHICH REACT WITH TANNINS FOUND IN SEVERAL NATURAL DYES AND FOODSTUFFS. DIY IRON ACETATE SHIFTS COLORS OF TANNIN RICH DYES TO GREENS AND GRAYS AND INCREASES COLOR FASTNESS OF DYES WHEN USED AS A MORDANT.

SEE ALSO: Oak gall tannin extraction | Fungal dye

SCOURING AND MORDANTING WOOL FIBRES

SCOURING AND MORDANTING WOOL (PROTEIN FIBRE) TO PREPARE IT FOR TEXTILE DYEING WITH NATURAL DYES.



SCOURING IS A METHOD OF CLEANING THE FIBRES. MORDANTS ARE TYPICALLY MINERAL SALTS THAT ARE APPLIED TO NATURAL FIBRES BEFORE DYEING, TO IMPROVE DYE UPTAKE AND LIGHT AND WASH FASTNESS.

SEE ALSO: Scouring and mordanting silk fibres | Scouring and mordanting cellulose

FUNGAL DYE

INGREDIENTS
250 g fresh sulphur tuft mushrooms, 25 g mordanted wool, DIY iron acetate

TOOLS
Large pot (non-food only), cooker, wash bag, spoon

TASKS

Find a mycologist to help you identify the right mushrooms

Preparing the dye bath
- Clean the mushrooms and break them into smaller pieces
- Put the pieces in a wash bag
- Put the wash bag in the pot and cover with water
- Bring to 80 degrees C and extract the pigment for 1 hour
- Allow to cool, then add the wet mordanted wool
- Dye the wool at 80 degrees C for 30-60 minutes

Rinsing and modifying
- Take half the wool out, rinse with warm water
- Add a splash of DIY iron acetate to the dye bath and modify the color of the remaining wool.
- Take out the wool, rinse with warm water

Note: this dye glows under a blacklight!

REFERENCE
- Miriam Rice (1974) Mushrooms for Color
- That Which Sustains Us: Lessons from the Forest Natural Dyeing with Mushrooms (2020) Museum of Vancouver: https://youtu.be/o-IXeTI7AwY

OAK GALL TANNIN EXTRACTION

INGREDIENTS
100 g oak galls, water, DIY iron acetate

TOOLS
Plastic bag, hammer, cooker, pot,

TASKS

Extracting the tannins
- Put the galls in a plastic bag and smash with a hammer
- Cover with water and bring to the boil
- Simmer for at least an hour to extract the tannins, strain

Modifying the color
- When tannins are exposed to iron ions (such as DIY iron acetate) the pale yellow/beige color will turn dark gray/ purple.

Uses
- Use the extraction to dye textiles, or use a diluted extraction as tannin mordant to prepare textiles for dyeing. Or evaporate more water to turn it into a water-based ink.

REFERENCE
- Joy Boutrup & Catherine Ellis (2019) The Art & Science of Natural Dyes: Principles, Experiments.
- Catherine Ellis (2018) Are All Oak Galls Equal? https://blog.ellistextiles.com/2018/08/06/are-all-oak-galls-equal/

MADDER PIGMENT EXTRACTION

INGREDIENTS
50 g dried madder roots, water

TOOLS
Pot, thermometer, cooker, spoon, old pantyhose, blender

TASKS

Soak the roots
- Soak the dried madder roots in water overnight
- Blend them with a blender

Extract the pigment
- Put the roots in the pantyhose and make a knot to close
- Put the madder in a pot and cover with water
- Optional: adding a tbsp of soda ash and/or calcium carbonate brings out the red tones
- Bring up to 60 degrees C, and keep there for 2 hours
- Overheating causes pigment to shift to brown
- Allow to cool, keep the madder roots for a 2nd extraction

Use or store the pigment
- Use the pigment solution as a textile dye, or evaporate water on low heat to create a water-based ink, or create a lake pigment for DIY crayons and paints.

REFERENCE
- Joy Boutrup & Catherine Ellis (2019) The Art & Science of Natural Dyes: Principles, Experiments.

SCOURING AND MORDANTING WOOL FIBRES

INGREDIENTS
100 g wool (dry weight), 1 g mild detergent, 15 g alum, 5 g cream of tartar, water

TOOLS
Large pot, cooker, glass jar, scale, spoon, bucket, thermometer

TASKS

Scouring
- Soak the fibres in water overnight
- Dissolve the detergent in hot water
- Put the wool in a large pot, add the solution
- Cover with water until the wool can float freely
- Bring up to 80 degrees C and keep there for 30 mins
- Allow to cool a little and rinse with warm water

Mordanting
- Measure the alum and cream of tartar, and put in the jar
- Add some boiling water and stir to dissolve
- Put the fibres in a large pot, add the solution
- Cover the fibres with additional water so they float freely
- Bring the fibres to 80 degrees C, slowly
- Turn off the heat and leave overnight
- Squeeze out excess water, rinse lightly
- Replenish the mordant bath by adding 50% to re-use

REFERENCE
- How to Scour (n.d.) Botanical Colors: https://botanicalcolors.com/how-to-scour/
- Joy Boutrup Catherine Ellis (2018) The Art & Science of Natural Dyes: p. 120-121.

DIY IRON ACETATE

INGREDIENTS
White vinegar, rusty iron nails or a fine steel wool sponge

TOOLS
Large glass jar, household gloves

TASKS

Make the iron acetate
- Put the rusty iron nails or the steel wool in the jar
- Cover with vinegar
- Leave for 1-3 weeks

Use the iron acetate
- Wear household gloves before using
- Can be used as mordant, dye modifier or wood stain.
- Use only small – diluted - amounts, the iron is corrosive to fibres and irritant to eyes and skin.

REFERENCE
- Make Wood Stain (n.d.) https://www.apieceofrainbow.com/make-wood-stain/

DIY PH PAPER

INGREDIENTS
Half a red cabbage, water, citric acid, soda ash

TOOLS
Food grater, pot, cooker, a clean spray bottle, filter paper or white coffee filters, 4 bowls

TASKS

Prepare the ink
- Grate the red cabbage
- Put in the pot and cover with water
- Bring to the boil and simmer for 30 mins
- Strain the liquid and put in a spray bottle
- Spray the purple liquid to cover the entire filter paper
- Allow to dry

Make a legend
- Boil some water and put in the bowls
- Add a pinch of citric acid to one bowl, stir to dissolve
- Add a pinch of soda ash to another bowl, stir to dissolve
- Dip a piece of paper in each and tweak until you get the following colors: fuchsia pink (pH3-4), pink/purple (pH5-6), blue/purple (pH7-8), blue/green (pH9-10), green (pH 13-14)
- Write up a legend and glue the papers to it

REFERENCE
- Anne Marie Helmenstine (2020) Make Red Cabbage pH paper: https://www.thoughtco.com/make-red-cabbage-ph-paper-605993
- https://class.textile-academy.org/2020/loes.bogers/files/recipes/phmodifiers

BETTER TOGETHER: COMBINING POLYMERS

COMBINING BIOPOLYMERS TO DISCOVER OTHER MATERIAL PROPERTIES

MANY BIOPLASTICS AND BIOMATERIALS RECIPES WILL PROVIDE THE PROTOCOL TO MAKE A MATERIAL WITH A SINGLE BIOPOLYMER (AND A PLASTICISER). COMBINING THEM LEADS TO WILDLY DIFFERENT RESULTS IN TERMS OF PROCESSABILITY AND PROPERTIES.

SEE ALSO: Material-objects | Morphology of ingredients | What is a material property?

MORPHOLOGY OF INGREDIENTS

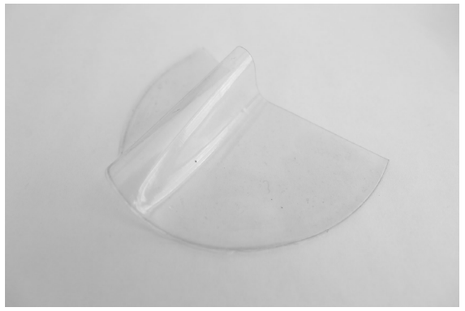
UNDERSTANDING THE FUNCTIONS AND ALTERNATIVES FOR DIFFERENT COMPONENTS

STUDYING THE STRUCTURE OF BIOMATERIALS, AND UNDERSTANDING THE FUNCTIONS OF INGREDIENTS IN RECIPES WILL HELP YOU FIND NEW ALTERNATIVES TO EXPERIMENT WITH. WHAT ARE POSSIBLE ALTERNATIVES FOR EACH INGREDIENT?

SEE ALSO: Better together | Material-objects | What is a material property

AGAR BIOPLASTIC

GUM POLYSACCHARIDE FOUND IN RED ALGAE



AGAR, CARRAGEENAN, AND ALGINATE ARE ***GUM POLYSACCHARIDES***. AS FOOD-SAFE BIOPOLYMERS THEY ARE USED WIDELY IN THE FOOD INDUSTRY AS THICKENERS AND STABILIZERS BUT THEY ALSO HAVE GOOD FILM-FORMING QUALITIES.

SEE ALSO: Alginate bioplastic | Carrageenan bioplastic

SCOURING AND MORDANTING SILK FIBRES

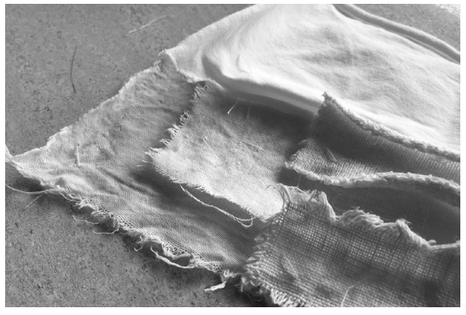
SCOURING AND MORDANTING SILK (PROTEIN FIBRE) TO PREPARE IT FOR TEXTILE DYEING WITH NATURAL DYES.

SCOURING IS A METHOD OF CLEANING THE FIBRES. MORDANTS ARE TYPICALLY MINERAL SALTS THAT ARE APPLIED TO NATURAL FIBRES BEFORE DYEING, TO IMPROVE DYE UPTAKE AND LIGHT AND WASH FASTNESS.

SEE ALSO: Scouring and mordanting wool fibres | Scouring and mordanting cellulose

SCOURING AND MORDANTING CELLULOSE FIBRES

SCOURING, MORDANTING AND DYEING CELLULOSE FIBRES (LINEN, COTTON, HEMP, RAMIE)



SCOURING IS A METHOD OF CLEANING THE FIBRES. CELLULOSE MORDANTS TYPICALLY START WITH APPLICATION OF TANNINS FOLLOWED BY MORDANTING WITH MINERAL SALTS BEFORE DYEING, TO IMPROVE DYE UPTAKE AND LIGHT AND WASH FASTNESS.

SEE ALSO: Scouring and mordanting wool fibres | Scouring and mordanting silk fibres

AGAR BIOPLASTIC

INGREDIENTS
5 g Agar, 15 g Glycerine,
250 g Water

TOOLS
Scale, pot, stove, spoon, walled mould

TASKS

Weigh the ingredients
- Bring water up to 80 degrees C
- Add glycerine and agar, stir gently to avoid bubbles

Allow mixture to thicken
- Keep the temperature around 80C
- Stir gently throughout for 30 mins
- Allow water to evaporate until liquid is like light syrup

Cast the bioplastic
- Cast the bioplastic slowly in the center of the mold (3-5 mm thick)
- Allow to dry for a week without touching

Release the bioplastic
- Check that the plastic no longer feels cold to the touch
- Gently peel it off the surface

REFERENCE
- Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/

MORPHOLOGY OF INGREDIENTS

WHY
Many biomaterials recipes include purified store-bought virgin materials and foodstuffs. In order not to compete with food, it's worth finding alternatives that can be sourced from waste streams, or alternatives that are more abundant in your environment. In many cases very pure food-grade ingredients can be avoided.

WHEN
You've experimented with bioplastics and want to dig a little deeper so you can start developing new materials that are embedded and tuned to a specific local context.

TASKS

Make a hypothesis
- Select a biomaterial recipe
- Research what kind of compound each ingredient is
- Use the morphological chart in this toolkit as reference
- Make a hypothesis of the function(s) of each ingredient

Morphology
- Determine what could be alternatives for each ingredient
- Locate alternatives that can be found in waste streams
- Locate alternatives that are more locally abundant

Experiments
- Recreate the biomaterial recipe by replacing one ingredient
- Analyse the results, reassess your hypotheses
- Do this with at least 3 times, changing one variable at a time

REFERENCE
- Morphological Chart (2021) Loes Bogers, Cecilia Raspanti & Sam Edens (included in this toolkit)

BETTER TOGETHER: COMBINING POLYMERS

TASKS

Choose a biopolymer or biomaterial that interests you. Then make a simple recipe with it using various proportions and study it's properties and challenges.

Scientific leads
- Look into scientific publications where researchers have tried to improve or modify properties of that biomaterial (e.g. chitosan and gelatine or alginate).
- Look up any terms you don't understand, try to get an understanding of the science.
- Which ingredients do they add or remove? Why?
- Do they make changes in the protocol? Why?
- Translate these insights into recipes and try them out in various ratios.

Material designers' leads
- Material designers take a very different approach, and may try out various different things they find in their direct surroundings.
- Look into ways other material designers have worked with your biopolymer of choice.
- What kind of additions do they make? Research those additions and try to understand why they lead to such different materials. Hypothesise about the functions of each of these additions?

REFERENCE
- Chemarts Cookbook (2020) Aalto University. Pdf download available for free at: https://shop.aalto.fi/p/1193-the-chemarts-cookbook/
- Materiom (2018-ongoing) https://materiom.org/
- Material Archive at AUAS (2019-ongoing) https://samplemanagementtool.org/
- Bioplastics Cookbook (2018) Fabtextiles at IAAC: https://issuu.com/nat_arc/docs/bioplastic_cook_book_3
- Recipes for Material Activism (2014) Miriam Ribul: https://issuu.com/miriamribul/docs/miriam_ribul_recipes_for_material_a

SCOURING AND MORDANTING SILK FIBRES

INGREDIENTS
100 g silk (dry weight), 1 g sodium carbonate (soda ash), 1 g neutral detergent, 15 g alum, water, vinegar

TOOLS
Large pot, cooker, glass jar, scale, spoon, bucket, thermometer

TASKS

Scouring
- Soak the silk in water overnight
- Dissolve the detergent in hot water
- Put the wool in a large pot, add the solution
- Cover with water until the silk can float freely
- Bring up to 80 degrees C and keep there for 30 mins
- Allow to cool a little and rinse with warm water
- Add vinegar to the rinse water and leave for 20 mins
- Rinse again, squeeze out excess water

Mordanting
- Measure the alum, and put in the jar
- Add some boiling water and stir to dissolve
- Put the fibres in a large pot, add the solution
- Cover the fibres with additional water so they float freely
- Bring the fibres to 80 degrees C, slowly
- Turn off the heat and leave overnight
- Squeeze out excess water, rinse in hot water
- Replenish the mordant bath by adding 50% to re-use

REFERENCE
- How to Scour (n.d.) Botanical Colors: https://botanicalcolors.com/how-to-scour/
- Joy Boutrup Catherine Ellis (2018) The Art & Science of Natural Dyes: p. 124.

SCOURING AND MORDANTING CELLULOSE FIBRES

INGREDIENTS
100 g cellulose fibres, 1 g soda ash and 1 g detergent for scouring, 10 g oak gall extract *OR*: 30 g ground oak galls, 12 g alum and 1.5 g soda ash for mordanting.

TOOLS
Large pot, cooker, glass jar, scale, spoon, bucket, pH paper, rubber gloves

TASKS

Scouring
- Fill a large pot with warm water
- Add and dissolve 1 g detergent and 1 g soda ash
- Measure pH, add soda until it reaches pH8-9
- Add fibres and cover with water, fibres should move freely
- Heat to 100 degrees C (boil), keep there for 1-2 hours
- Move the textiles regularly
- Allow to cool in the mordant bath, then rinse well

Application of tannins
- Fill a large (30L) pot with hot water (50 degrees C)
- Add the tannin powder and stir until dissolved.
- Add the fibres and soak for 2 hrs. Do not heat the bath.
- Remove fibre, squeeze out wearing gloves
- While still damp: proceed to alum mordant

Alum mordanting
- Dissolve the alum in boiling water, allow to cool
- Dissolve the soda in boiling water, allow to cool
- Combine the alum and soda solution, while stirring
- Add enough warm water (50 degrees C) to immerse fibres
- Place moist tannin-treated fibres in mordant, soak for 2 hours
- Stir occasionally, then take out wearing gloves
- Squeeze our excess mordant and rinse well

REFERENCE
- How to Scour (n.d.) Botanical Colors: https://botanicalcolors.com/how-to-scour/
- Joy Boutrup Catherine Ellis (2018) The Art & Science of Natural Dyes: p. 117, 127, 132.