FABRICADEMY
textile and technology academy

#FABRICADEMY2021 TUTORIALS

MICROBIAL CELLULOSE
PRESENTATION

27-10-2021 | LORENA TREBBI

“The future is not a predefined destination, a separate space or time

The future is a multiplicity of ideas, critiques and potentialities that are embedded in the narratives, objects and practices of our daily lives

In this sense, multiple, often conflicting, futures are always already here as part of a continuously unfolding present and past”

Kjaersgaard, Halse, Smith, Vangkilde, Binder & Otto

The current environmental crisis, a consequence of the broken relationship we established with the planet, prompts the question: **what sort of future awaits us? Which materials, artifacts, resources and systems will populate the planet in fifty years?**

RQ1 – **How design places itself in the transdisciplinary dimension of biofabrication?**

RQ2 – **How far its range expands and which are indeed its limits?**

RQ3 – **Which is the contribution of designers in fostering the application, appreciation and consequent diffusion of biofabricated materials?**

PART II

HANDS-ON

HOW TO DESIGN WITH NATURE

BASIC EXPERIMENTS

Learning-by-Doing

Experience as starting point for Knowledge Building

John Dewey

Experiential Learning

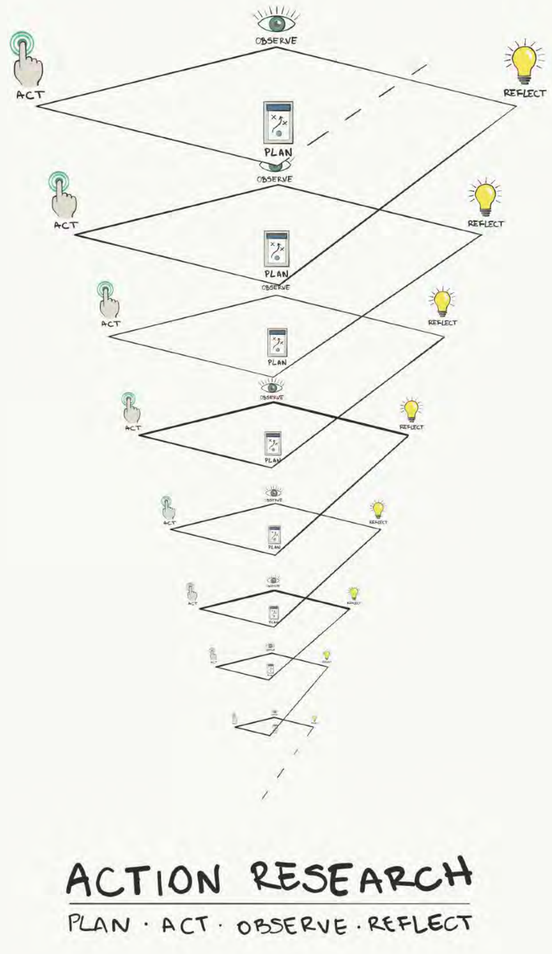
Experience as central process of human adaptation to the social and physical environment

David Kolb

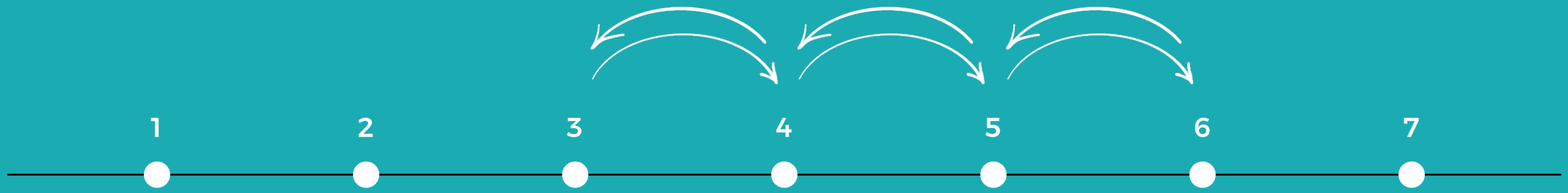
Action Research

No action without research, no research without action

Kurt Lewin



basic experiments: methodology



1 **REMAKE**
Information gathering from existing protocols and basic recipes reproduction

2 **TINKER**
First moment of observation and manipulation of the material sample

3 **EXPERIMENT**
Inductive experimentation which starts from processes

4 **SENSE**
Experiential analysis of the results, based on tinkering and sensory exploration

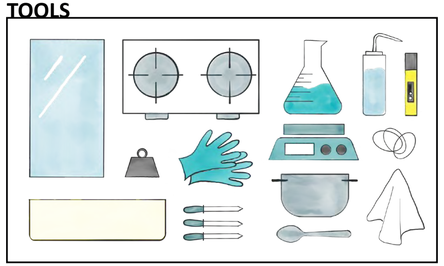
5 **FOCUS**
Focused experimentation which starts from material's features

6 **ENVISION**
Material as input for concept development

7 **FABRICATE**
Targeted experiment for design prototype fabrication

bacteria: S.C.O.B.Y.

TOOLS



DRYING PANEL	SCALE
STOVE	RUBBER BANDS
BEAKER	CONTAINER
ETHANOL	PIPETTES
PH-METER	POT
WEIGHT	SPOON
GLOVES	CLOTH/LID

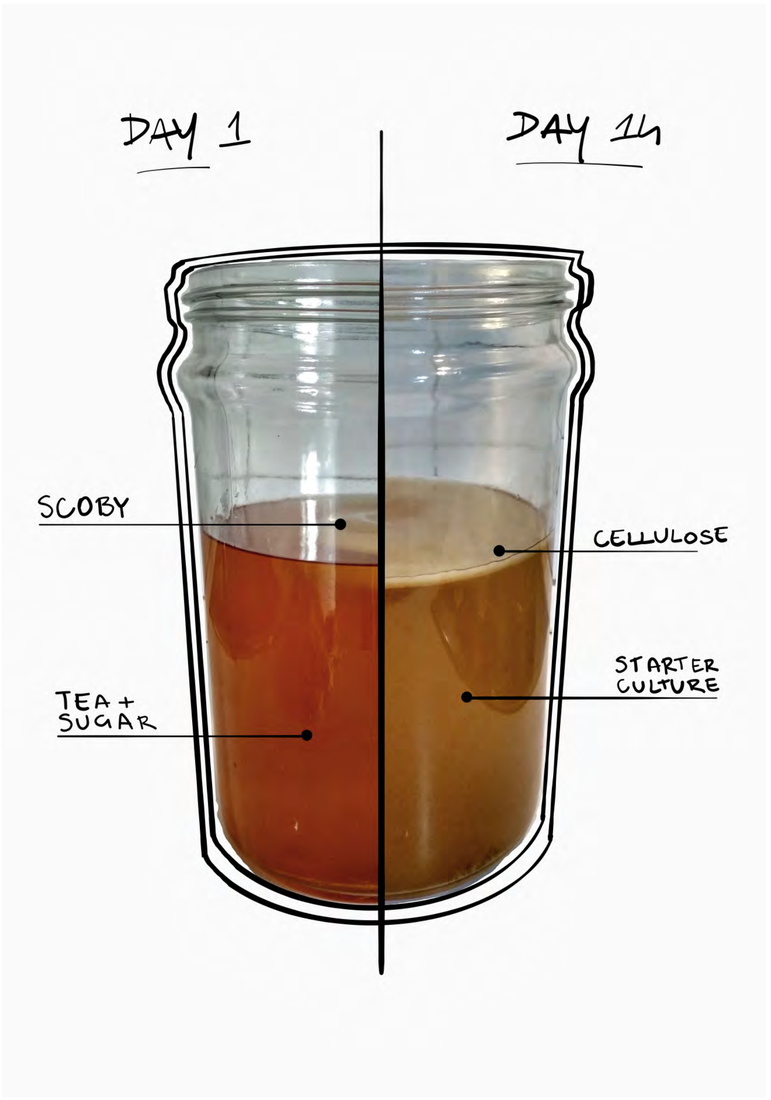
INGREDIENTS

$C_n(H_2O)_n$ SUGAR | H_2O WATER | CH_3COOH VINEGAR | TEA | S.C.O.B.Y.

PROCESS

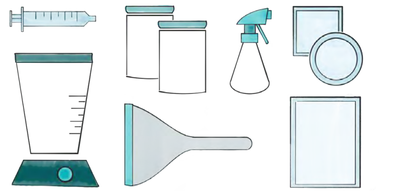
- Wear gloves and sterilise all the containers and instrument used to prevent contamination
- Boil the water, add the sugar and stir, then add the teabags and leave to rest
- Wait until the water cools and reaches room temperature, measure the pH and gradually add vinegar to reach the right acidity
- Add the scoby, use the weight to keep it on the bottom of the container
- Cover the container with a breathable cloth or a lid
- Keep in a dark ventilated environment without moving the container
- When reached the desired thickness harvest the material from the surface, wash it with neutral soap and rinse with water
- Place it on a flat surface for drying (different surfaces will result in different surface textures), remove all the air bubbles, turn it periodically on both sides until dry

* the remaining liquid can be used as starter for a new culture, it is already acid so ther is no need to add vinegar, and can be feed with new sugars to continue the fermentation process again and again



algae: alginate bioplastics

TOOLS



- ETHANOL
- BLENDER
- JARS
- SPRAY BOTTLE
- MOULDS
- SYRINGE
- SPATULA

INGREDIENTS

PROCESS

- Pour the alginate powder, water, glycerine and any other additive in the blender and mix
- Pour it in a jar and leave it rest overnight to let the air bubbles disappear
- Prepare the calcium chloride solution and put it in the spray bottle

For *thicker bioplastics*:

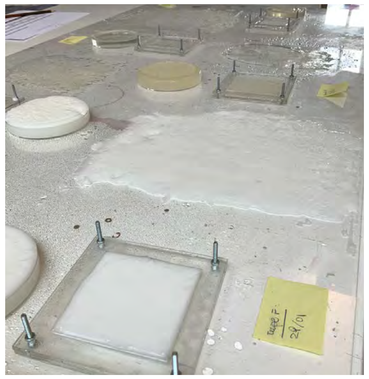
- spray the mould with the calcium chloride solution
- cast the material
- spray it with calcium chloride solution and let it dry

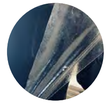
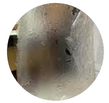
For *thin biofilms*:

- spray the surface with the calcium chloride solution
- pour the mixture on the surface and smooth with a spatula
- spray it with calcium chloride solution and let it dry

For *strings*:

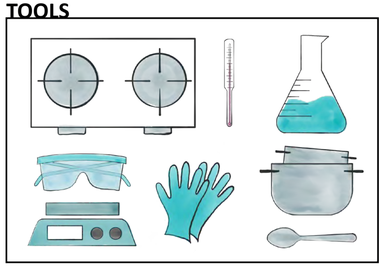
- prepare a vertical jar filled with the calcium chloride solution,
- inject the mixture in the syringe and extrude it in the jar
- collect the strings and let them dry



FILM	MOLD 1 [h 3mm]	MOLD 2 [h 1cm]
RECIPE B [water x1]		
 difficult to spread irregularities and holes thin and fragile	 air bubbles high shrinkage	 little deformation
RECIPE A [water x2]		
 too thin and fragile	 thin almost disappeared with shrinkage	 too thick only the surface shrinks
RECIPE E [water x4]		
 strong right thickness	 little deformation	 too thick too much deformation
RECIPE D [water x1]		
 difficult to spread irregularities and holes	 irregularities and holes	 keeps the shape with little deformation
RECIPE C [water x2]		
 ok but too thin	 high shrinkage (50%) irregular thickness	 too thick too much deformation
RECIPE F [water x4]		
 too thin irregular and fragile	 high shrinkage (50%) irregular thickness	 extreme deformation

hair: keratin extraction

TOOLS



STOVE
TERMOMETER
BEAKER
GOGGLES
SCALE
GLOVES
POTS
SPOON

INGREDIENTS

NaOH
SODIUM HYDROXIDE

H_2O
WATER

HAIR

PROCESS

Liquid Keratin Solution:

- Dissolve sodium hydroxide in cold water
- Prepare a water bath at 50°C
- Add hair
- Stir and keep at constant temperature and agitation for 5h: hair will start breaking until it completely dissolv
- Filter with a strainer

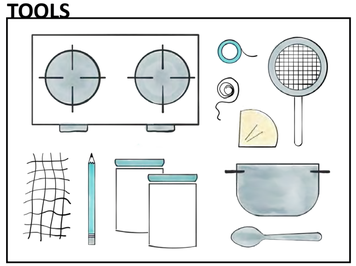
Keratin bio-flm and composites:

- Pour the keratin solution plus additives (glycerol and any other) in the pot and stir for a couple of minutes
- Pour in Petri dishes
- Desiccate in the oven at 60°C until dry

For this experiment hair was collected from hair saloons. After the extraction, keratin was combined with glycerine and seaweed in different grains (from powder to larger pieces), in order to realise materials with variations in thickness, texture and translucency.
The experiment was part of a collaboration with the multi-media artist Bela Rofe for her fabricademy project "Gaia", investigating the interconnection between women and the sea, highlighting the delicate balance among living systems on Earth.

crystals: alum

TOOLS



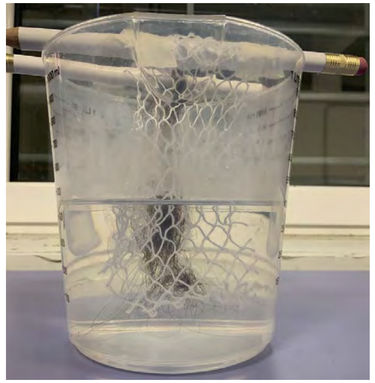
- STOVE
- TAPE
- TWINE
- COFFEE FILTER
- SIEVE
- SCAFFOLD MATERIAL
- PENCIL
- JARS
- POT
- SPOON

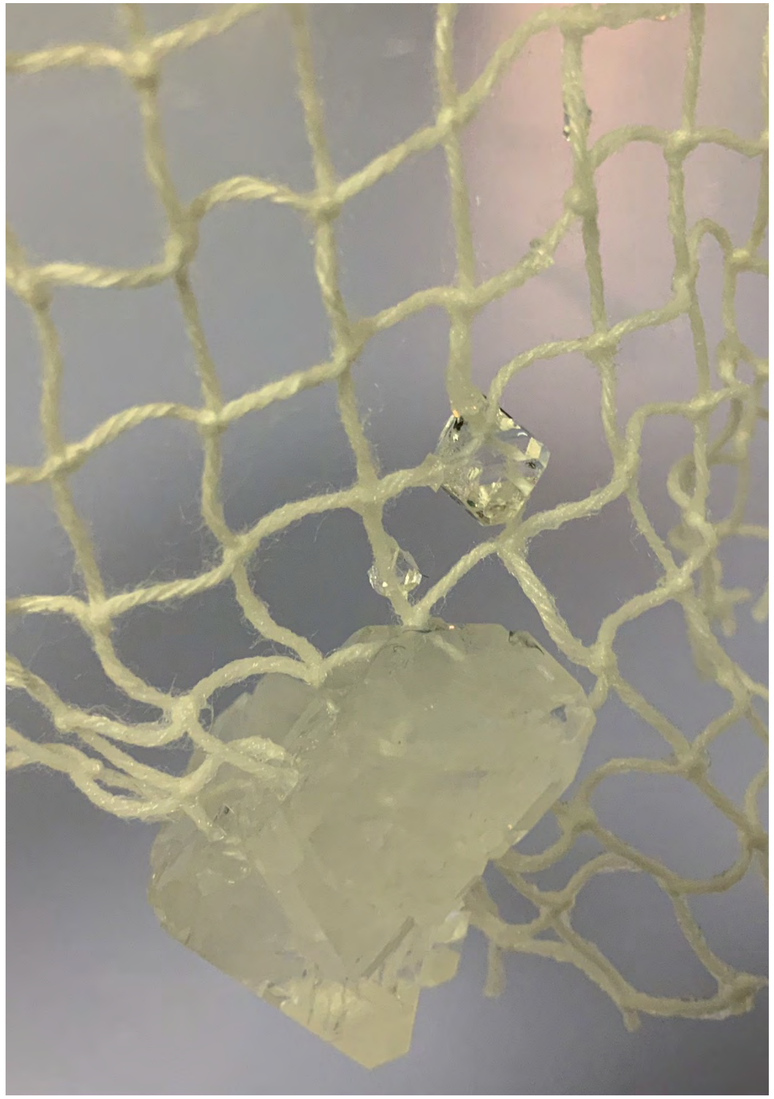
INGREDIENTS

- $KAl(SO_4)_2 \cdot 12H_2O$ POTASSIUM ALUM
- H_2O WATER

PROCESS

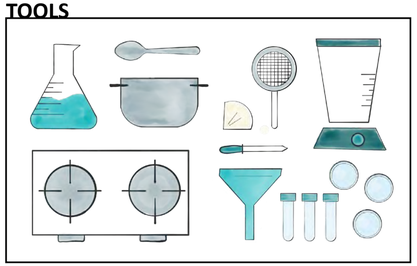
- Boil the water
- Add the alum and stir until the solution is saturated and it stops dissolving
- Filter the solution to remove any undissolved material
- Place the scaffold material suspended in the jar with the help of pencil, tape and twine
- Pour the solution and wait for crystal formation without moving the jar
- Harvest the crystallised scaffold material and leave it dry





natural dyes: blueberry

TOOLS



- BEAKER
- SPOON
- POT
- COFFEE FILTERS
- SIEVE
- BLENDER
- STOVE
- PIPETTES
- FUNNEL
- TEST TUBES
- PETRI DISHES

INGREDIENTS

- BLUEBERRIES
- H_2O WATER
- CH_3COOH VINEGAR
- $NAHCO_3$ VINEGAR

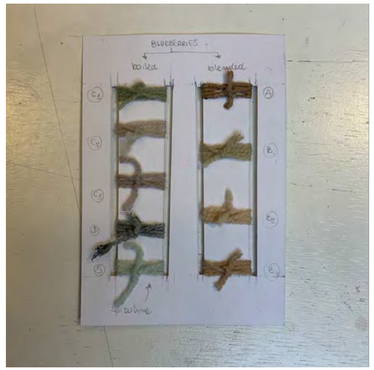
PROCESS

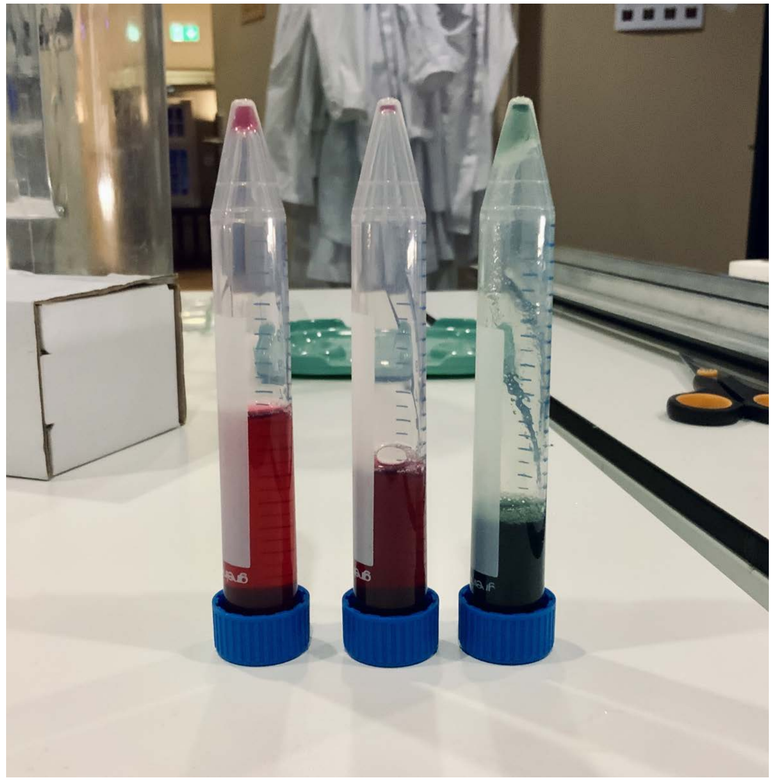
Mechanical separation:

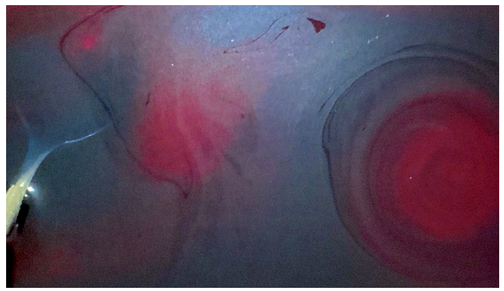
- Blend blueberries
- Filter with a strainer and coffee filters
- Divide the dye in three petri dishes: add baking soda to the first, add vinegar to the second one, and leave the third as it is
- Store in test tubes

Heat separation:

- Boil blueberries for about fifty minutes
- Filter with a strainer and coffee filters separating berries from boiling water
- Divide the dye in three petri dishes: add baking soda to the first, add vinegar to the second one, and leave the third as it is
- Store in test tubes







The dye was extracted from blueberries through heat and mechanical separation. The dyes obtained were then reacted with acids and bases through which changing the pH and consequently the colour.
Fabric threads were then dipped into the dyes to get a colour palette, however the threads weren't treated with the mordants required to retain the colour on the fabric, and therefore the threads' colours appear much lighter and mild then the actual dye.

inks: charcoal

TOOLS

MORTAR & PESTLE

FILTER

STRAIN

GLASS CONTAINERS

MEASURING CUPS

SPOON

BOWLS

INGREDIENTS

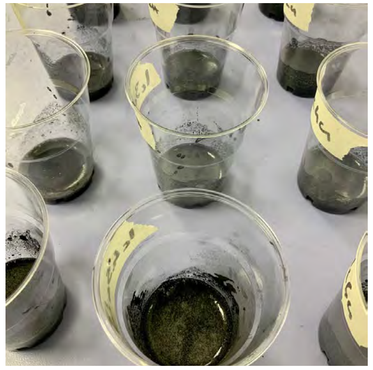
C
CHARCOAL

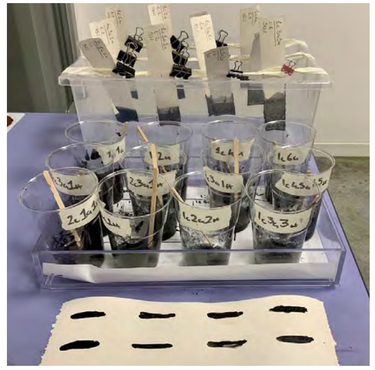
H_2O
WATER

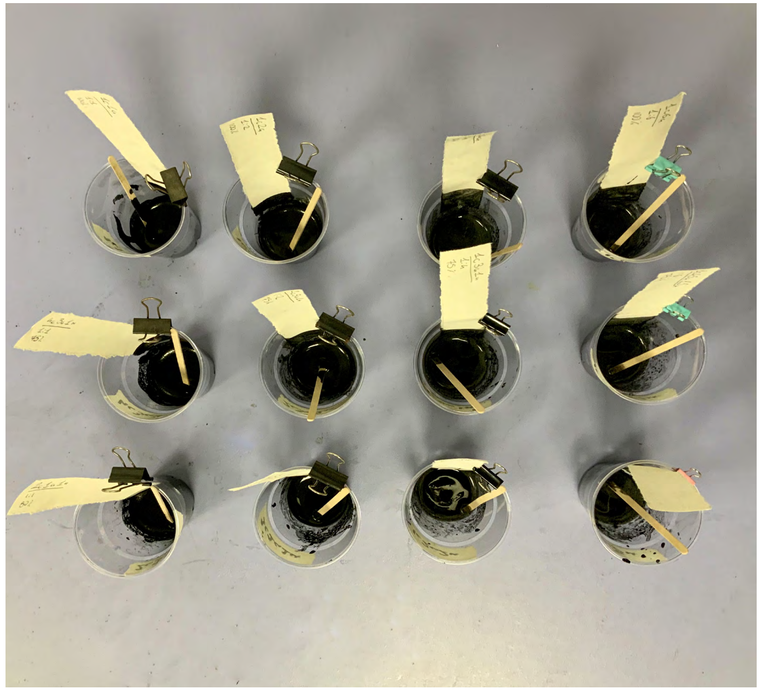
$C_{15}H_{20}NNA_{04}$
GUM ARABIC

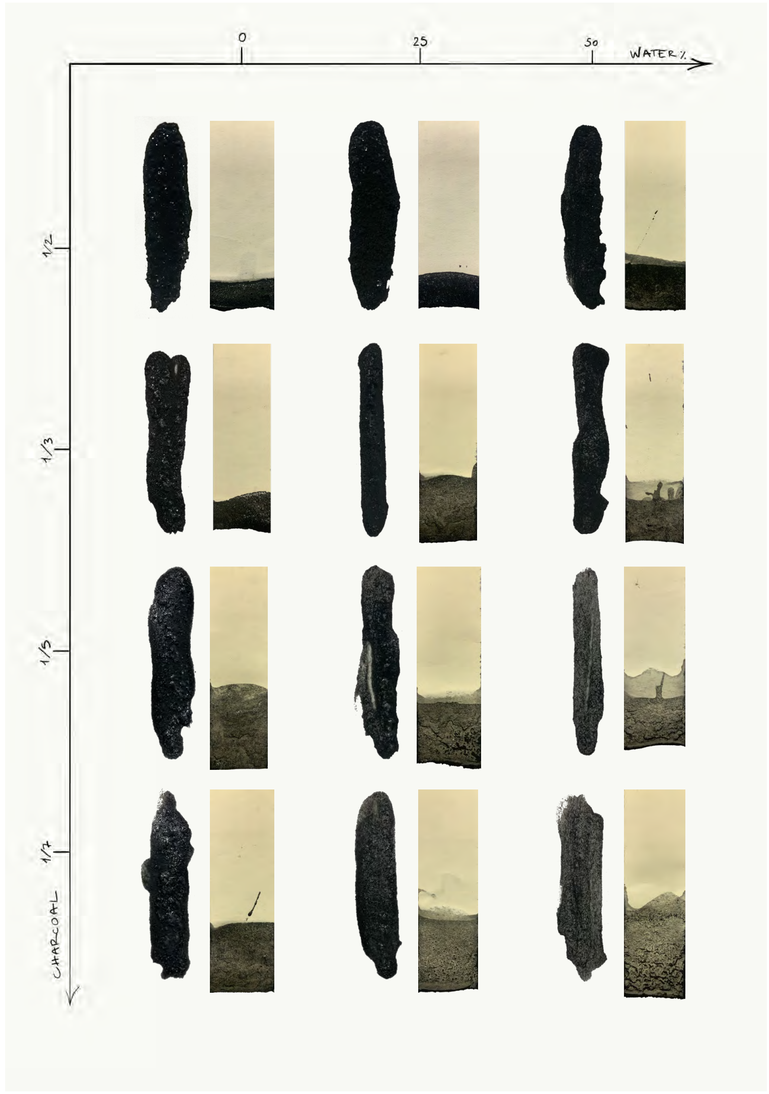
PROCESS

- Turn the charcoal into powder with mortar and pestle;
- Put the powder in a bowl, gradually add water and gum arabic alternating;
- Stir;
- Filter with coffee filters to remove solid parts;
- Pour in a glass container and shake.





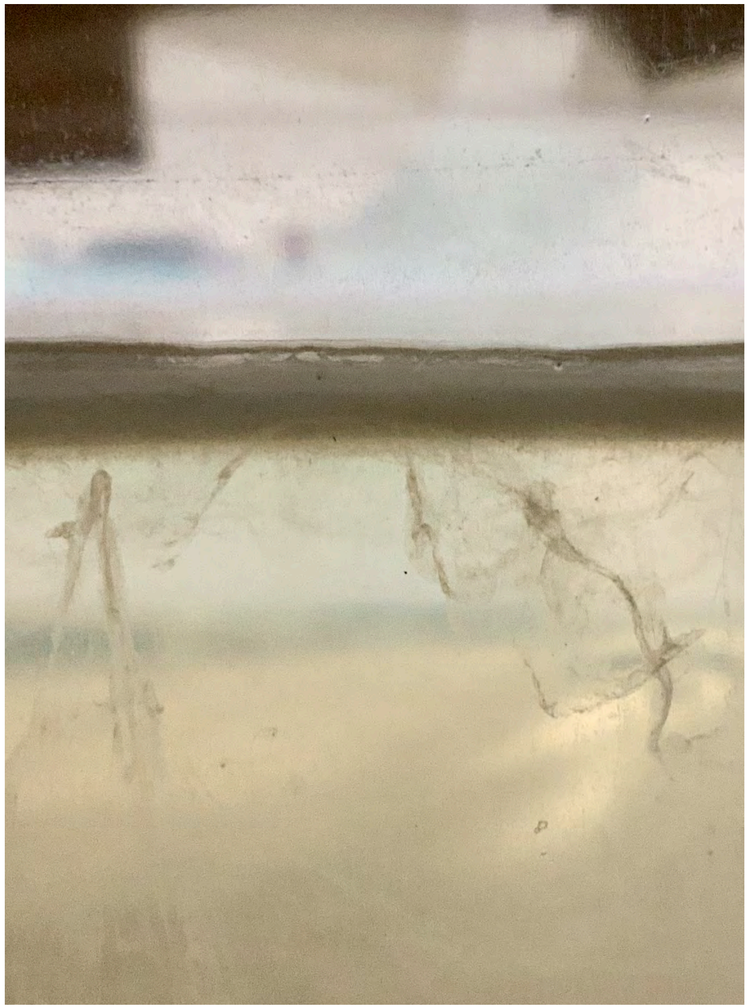




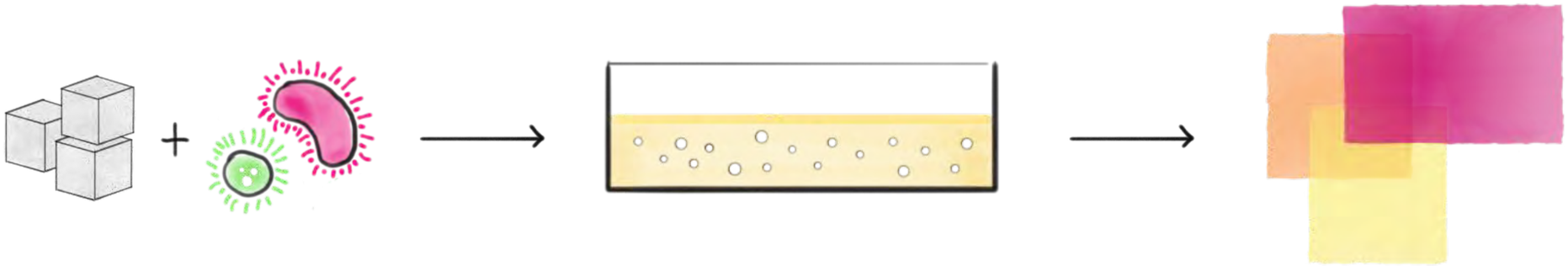
FERMENTATION

DESIGN WITH LIVING SYSTEMS

S.C.O.B.Y. = Symbiotic Culture Of Bacteria and Yeasts



S.C.O.B.Y. = Symbiotic Culture Of Bacteria and Yeasts



SUGARS > YEASTS > ETHANOL > BACTERIA > ACETIC ACID + NANOCELLULOSE

state of the art

Biocouture / Suzanne Lee

Riina Oun

Ponto Biodesign / Elena Amato

Emma Sicher

ScobyTec

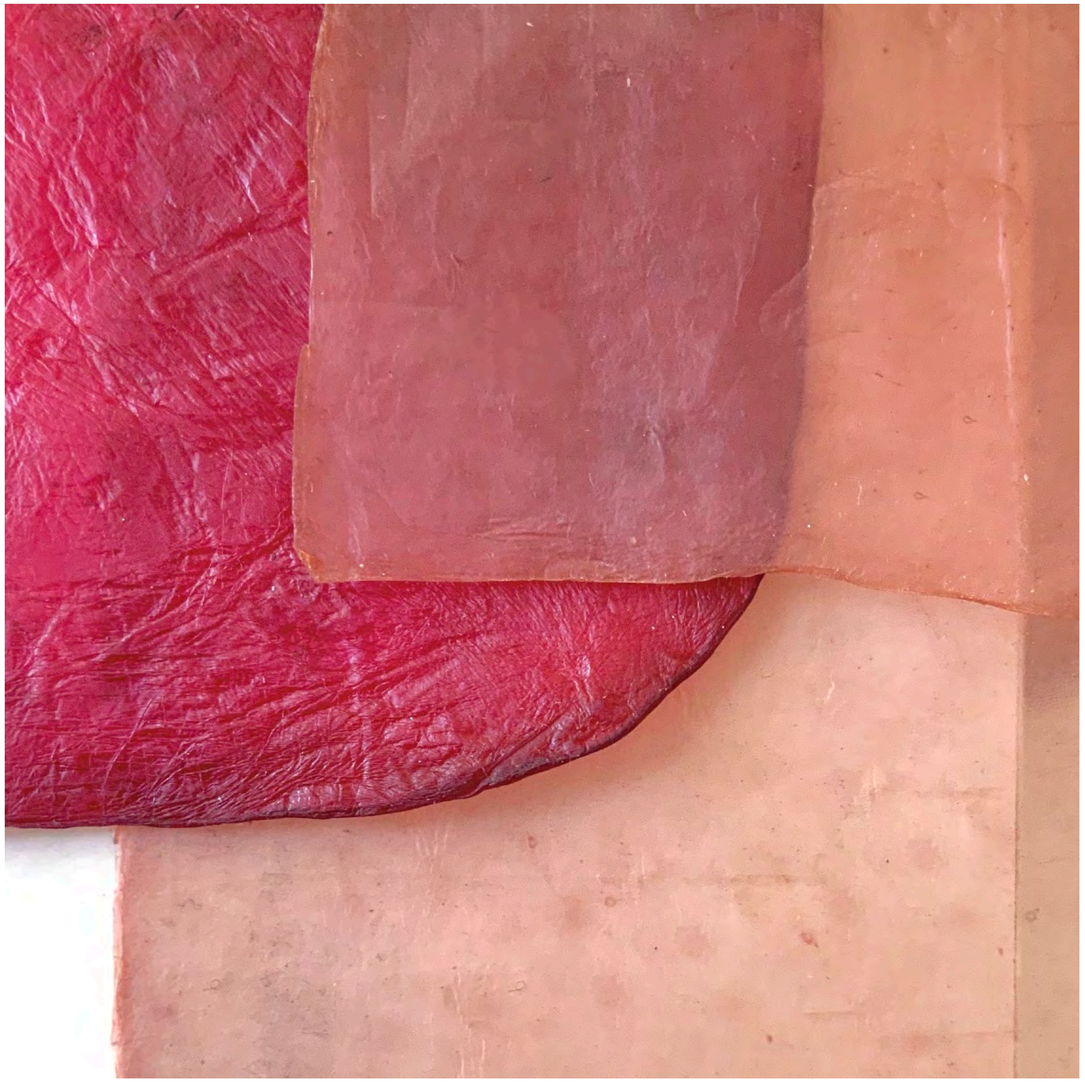
Malai

MakeGrowLab

The Kombucha Paper

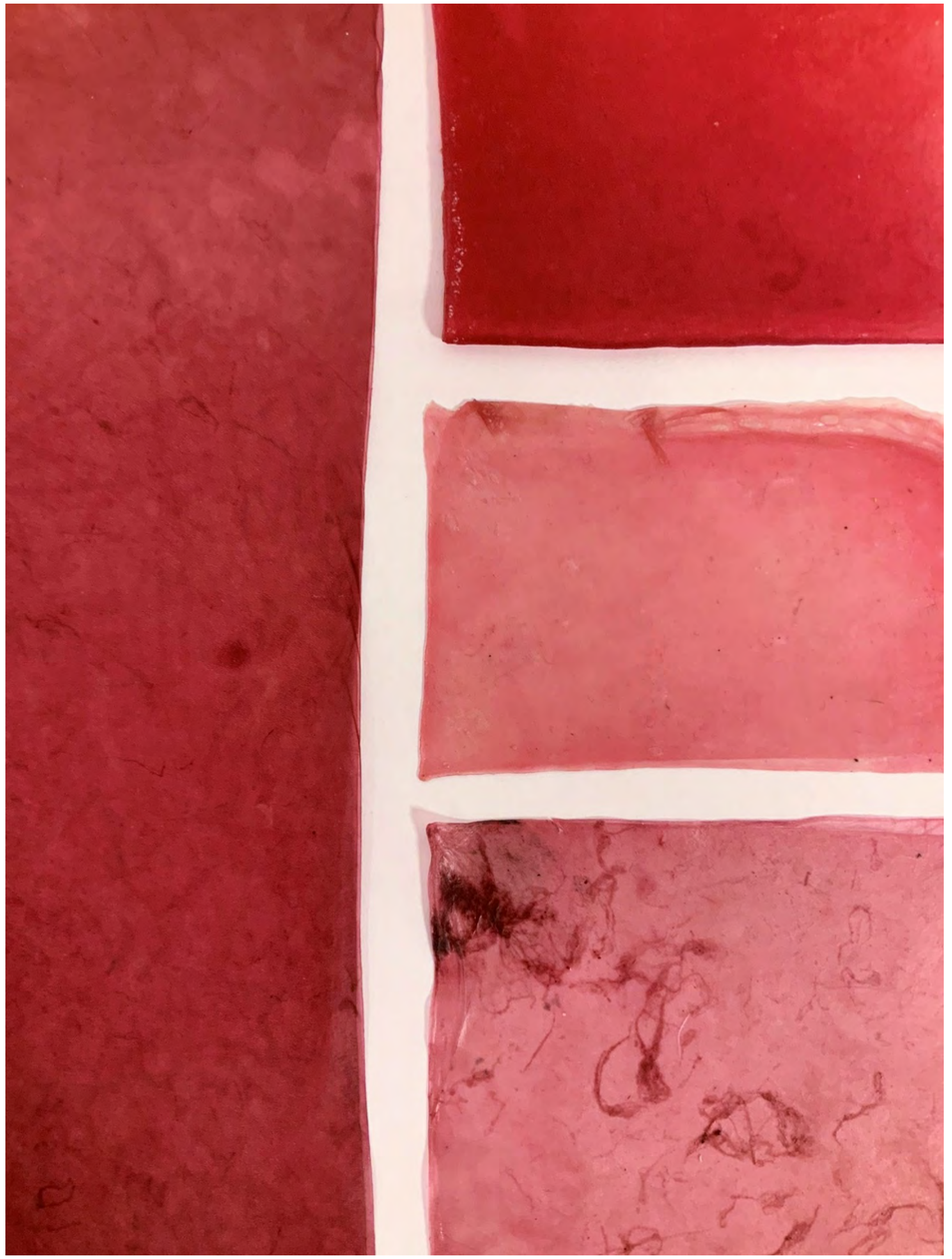
Kombutex / Studio Samira Boon

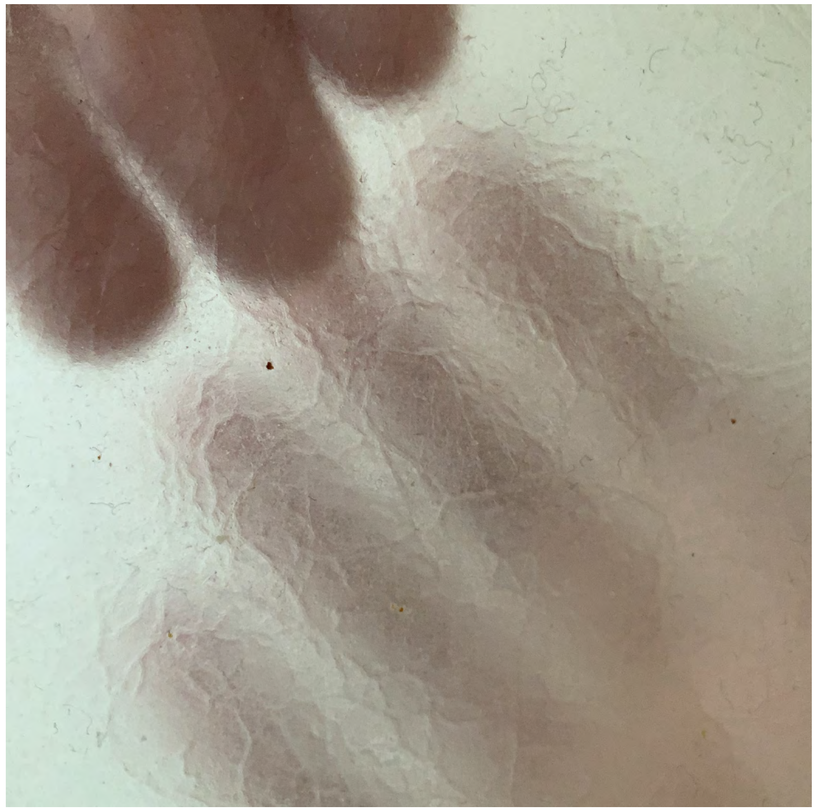
sensory exploration

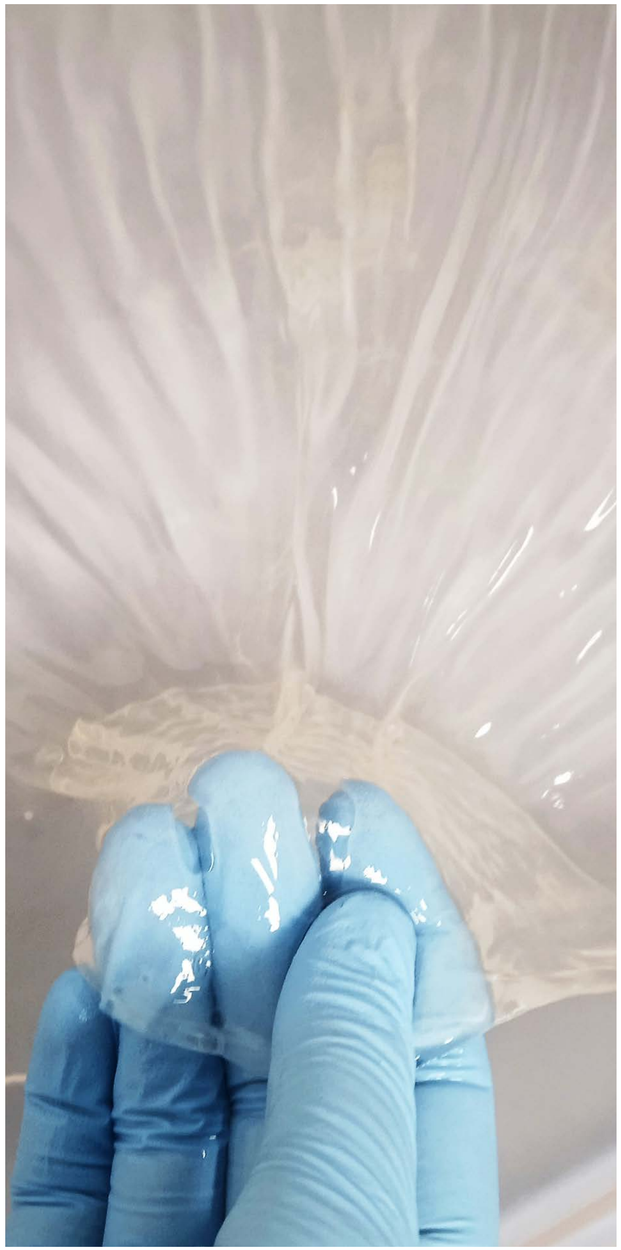


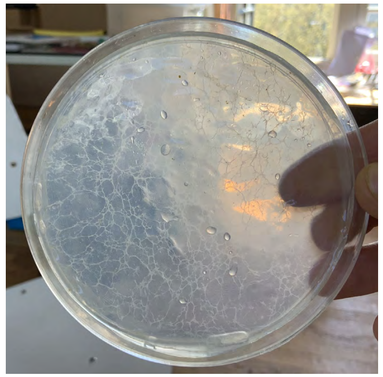
fermentation - sensory exploration

food = colour&smell







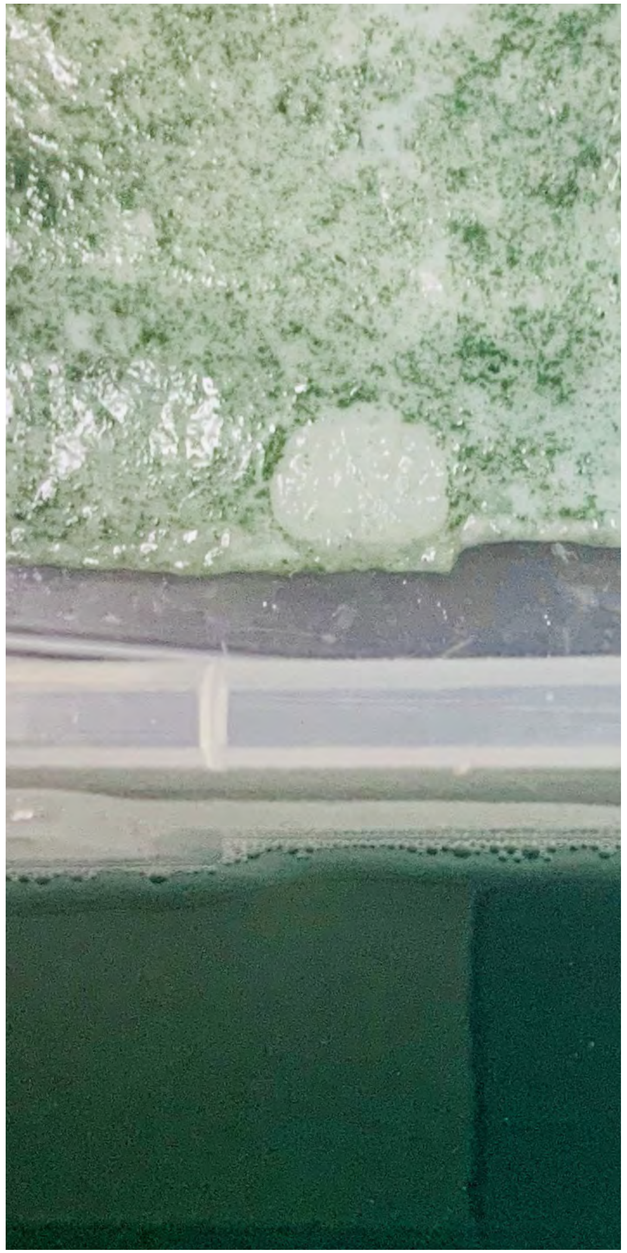


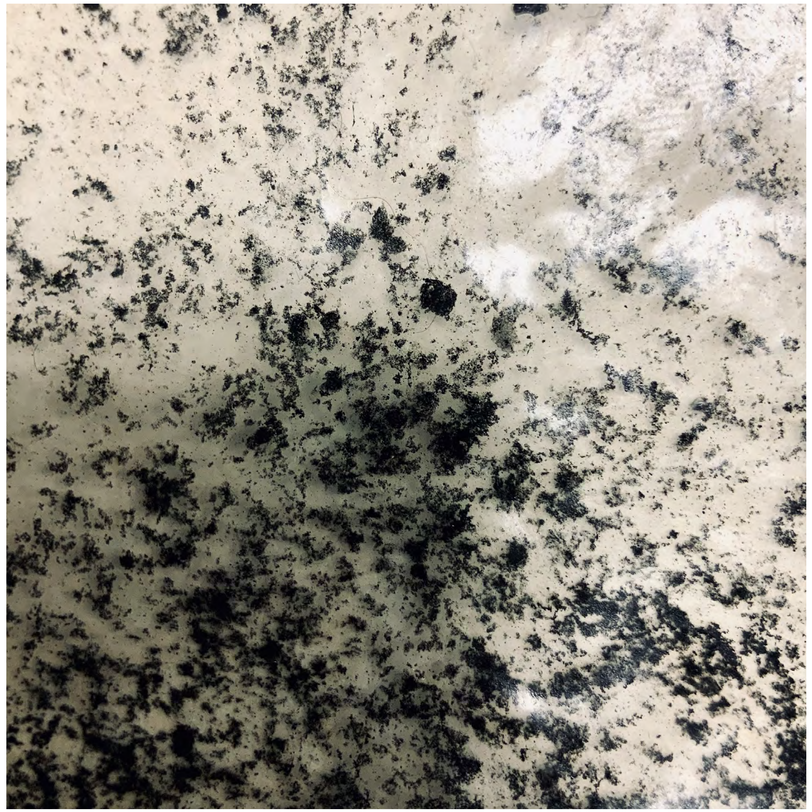
fermentation - sensory exploration

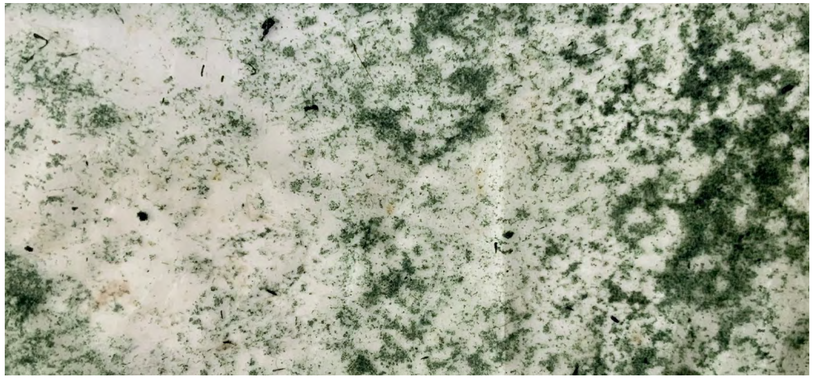
texture: irregularity vs uniformity

fermentation - sensory exploration

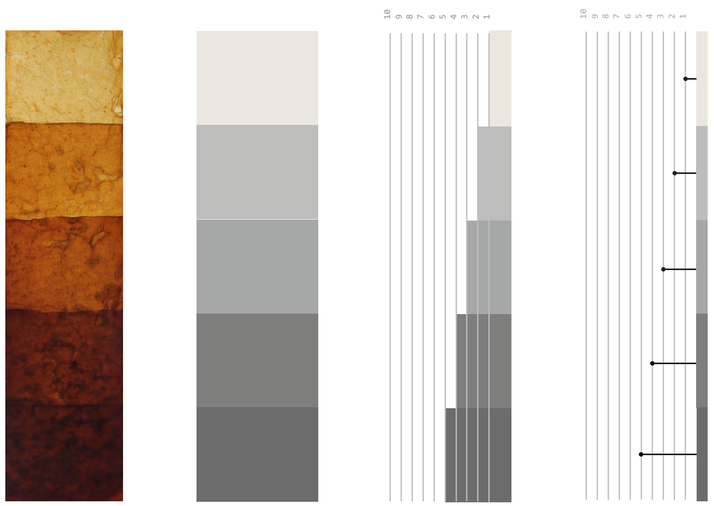
texture: powdered pigments vs liquid dye



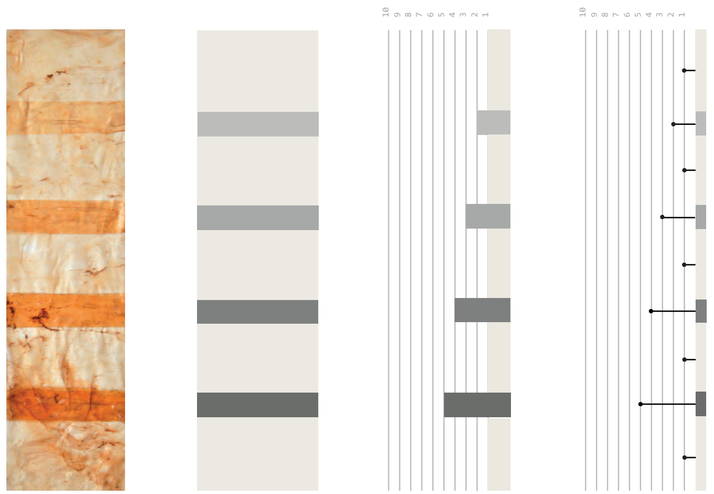




processing



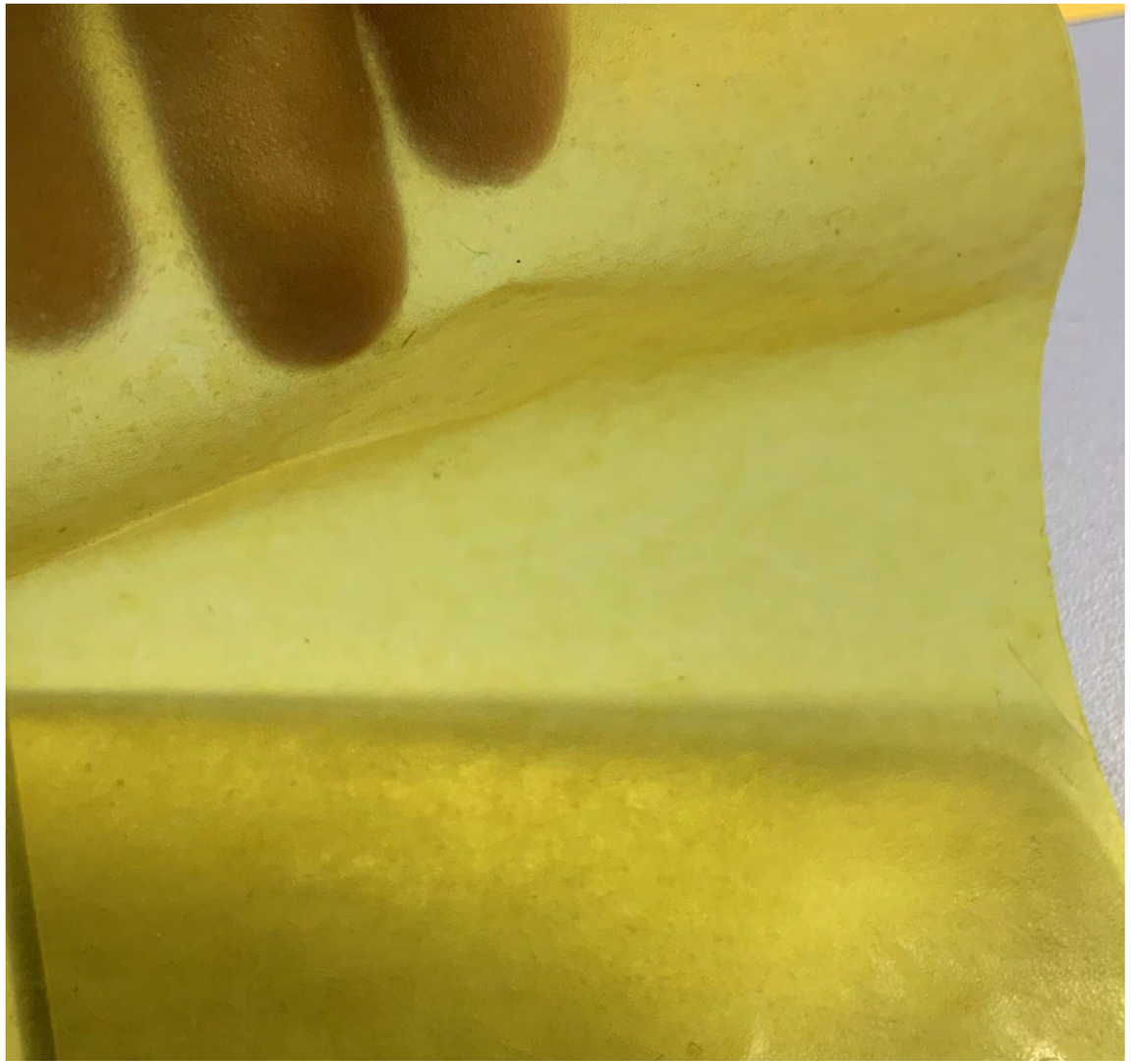
Transparent-Opaque / table 25



Transparent-Opaque / table 19

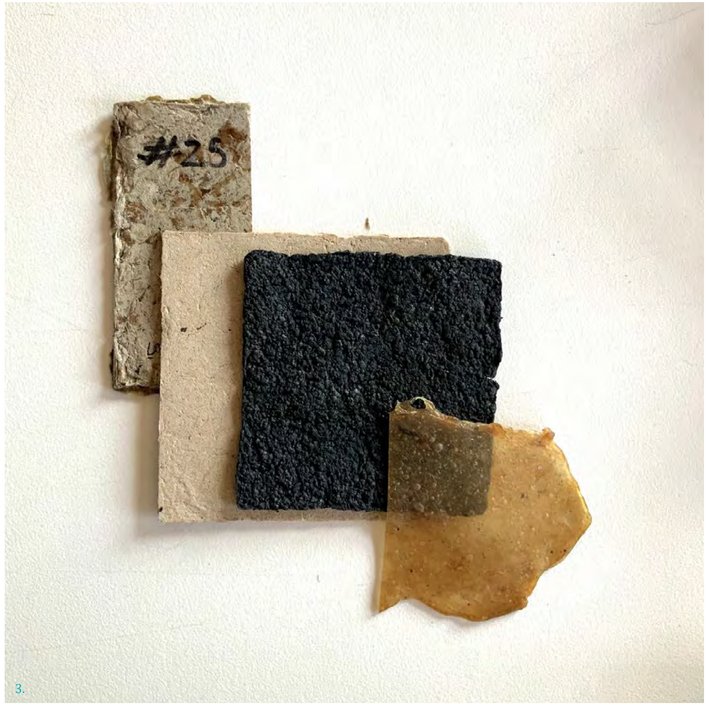
fermentation - processing

wet > **stratification**



fermentation - processing

wet > **texture and moulding**



3.

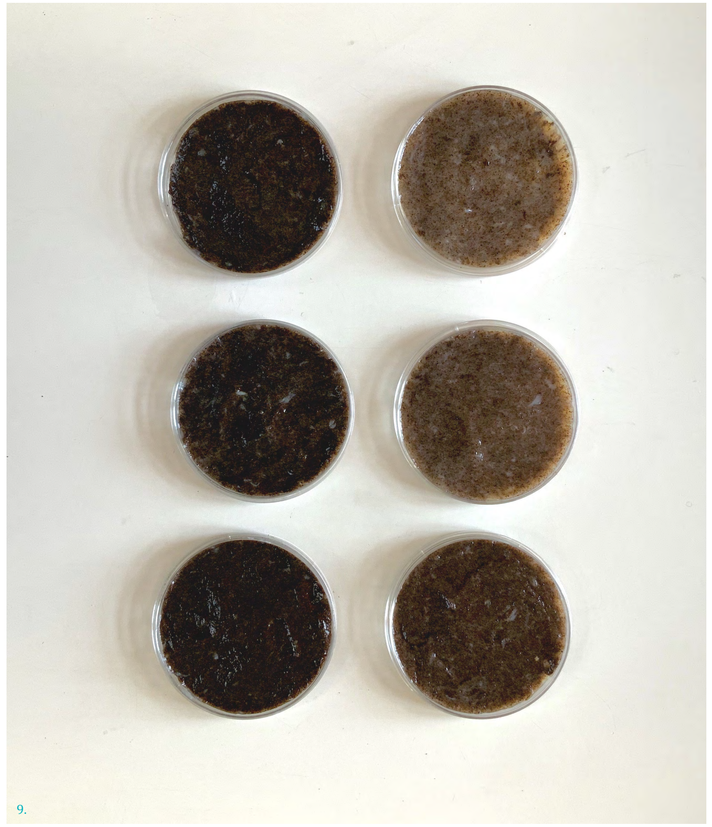

4.

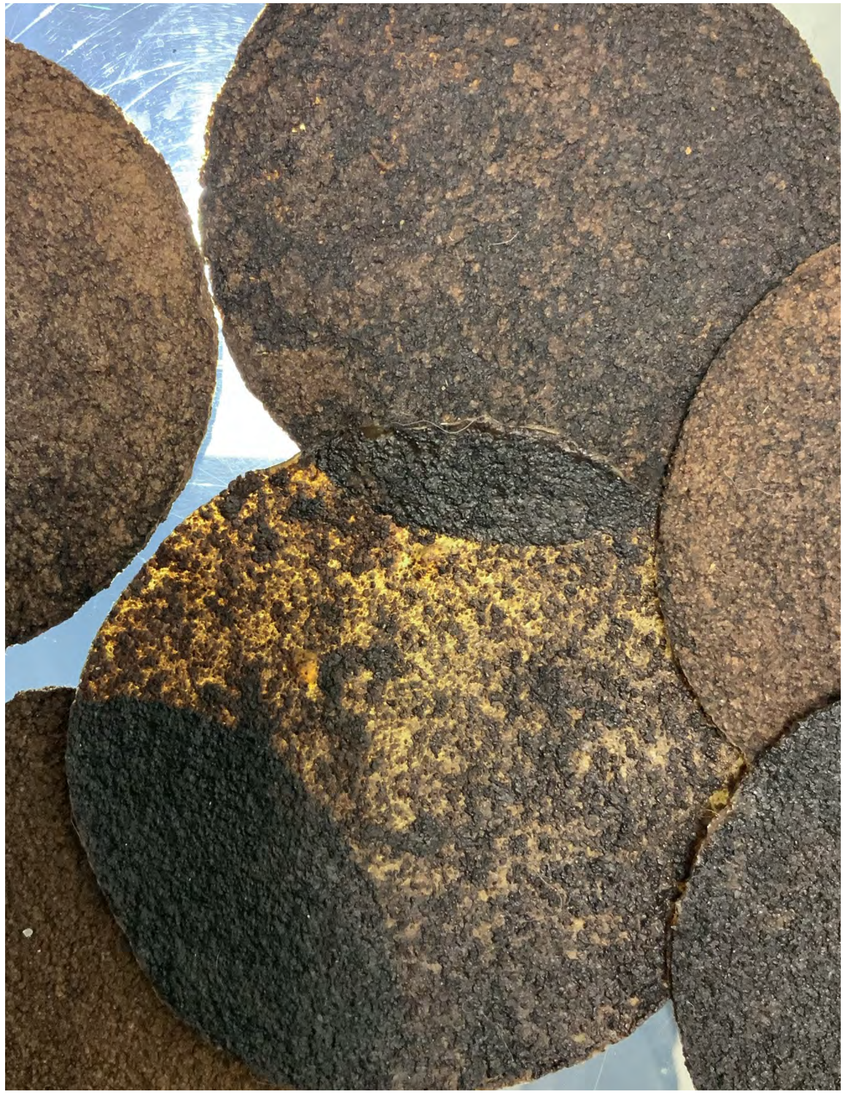

5.


6.


7.


8.


9.

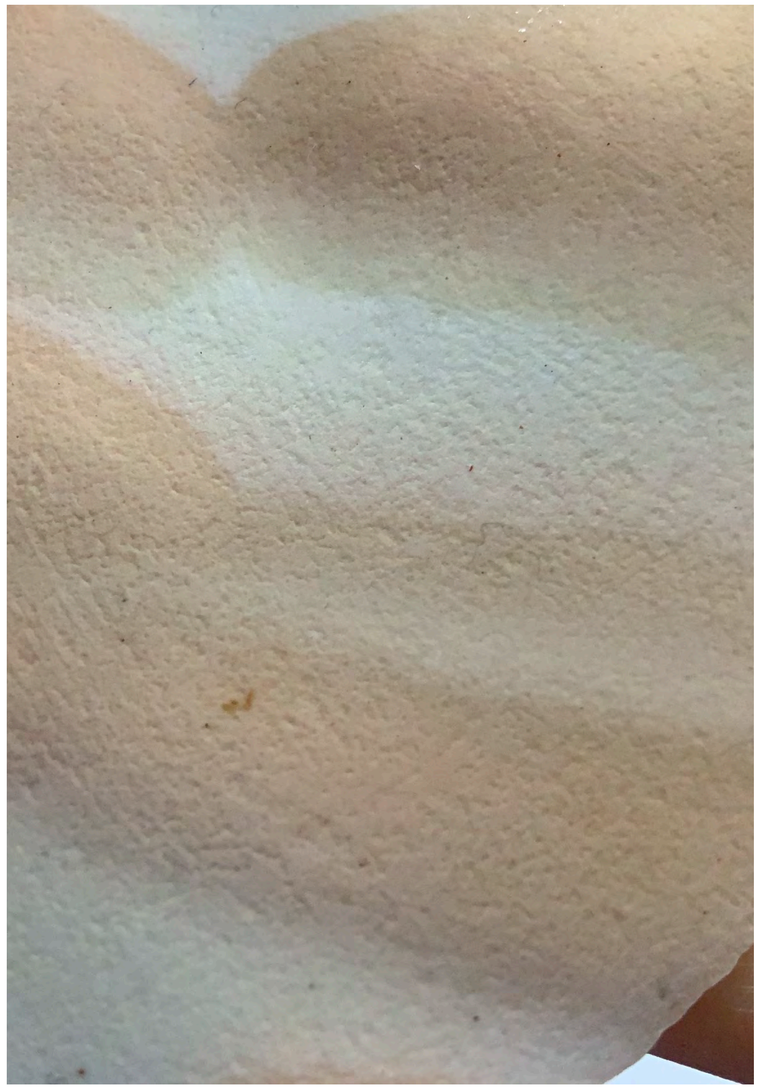


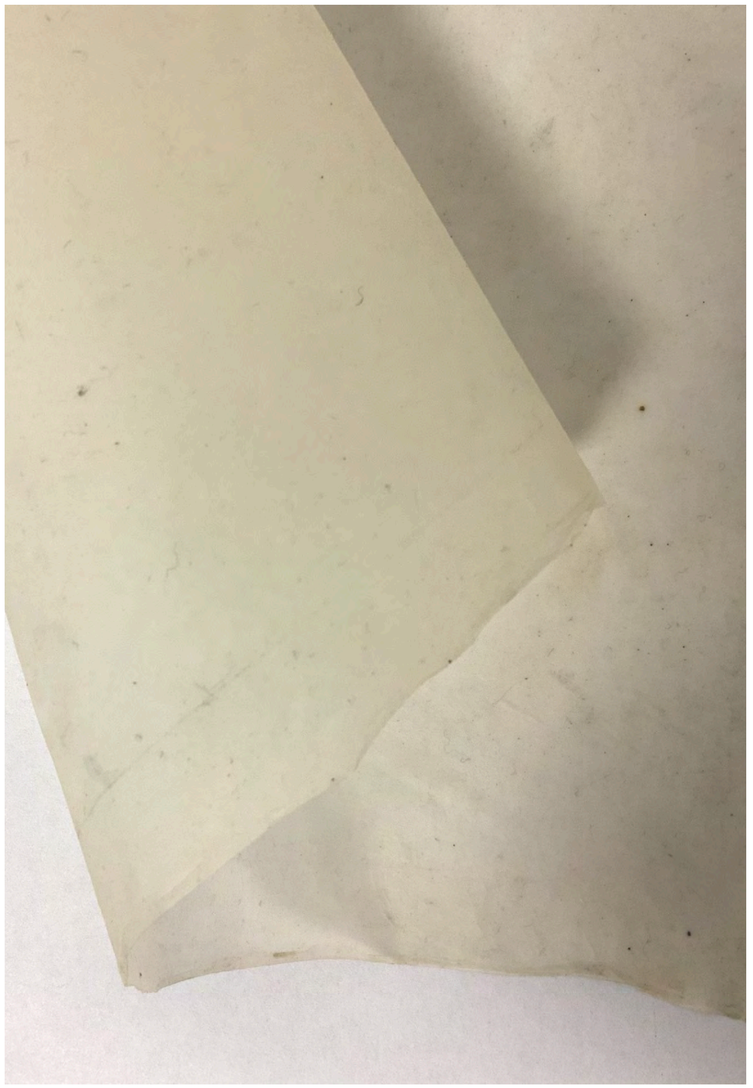
fermentation - processing

wet > **composites**

fermentation - processing

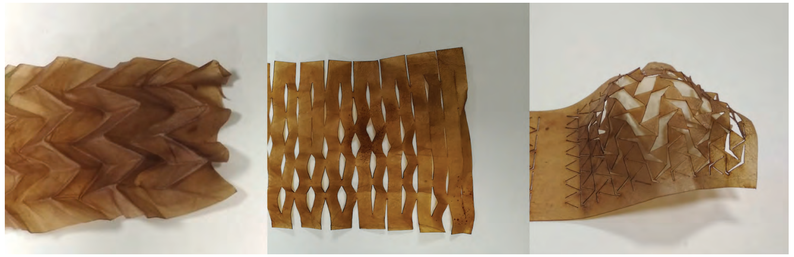
dry > **absorption**

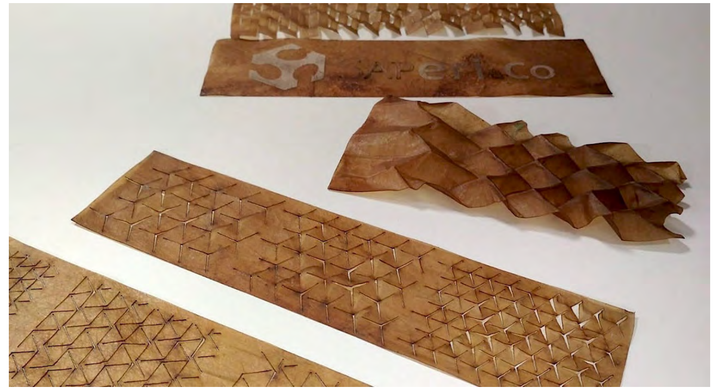




fermentation - processing

dry > **surface treatment**



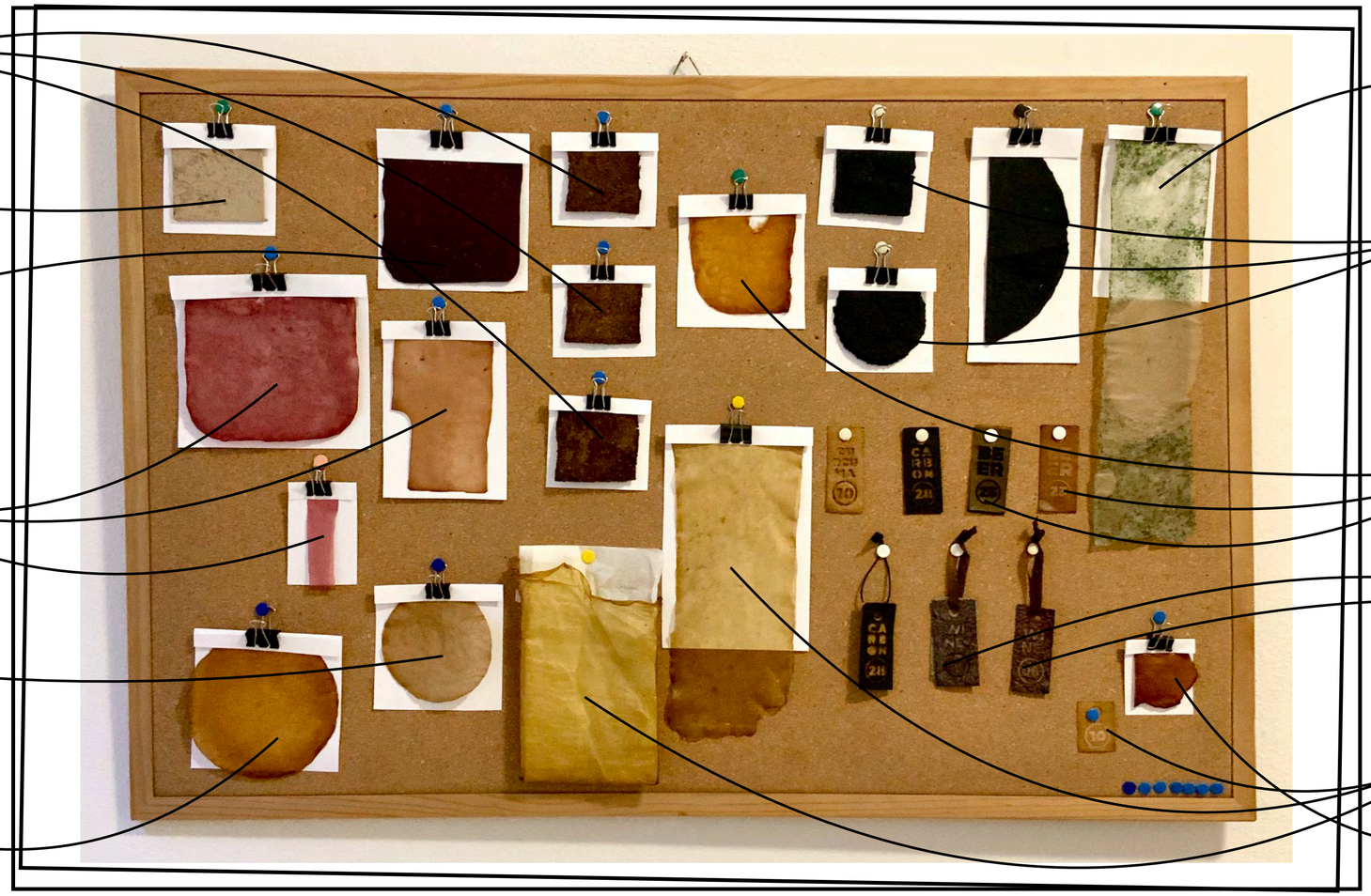


fermentation - processing

dry > **laser cut & engrave**

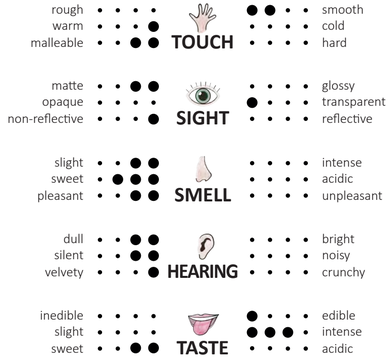
ageing & decay

material archive


COMPOSITES: TEA
COMPOSITES: CARDBOARD
RED WINE
BLUEBERRY DYE
WATER
TEA
SPIRULINA
COMPOSITES: CHARCOAL
BEER
RED WINE
TURMERIC
COMPOSITES: ALGINATE

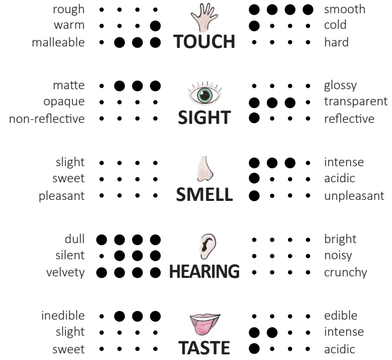
#F_01

blueberry dye 40%
polypropylene drying / natural finish



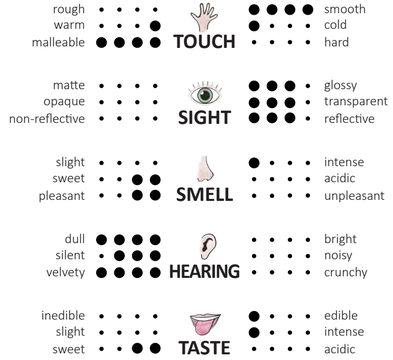
#F_02

blueberry dye 20%
acrylic drying / tung oil finish



#F_03

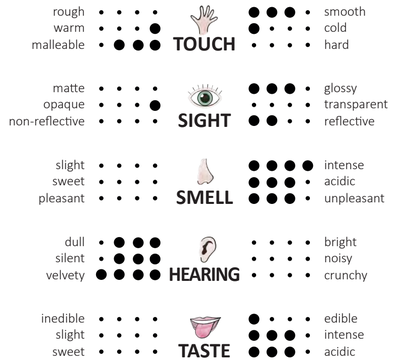
blueberry dye 10%
acrylic drying / natural finish

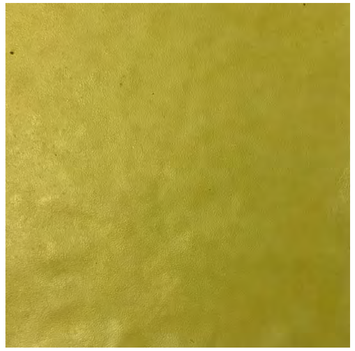


fermentation - material archive

#F_04

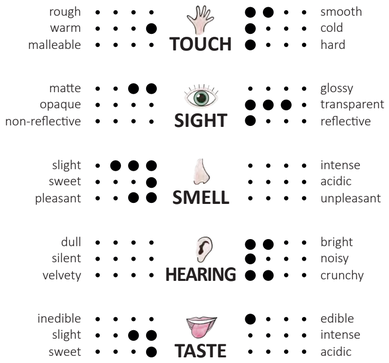
red wine
acrylic drying / natural finish





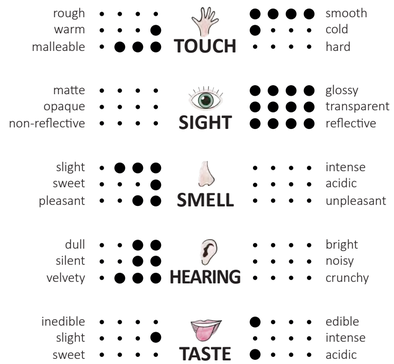
#F_05

turmeric
polypropylene drying / natural finish



#F_06

water
acrylic drying / natural finish

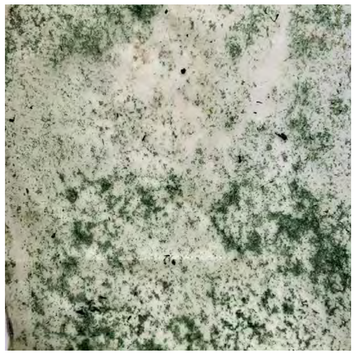


fermentation - material archive

#F_07

rice milk
acrylic drying / tung oil finish

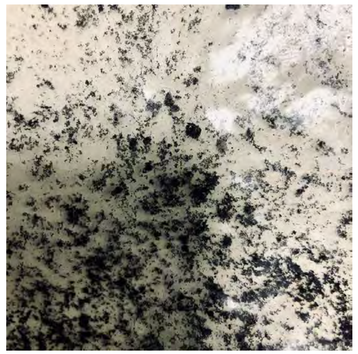
rough	TOUCH	smooth
warm		cold
malleable		hard
matte	SIGHT	glossy
opaque		transparent
non-reflective		reflective
slight	SMELL	intense
sweet		acidic
pleasant		unpleasant
dull	HEARING	bright
silent		noisy
velvety		crunchy
inedible	TASTE	edible
slight		intense
sweet		acidic



#F_08

spirulina powder
natural drying / natural finish

rough	TOUCH	smooth
warm		cold
malleable		hard
matte	SIGHT	glossy
opaque		transparent
non-reflective		reflective
slight	SMELL	intense
sweet		acidic
pleasant		unpleasant
dull	HEARING	bright
silent		noisy
velvety		crunchy
inedible	TASTE	edible
slight		intense
sweet		acidic



#F_09

charcoal powder
acrylic drying / natural finish

rough	TOUCH	smooth
warm		cold
malleable		hard
matte	SIGHT	glossy
opaque		transparent
non-reflective		reflective
slight	SMELL	intense
sweet		acidic
pleasant		unpleasant
dull	HEARING	bright
silent		noisy
velvety		crunchy
inedible	TASTE	edible
slight		intense
sweet		acidic

fermentation - material archive

#C_01

charcoal 3% | fine-grained
wet scoby pulp

rough	TOUCH	smooth
warm		cold
malleable		hard
matte	SIGHT	glossy
opaque		transparent
non-reflective		reflective
slight	SMELL	intense
sweet		acidic
pleasant		unpleasant
dull	HEARING	bright
silent		noisy
velvety		crunchy
inedible	TASTE	edible
slight		intense
sweet		acidic

#C_02

charcoal 7% | medium-grained
wet scoby pulp

rough	TOUCH	smooth
warm		cold
malleable		hard
matte	SIGHT	glossy
opaque		transparent
non-reflective		reflective
slight	SMELL	intense
sweet		acidic
pleasant		unpleasant
dull	HEARING	bright
silent		noisy
velvety		crunchy
inedible	TASTE	edible
slight		intense
sweet		acidic

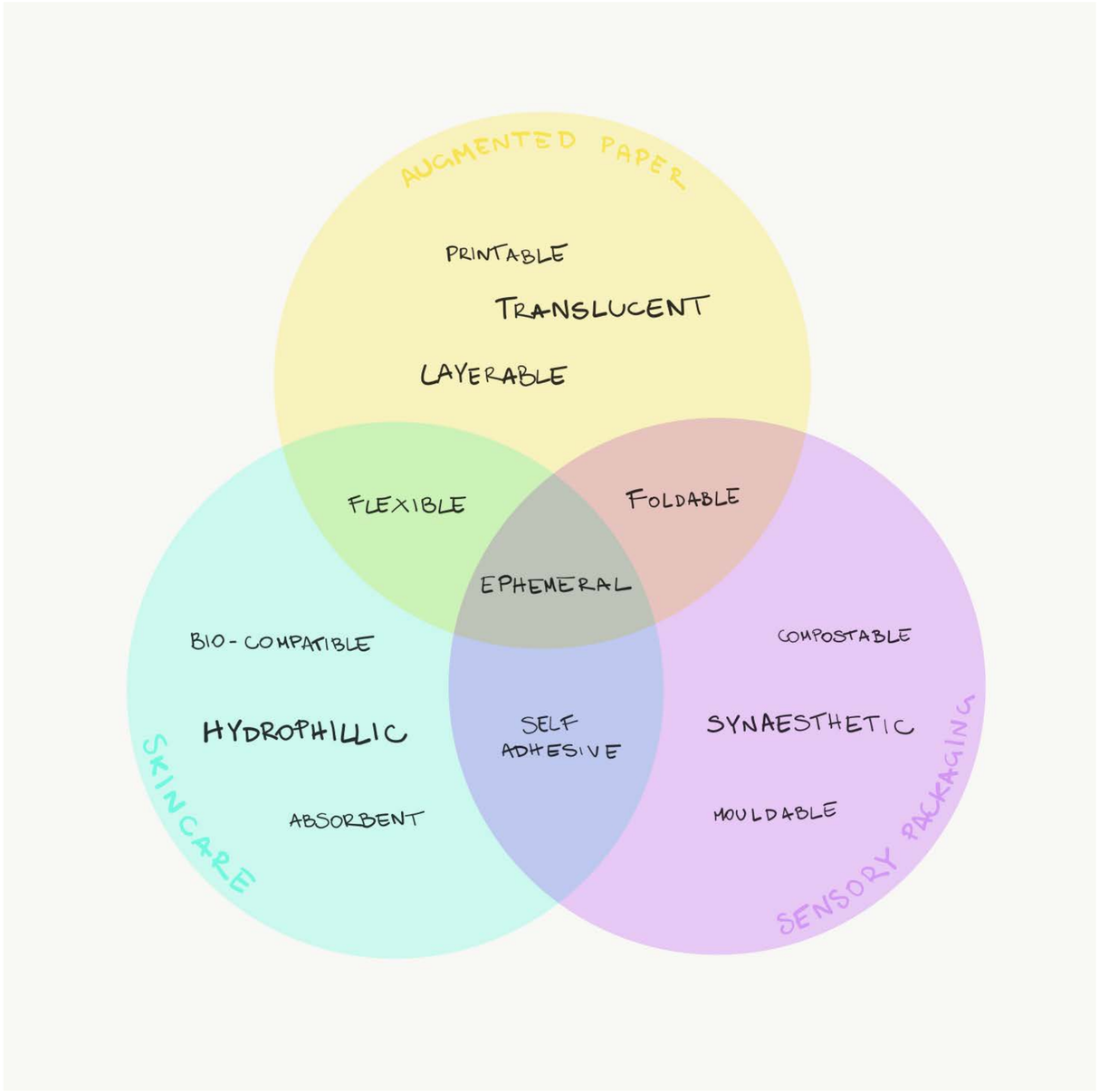
#C_04

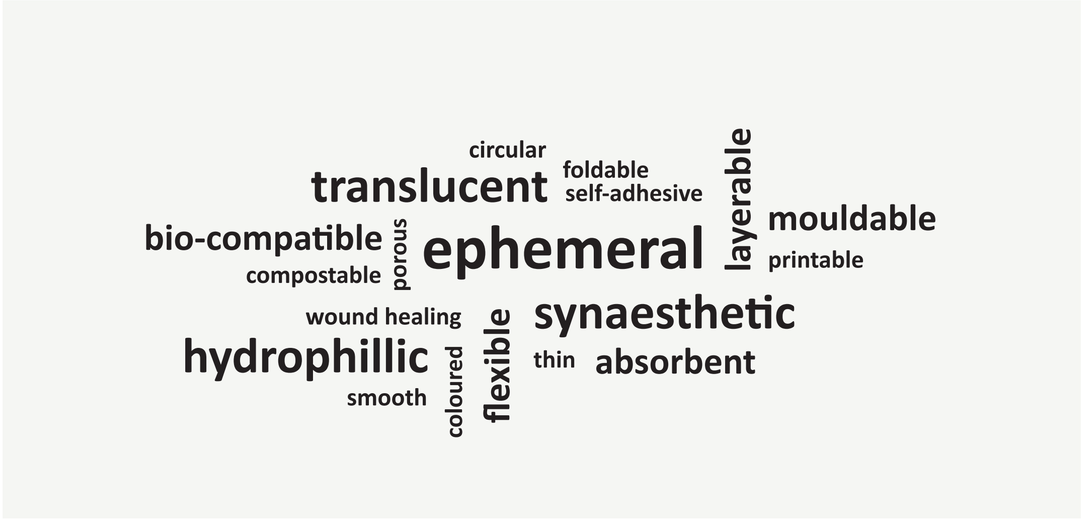
coffee grounds 35%
wet scoby pulp

rough	TOUCH	smooth
warm		cold
malleable		hard
matte	SIGHT	glossy
opaque		transparent
non-reflective		reflective
slight	SMELL	intense
sweet		acidic
pleasant		unpleasant
dull	HEARING	bright
silent		noisy
velvety		crunchy
inedible	TASTE	edible
slight		intense
sweet		acidic

fermentation - material archive

application scenario



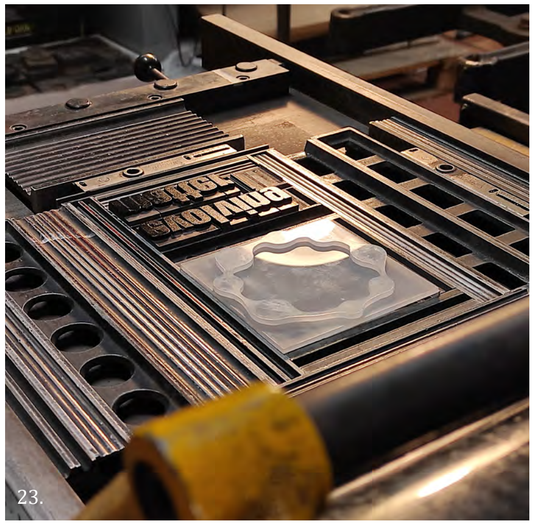


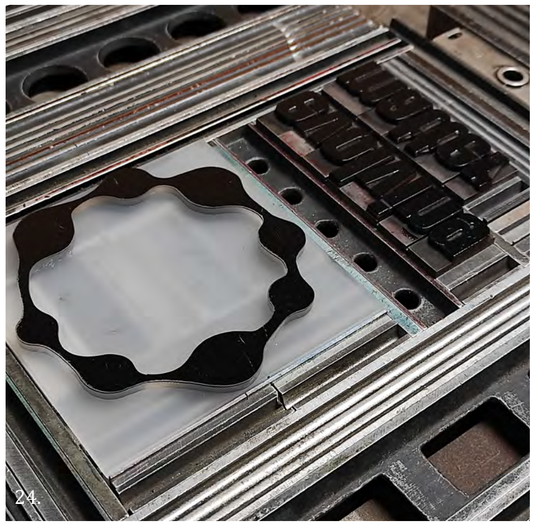
• **augmented paper**, since microbial cellulose has characteristics common to traditional paper (vegetable cellulose) plus extra features such as translucency and flexibility;

• **sensory packaging** with synesthetic features, self-adhesive and self-produced from organic waste;

• **skincare**, for its biocompatibility, absorption and wound-healing properties.

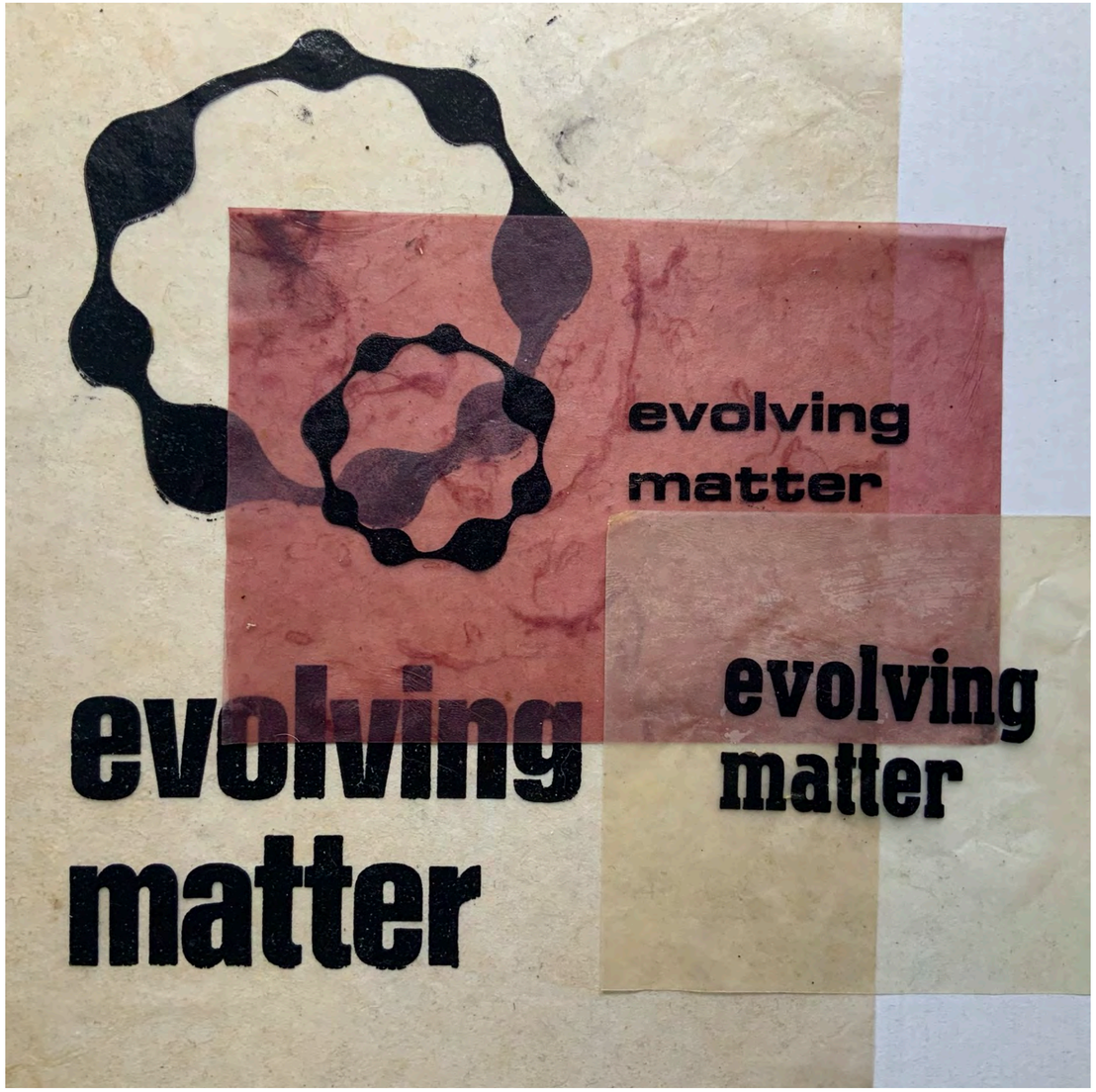
22.

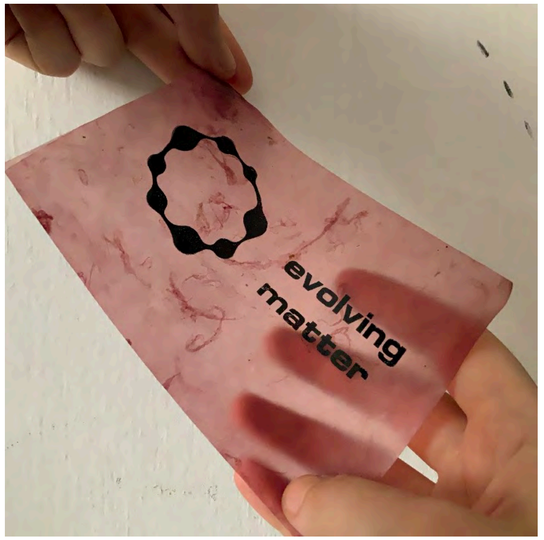

23.

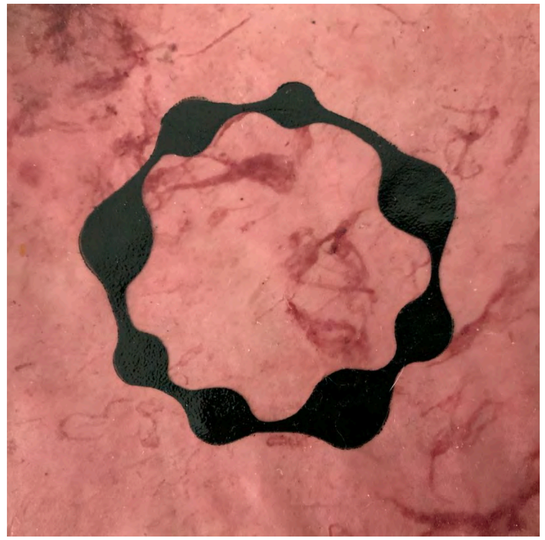

24.

25.

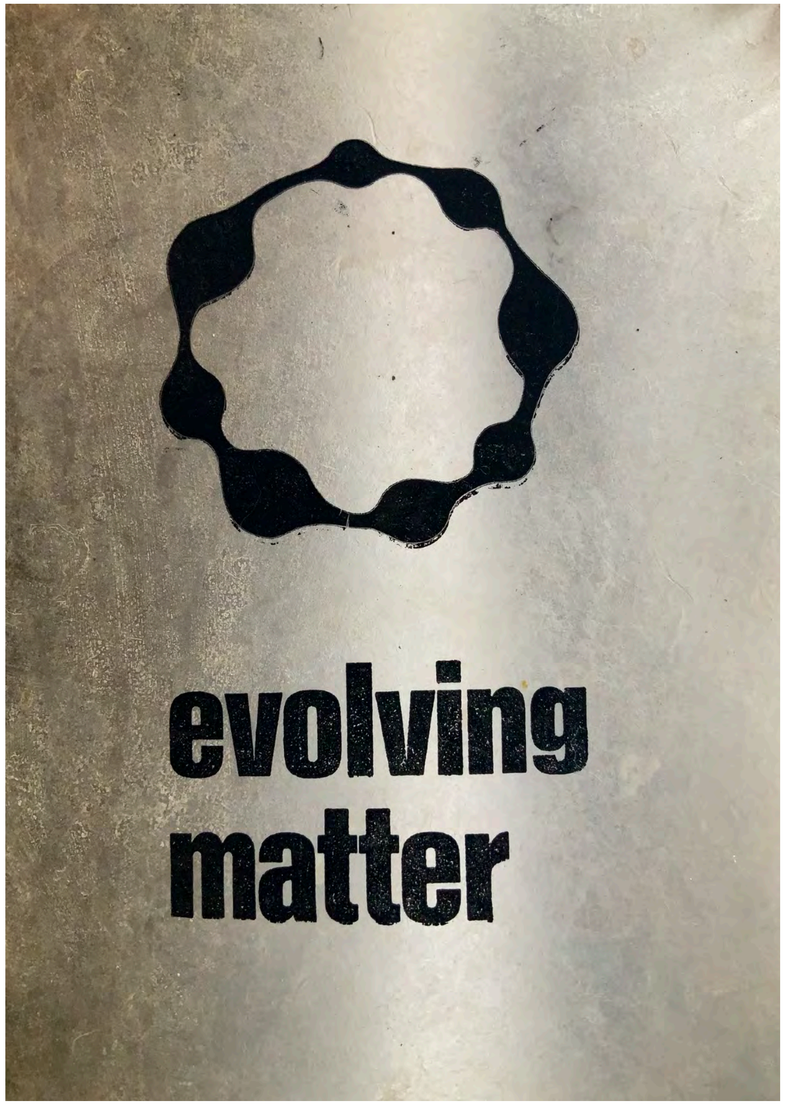
application scenario > augmented paper

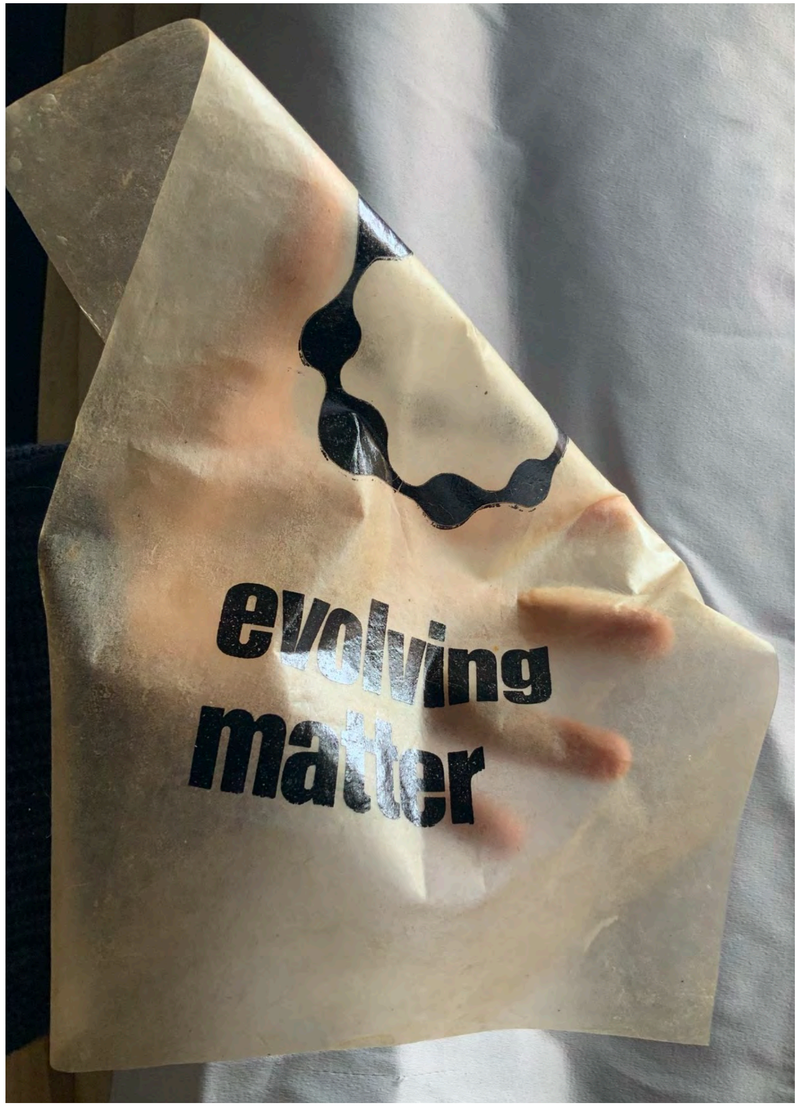




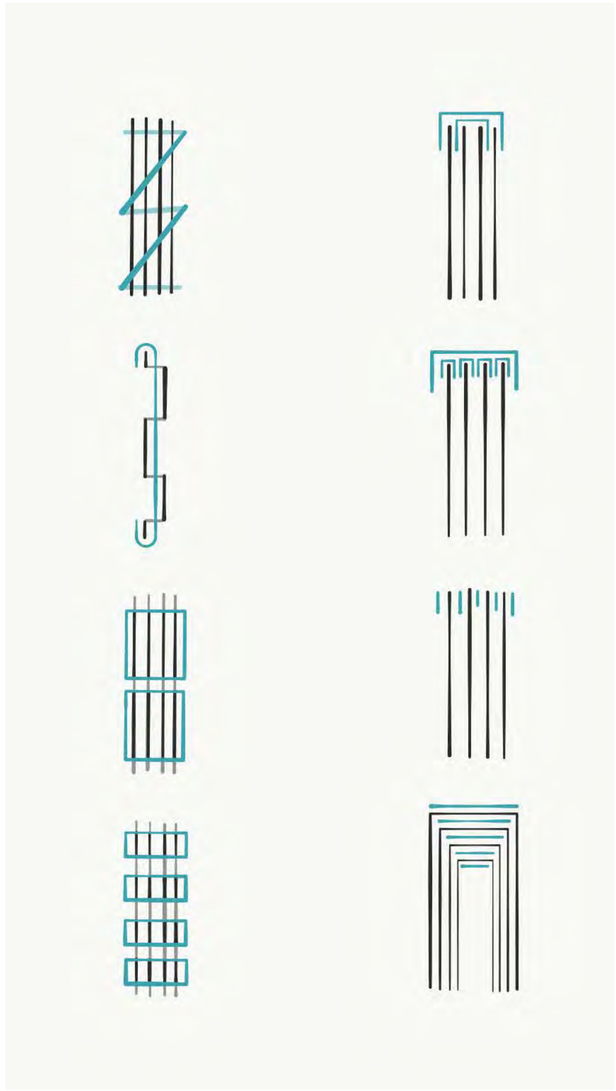


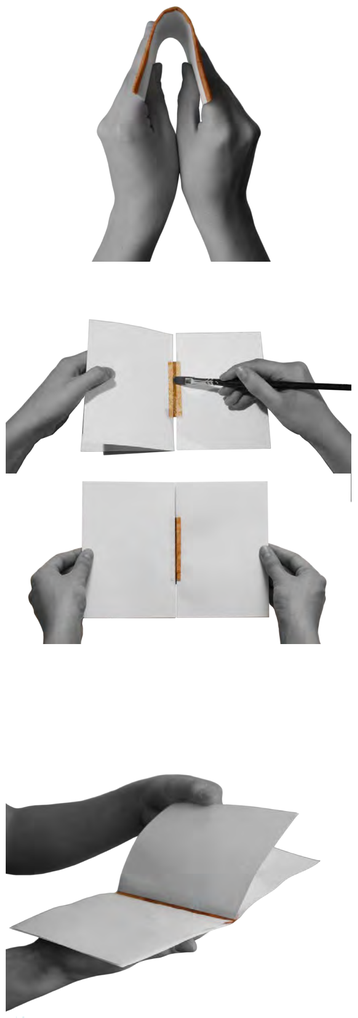
application scenario > augmented paper



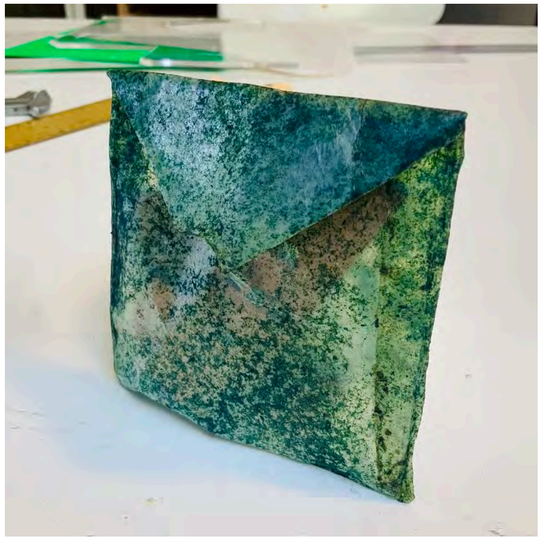


application scenario > augmented paper



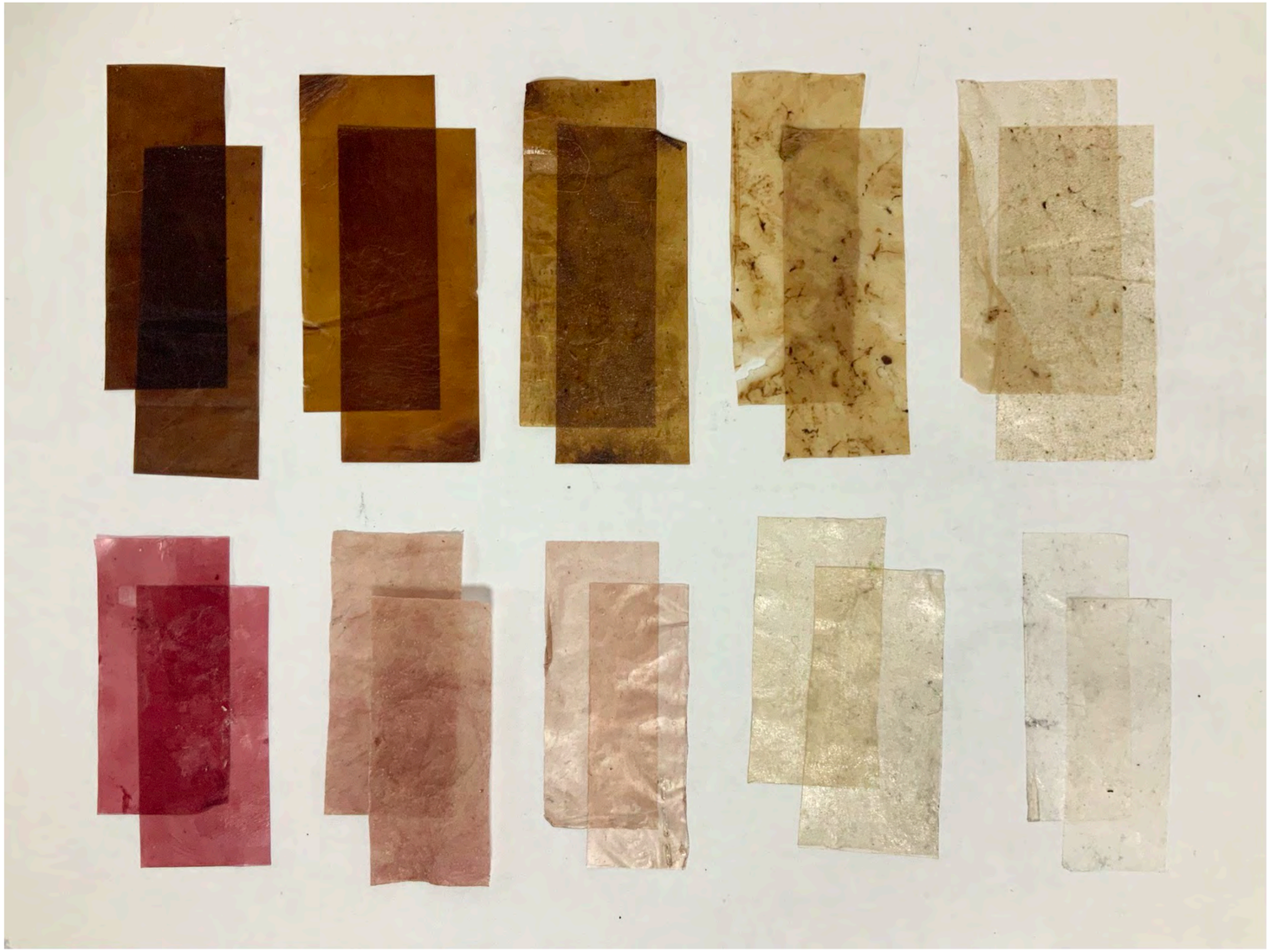


application scenario > augmented paper



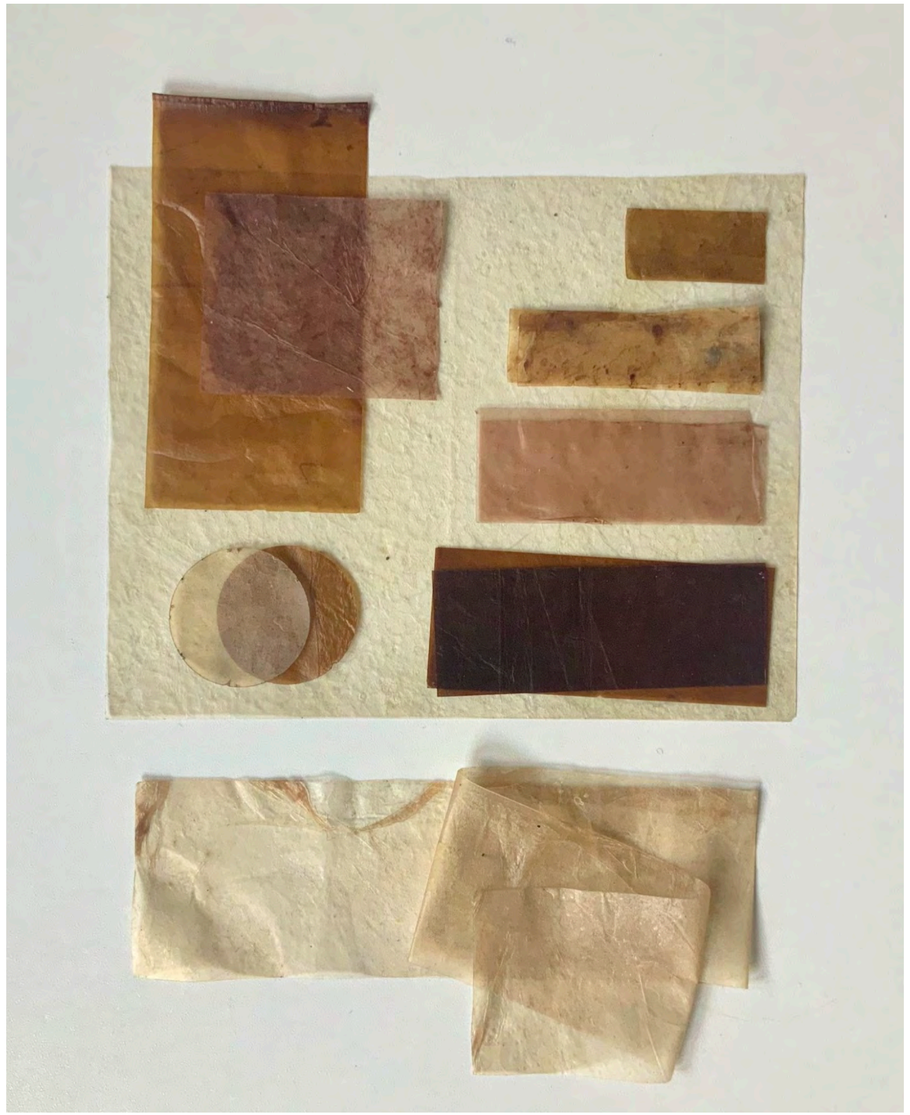
application scenario > sensory packaging

application scenario > healing second skin



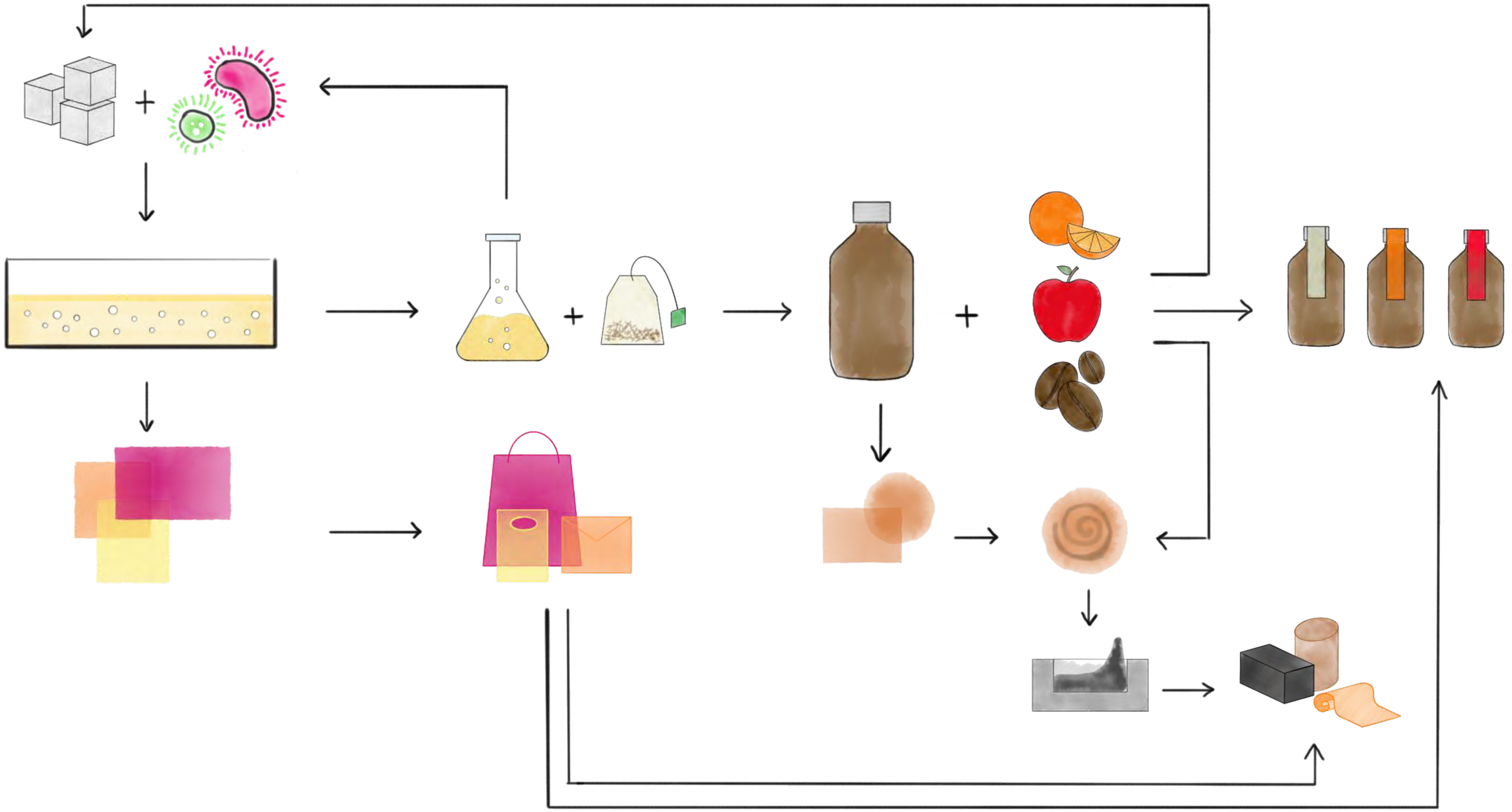
application scenario > healing second skin

application scenario > healing second skin

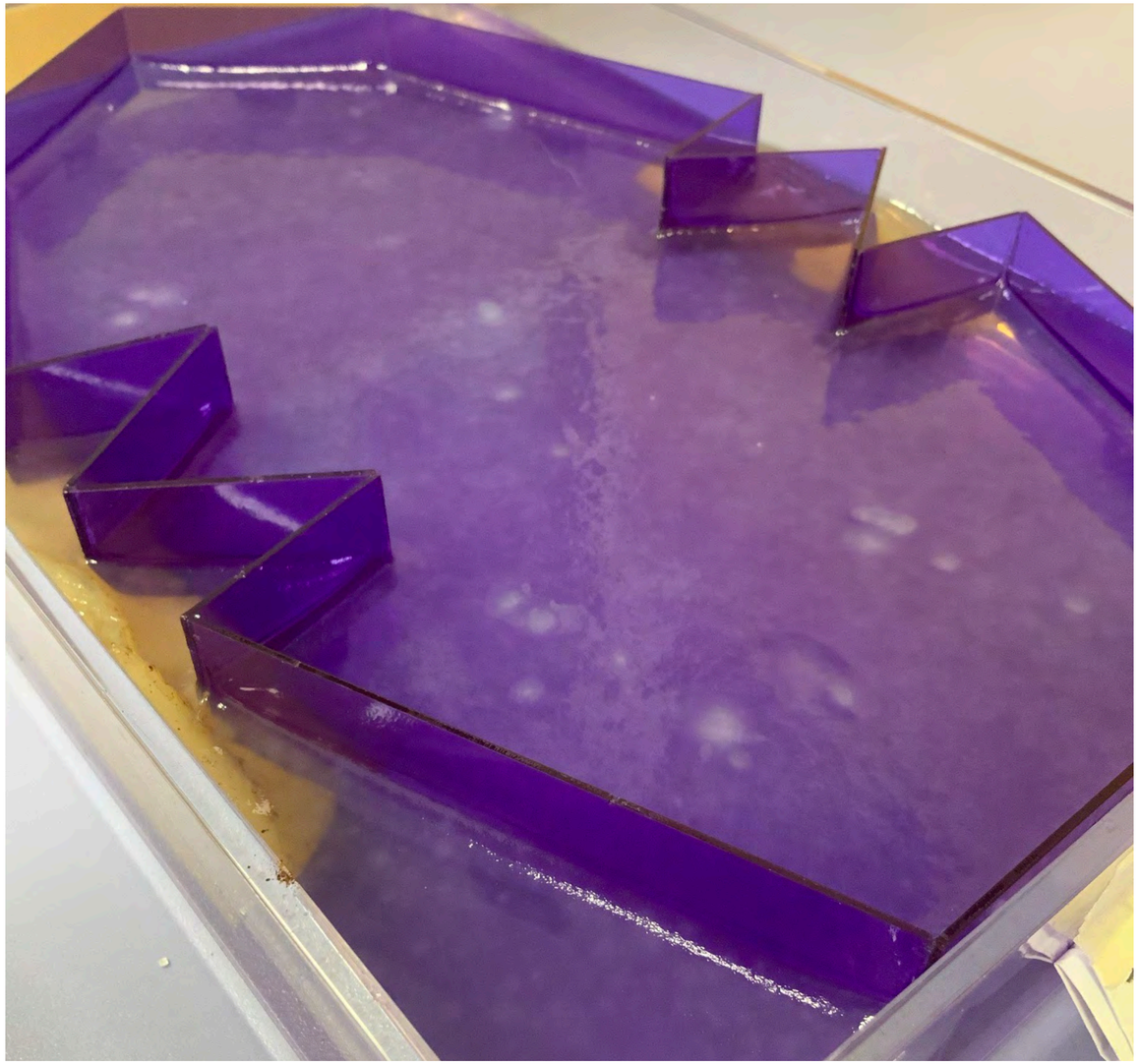


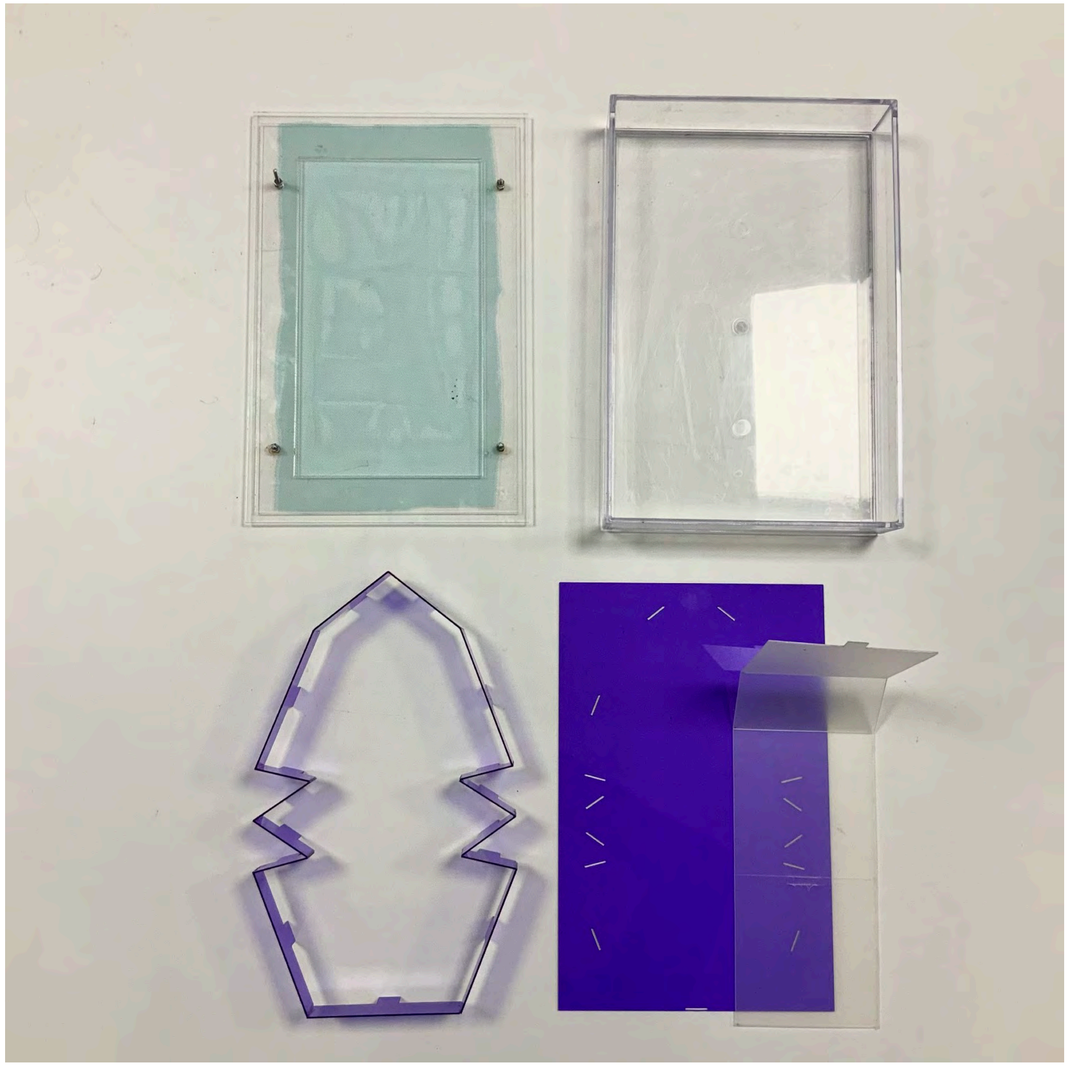
application scenario > healing second skin

diffuse micro-factory

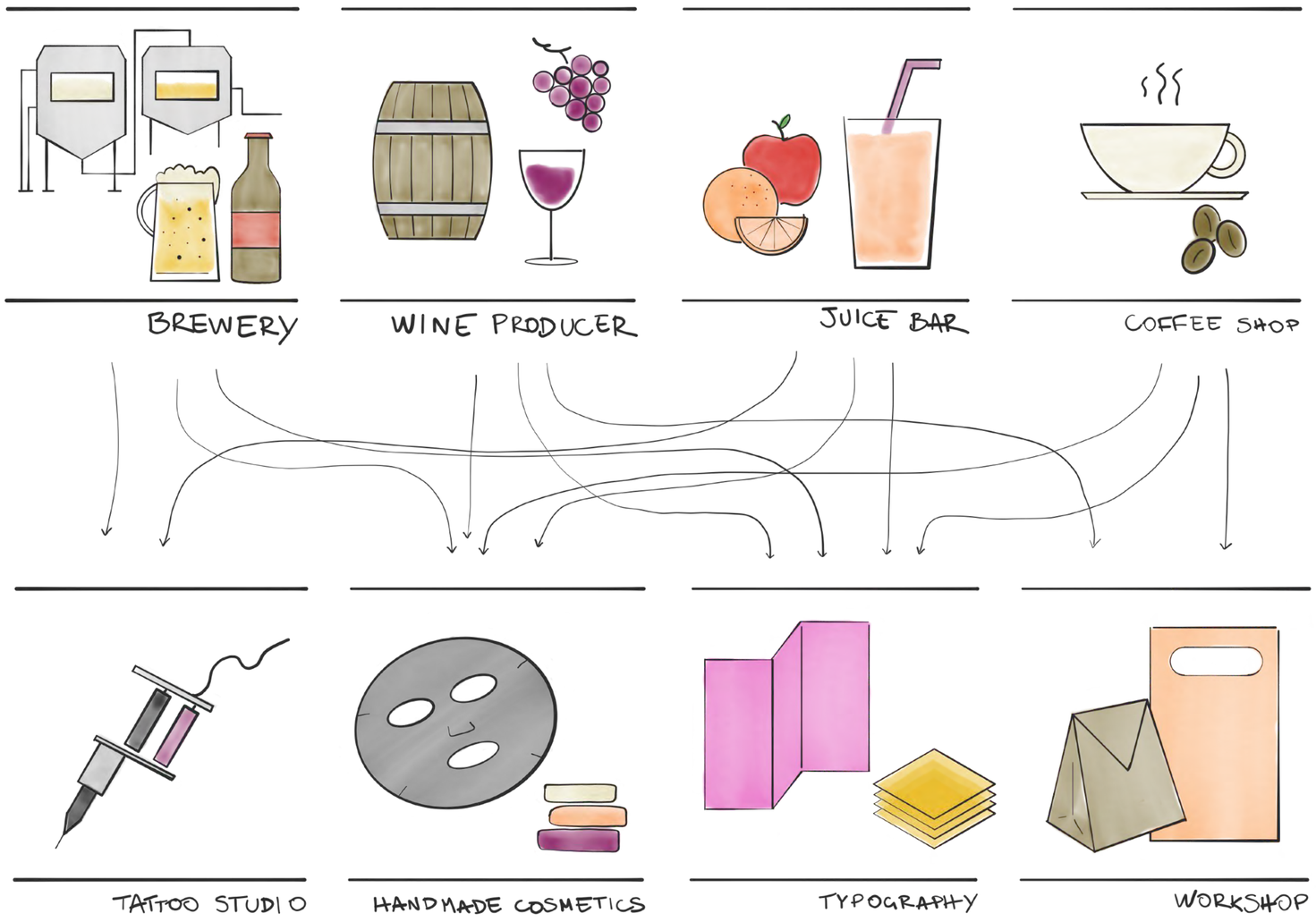


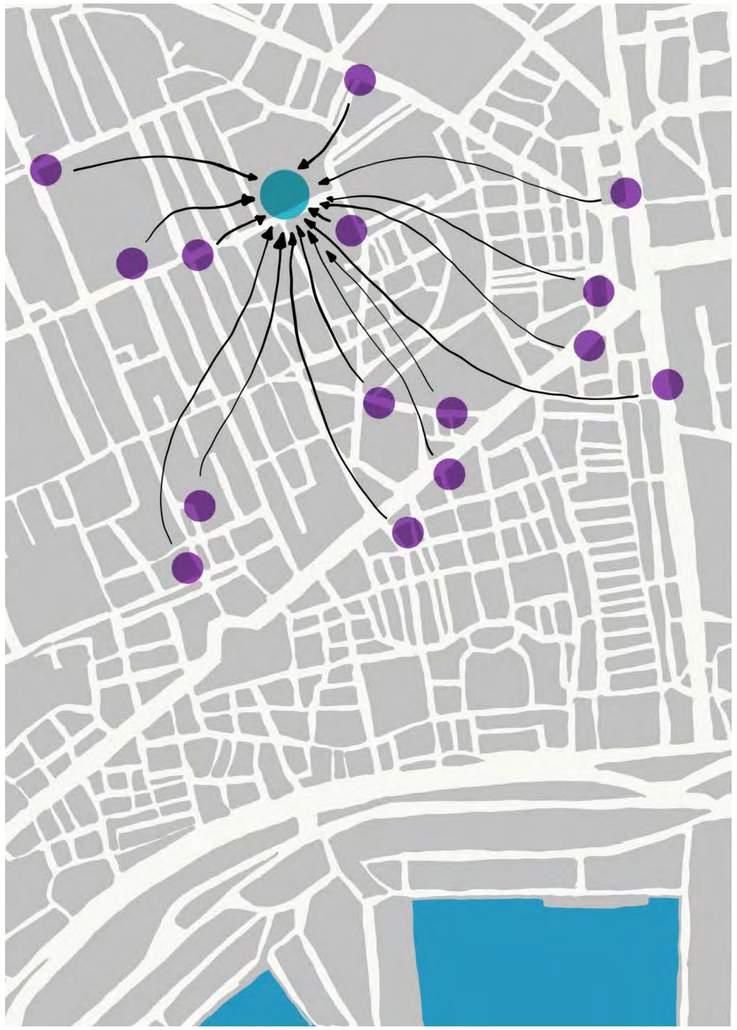
step 1. operating model for a kombucha brewery





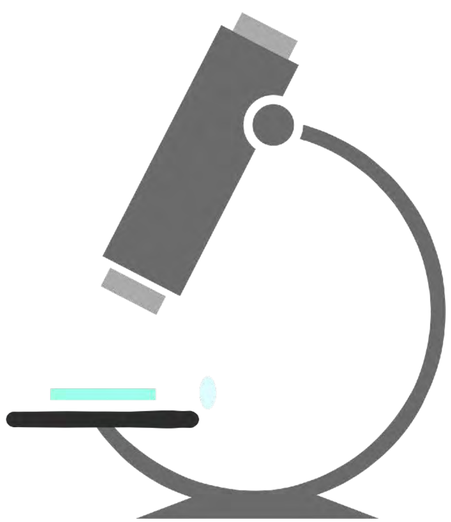
step 2. fermentation toolkit





step 3. **horizontal scaling**

CONCLUSIONS



microscope & macroscope

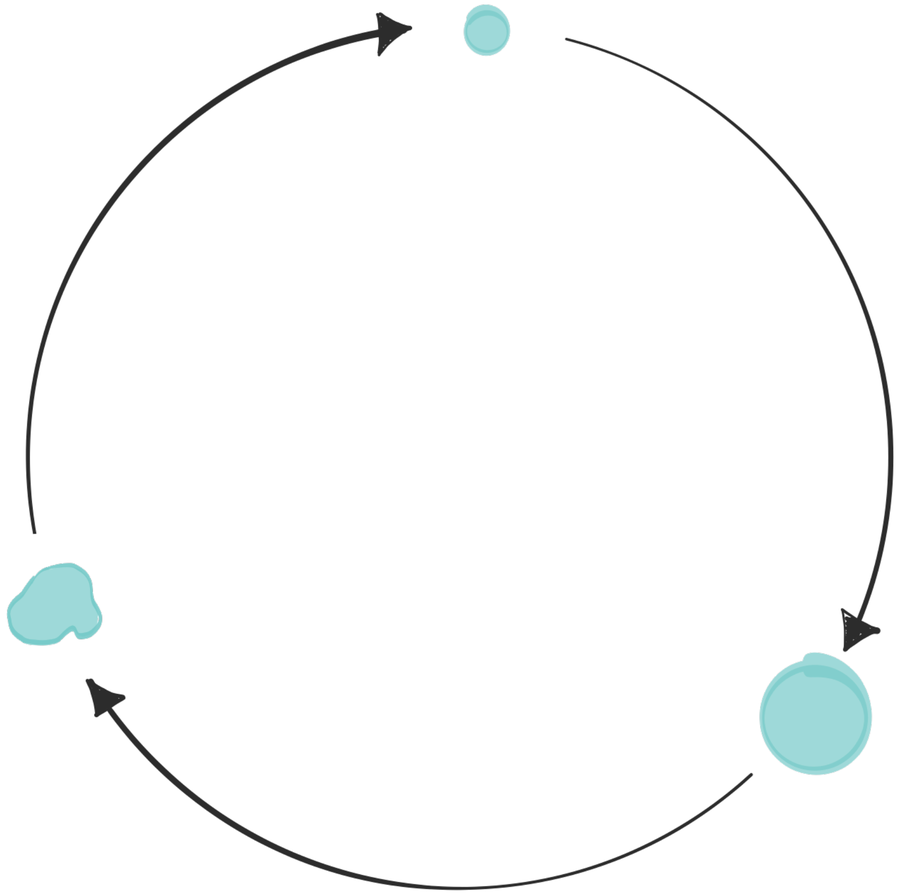
“They are both needed to see things which can escape our view: ones because too big and complex, the others, on the contrary, because too small and specific”

E. Manzini

biofabrication

technological revolution + **cultural** revolution

exploitation > collaboration



"A Micro Odyssey" - Photographs by Marco Castelli

PART III

GROW-IT-YOURSELF

MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

tools:

> container

> lid or cloth

> rubber bands, lace or tape

> scale

> pH-meter or pH-strips

> spoon/fork/something to stir

> weight

MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

ingredients:

> growth medium

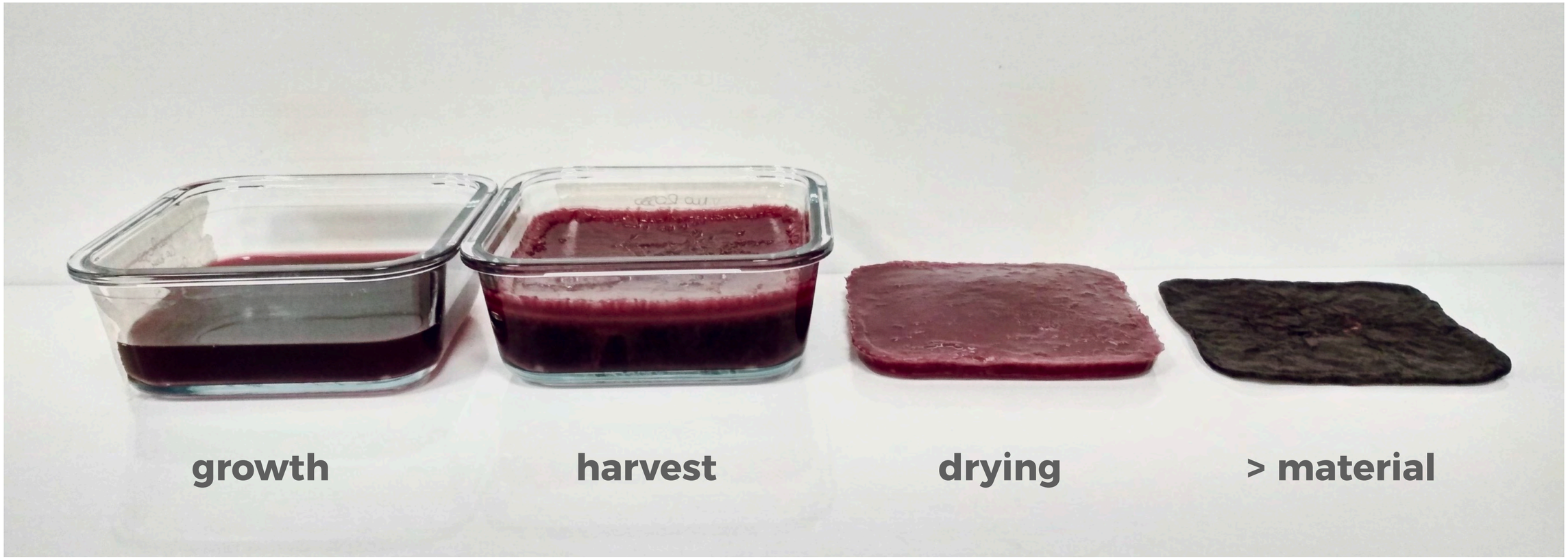
> sugar

> vinegar

> scoby starter

MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

steps:

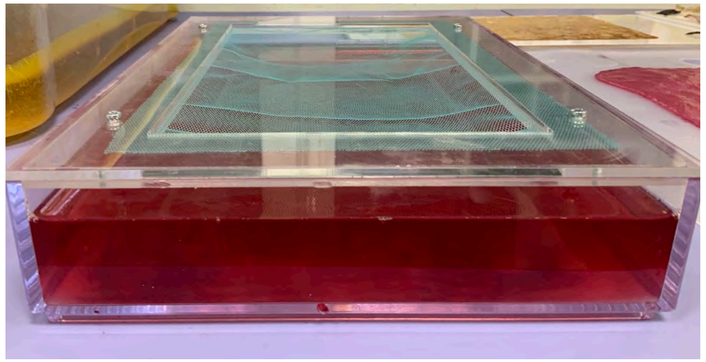


MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > GROWTH > HEATING

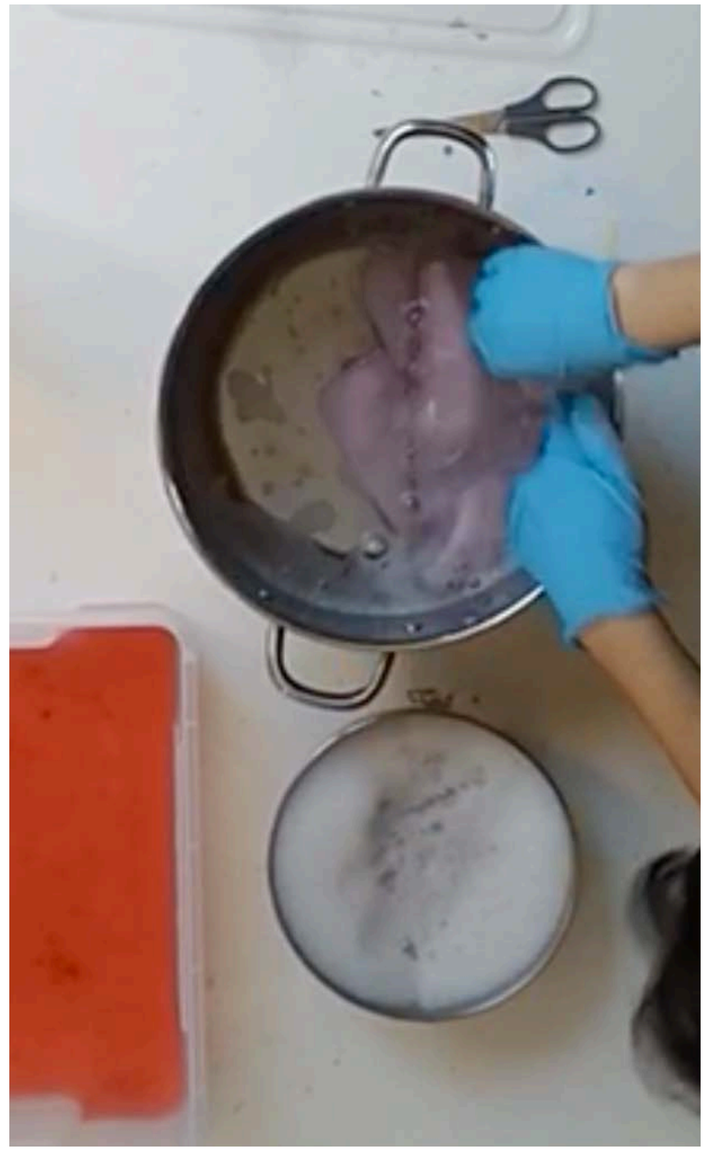
MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > GROWTH > AIR FLOW



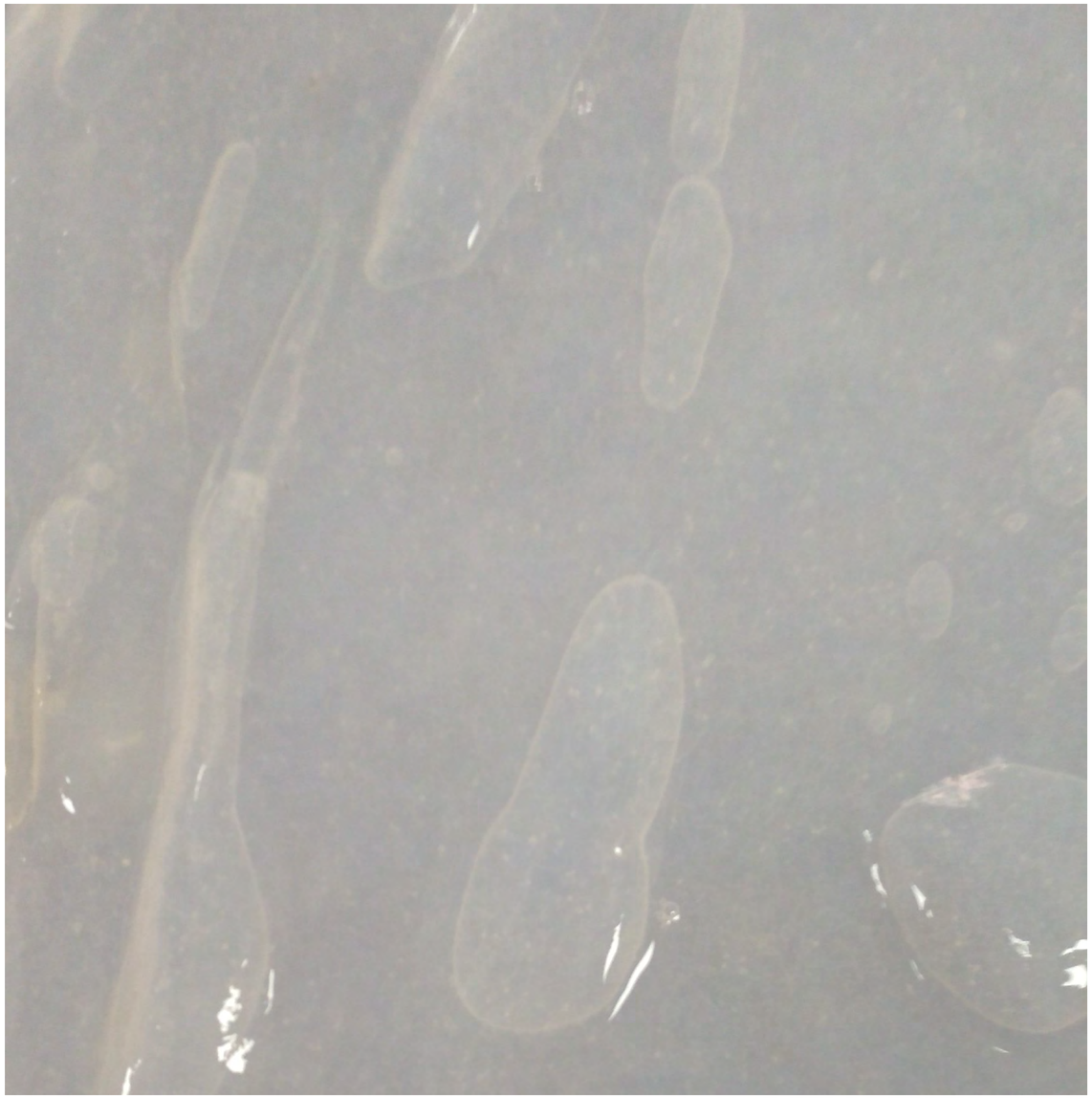
MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > HARVEST > WASHING



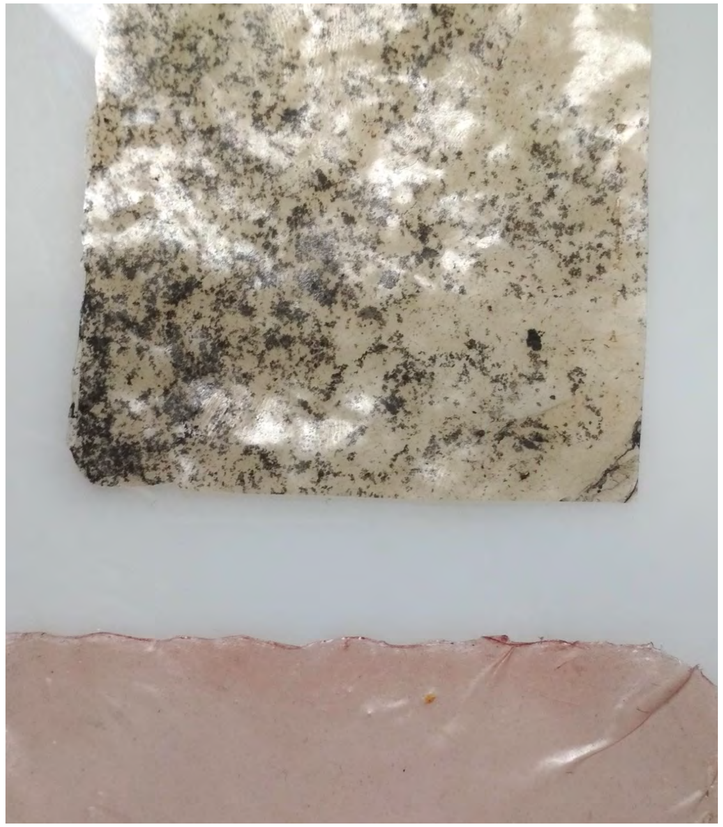
MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > DRYING > BUMPS



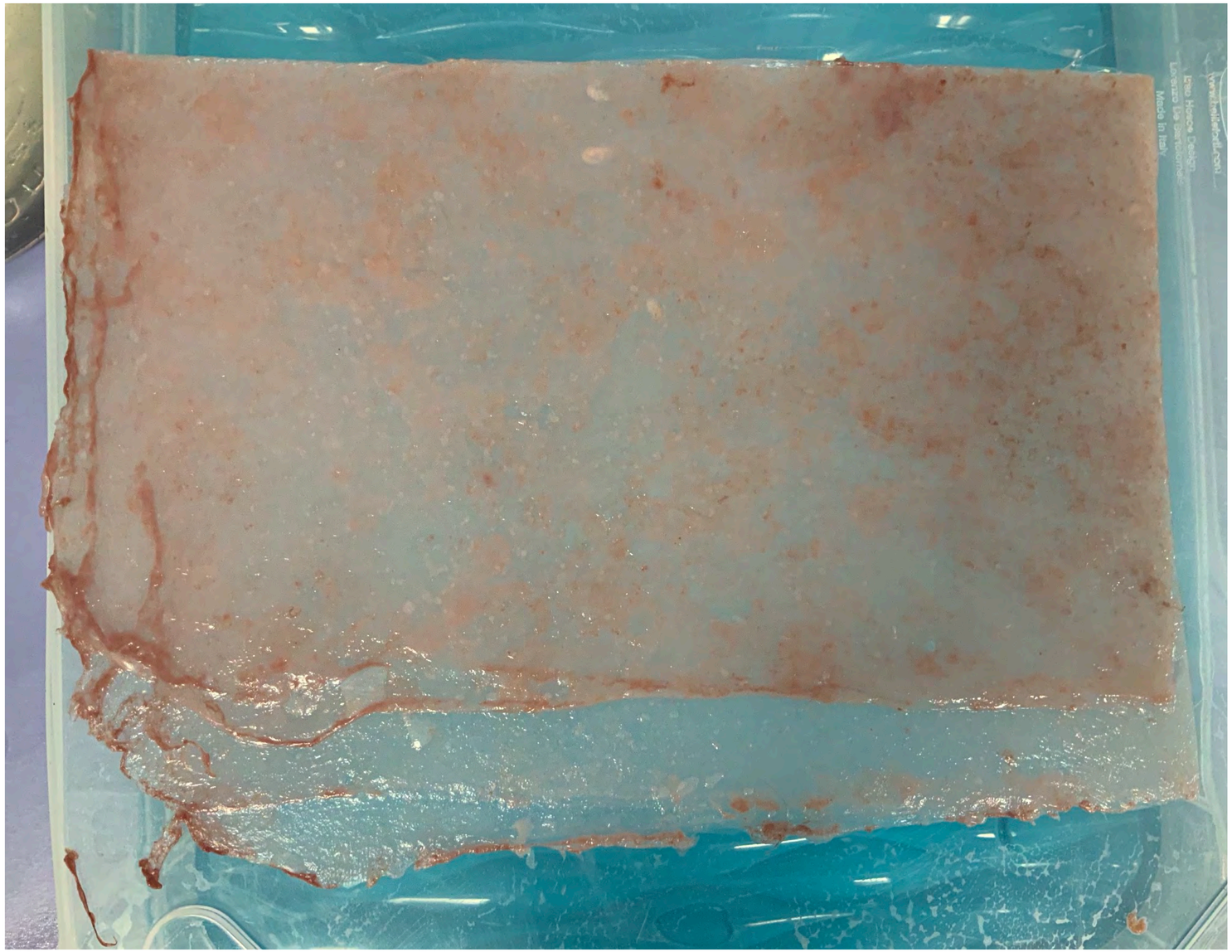
MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > DRYING > TEXTURE



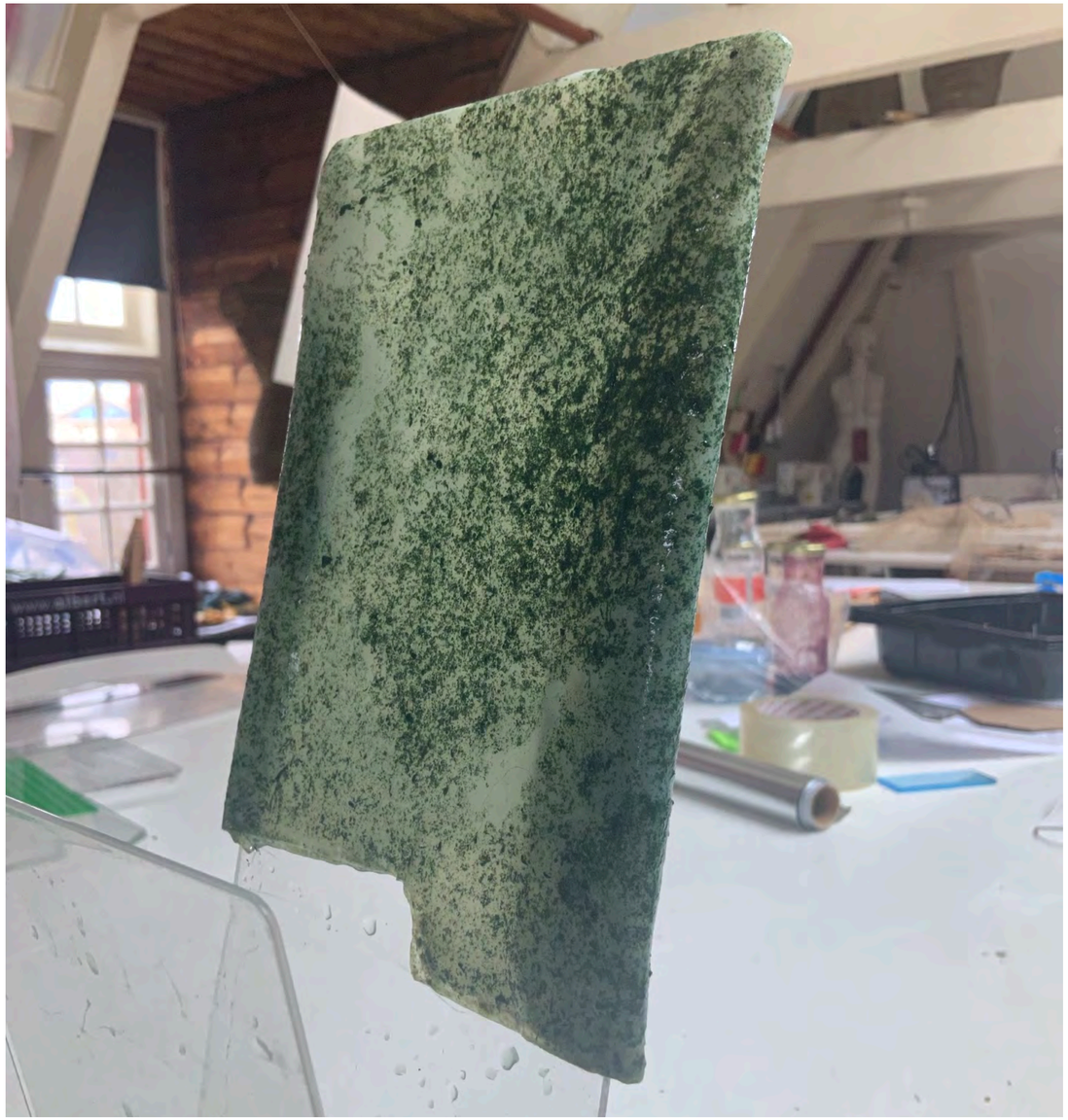
MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > DRYING > LAYERING



MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

TIPS > DRYING > SHAPING



MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

recipes

TEA:

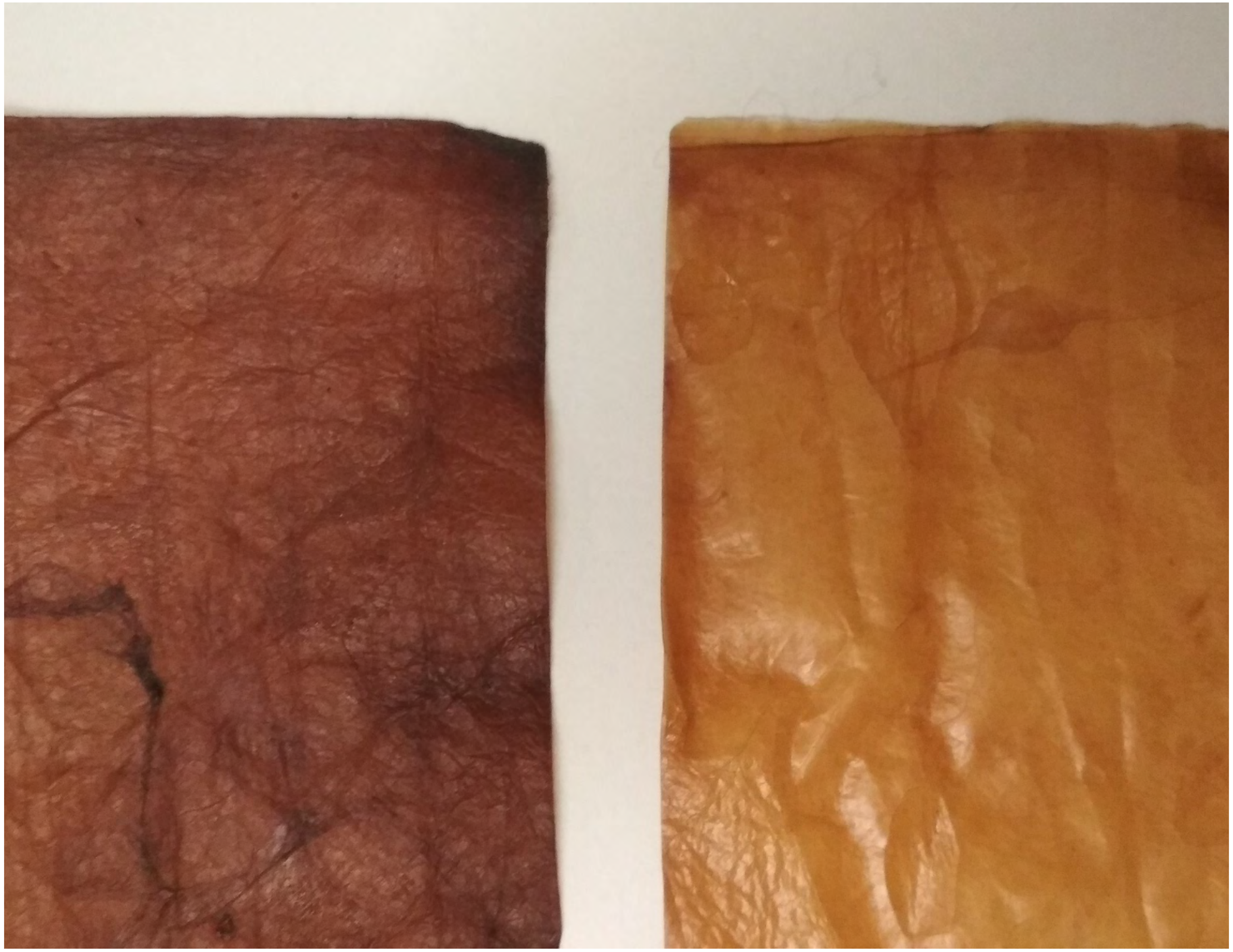
> 1 L WATER

> 3 TEABAGS

> 100 G SUGAR [10%]

> VINEGAR q.s. (for pH adjustments)

> SCOBY



MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

recipes

BEER:

> 500 ML BEER

> 500 ML WATER

> VINEGAR q.s. (for pH adjustments)

> 100 G SUGAR [10%]

> SCOBY

MICROBIAL CELLULOSE
> GROW-IT-YOURSELF

recipes

WINE:

[A]

> 0,75 L RED WINE

> 100 G SUGAR [10%]

> VINEGAR q.s. (for pH adjustments)

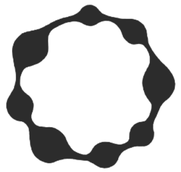
> SCOBY

[B]

> 0,75 L RED WINE

> 0,75 L SCOBY STARTER

> 150 G SUGAR [10%]



thank you

lorena.trebbi@uniroma1.it

@evolvingmatter