BIOMATERIALS

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CONTENTS

INTRODUCTION

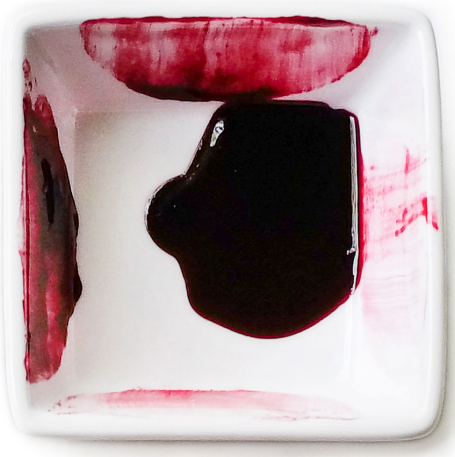
Biomaterials are pure biodegradable substances and substrates made from pure and organic plant-based elements and chemical compounds. Biomaterials can be an alternative solution to synthetic materials such as polyethylene plastic bags, toxic dyes, and composite woods made with formaldehyde. By choosing biomaterial alternatives we can: create a responsible, waste-free, ecologically friendly, and sustainable design and manufacturing practice.

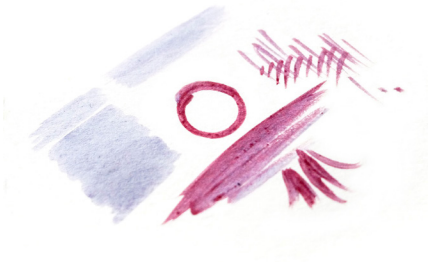
In this demonstration, I offer recipes I have made and possible fabrication techniques and applications through ways biomaterials have been employed by artists and designers.

RECIPES

INK

HIBISCUS FLOWER





TOOLS & EQUIPMENT

measuring cups / digital scale
saucepan
stirring spoon / whisk
storage container

INGREDIENTS

dried hibiscus flowers
filtered water

1. combine 64g (2.25 oz or 1/2 cup) dried hibiscus flowers with 240 ml (approximately 8 oz or 1 cup) filtered water in a saucepan
2. heat the ingredients to a boil
3. simmer for approximately 15 minutes (or until the flower petal edges turn desaturated/light pink or white)
4. remove the flowers from the liquid with a stirring spoon
5. continue to simmer the liquid for approximately 30 - 45 minutes (or until most of the water evaporates out of the mixture), stirring occasionally
6. the ideal consistency for the ink is sticky like syrup but not sticking to the pan
7. remove the liquid from the heat
8. cool the liquid to room temperature, use it straight away, or store it in an air-tight container. you can keep the ink at room temperature. it can also be refrigerated to keep for longer

* thin the ink with water or a raw non-toxic oil. Over time the ink will oxidize. to prevent oxidation from occurring, coat the media with a biomaterial.

TOOLS & EQUIPMENT

liquid measuring cup
storage container / bowl

INGREDIENTS

filtered water
ash

INK

INCENSE & SAGE ASH

1. fill a small container or bowl with the ash left over from burning incense, sage, palo santo, etc
2. fill a separate container or bowl with 3 or more milliliters of filtered water
3. slowly add water to the ash until you reach a color and viscosity that satisfies an ideal level of saturation and consistency
4. apply ink to the surface of an absorbent material with a tool or brush
5. store ink in a sealed container

* you can also thin the ash with a raw non-toxic oil to achieve a different color, texture, and consistency.

INK

SPIRULINA

TOOLS & EQUIPMENT

liquid measuring cup
storage container / bowl

INGREDIENTS

filtered water
finely ground spirulina powder

1. fill a small container or bowl with 3 grams of finely ground spirulina powder
2. fill a separate container or bowl with 3 or more milliliters of filtered water
3. slowly add water to the spirulina powder until you reach a color and viscosity that satisfies an ideal level of saturation and consistency
4. apply ink to the surface of an absorbent material with a tool or brush
5. store ink in a sealed container

* over time the ink will oxidize green to blue.

TOOLS & EQUIPMENT

liquid measuring cup
digital scale / measuring spoon
storage container / bowl
stirring spoon
saucepan with lid
strainer

INGREDIENTS

filtered water
turmeric powder

DYE

TURMERIC ROOT

1. combine 5 grams of turmeric root with 3 liters of water in a saucepan
2. cover and heat for 15 minutes on a medium setting
3. remove the saucepan from heat and cool the dye to room temperature
4. you can make this recipe in batches. try varying the quantity of turmeric or water in the recipe to get a weaker or more concentrated solution. you can use the dye straight away. you could also store it in a clean jar or glass for up to 3 days at room temperature. you can keep this in the fridge if you want to keep it longer. you can even freeze the dye once it is at room temperature. you substitute this dye for water in a biomaterial recipe.

TOOLS & EQUIPMENT

liquid measuring cup
digital scale / measuring spoon
storage container / bowl
stirring spoon
saucepan with lid
strainer

INGREDIENTS

filtered water
butterfly pea flower

DYE

BUTTERFLY PEA FLOWER

1. combine 13 grams of dried butterfly pea flowers with up to 3 liters of water in a saucepan
2. cover and heat for 15 minutes on a medium/low setting
3. remove the cover
4. press the flowers against the edge of the pot with the back of a stirring spoon to release additional pigment. press as much as you would like until the flowers turn white
5. remove the flowers with the stirring spoon, or strain the dye
6. you can make this recipe in batches. depending on the amount of pigment in the flowers, you might be able to get a larger quantity of dye. try varying the number of flowers or water in the recipe to get a weaker or more concentrated solution. you can use the dye straight away. you could also store it in a clean jar or glass for up to 3 days at room temperature. you can keep this in the fridge if you want to keep it longer. you can even freeze the dye once it is at room temperature. you substitute this dye for water in a biomaterial recipe.

TOOLS & EQUIPMENT

liquid measuring cup
digital scale / measuring spoon
storage container / bowl
stirring spoon
saucepan with lid
strainer

INGREDIENTS

filtered water
hibiscus flowers

DYE

HIBISCUS FLOWER

1. combine 13 grams of dried hibiscus flowers with up to 3 liters of water in a saucepan
2. cover and heat for 15 minutes on a medium/low setting
3. remove the cover.
4. press the flowers against the edge of the pot with the back of a stirring spoon to release additional pigment. press as much as you would like until the flowers turn white
5. remove the flowers with the stirring spoon, or strain the dye
6. you can make this recipe in batches. depending on the amount of pigment in the flowers, you might be able to get a larger quantity of dye. try varying the number of flowers or water in the recipe to get a weaker or more concentrated solution. you can use the dye straight away. you could also store it in a clean jar or glass for up to 3 days at room temperature. you can keep this in the fridge if you want to keep it longer. you can even freeze the dye once it is at room temperature. you substitute this dye for water in a biomaterial recipe.

BIOPLASTIC

RAW GUAR GUM

TOOLS & EQUIPMENT

mold
liquid measuring cylinder
water dropper / pipette
degasser
liquid measuring cup
storage container / bowl

INGREDIENTS

840ml filtered water
8g organic guar gum powder
5ml organic glycerin

1. combine water, glycerin, and guar gum powder in a blender
2. blend until smooth
3. pour the mixture into a degasser and degas for approximately 1-2 minutes to remove bubbles
4. transfer the mixture into a mold or dehydrator tray
5. dehydrate at 40° C for 1-2 days
6. remove bioplastic from mold or dehydrator tray and use it straight away. you can also prepare another batch of bioplastic and pour it over the dehydrated bioplastic and dehydrate it again to create a thicker material

* this bioplastic will stick to other materials when wet.




BIOPLASTIC

HIBISCUS FLOWER AGAR

TOOLS & EQUIPMENT

mold
liquid measuring cylinder
water dropper / pipette
degasser
liquid measuring cup
storage container / bowl

INGREDIENTS

8g organic agar powder
5ml organic glycerin
840ml hibiscus flower dye [p.15]

1. combine hibiscus flower dye, glycerin, and agar powder in a saucepan
2. stir ingredients until the agar dissolves
3. heat the mixture to 95° C (just before boiling), gently stirring without creating bubbles the entire time
4. remove the liquid from the heat
5. let liquid cool at air temperature for 5-10 minutes
6. slowly and carefully pour 3-8mm of liquid into a mold or dehydrator tray and pop any air bubbles with a pin or toothpick
7. dehydrate the plastic at 35° C for 1-2 days, or air dry for 3-4 days

★ to prevention mold growth on air-dried bioplastic, you can spray a solution of 3-parts water, 1-part vinegar, and a few drops of peppermint essential oil on the top as it dries.

BIOPLASTIC

CHAMOMILE FLOWER AGAR

1. combine chamomile flower dye*, glycerin, and agar powder in a saucepan
2. stir ingredients until the agar dissolves
3. heat the mixture to 95° C (just before boiling), gently stirring without creating bubbles the entire time
4. remove the liquid from the heat
5. let liquid cool at air temperature for 5-10 minutes
6. slowly and carefully pour 3-8mm of liquid into a mold or dehydrator tray and pop any air bubbles with a pin or toothpick
7. dehydrate the plastic at 35° C for 1-2 days, or air dry for 3-4 days

* to prevent mold growth on air-dried bioplastic, you can spray a solution of 3-parts water, 1-part vinegar, and a few drops of peppermint essential oil on the top as it dries

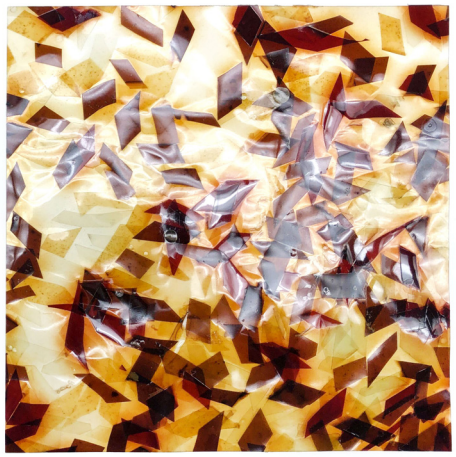
to create chamomile dye, replace hibiscus flowers with chamomile flowers in the dye recipe on [p.15].

TOOLS & EQUIPMENT

mold
liquid measuring cylinder
water dropper / pipette
degasser
liquid measuring cup
storage container / bowl

INGREDIENTS

8g organic agar powder
5ml organic glycerin
840ml chamomile flower dye [p.15]



BIOPLASTIC

SCRAP AGAR

1. combine filtered water, glycerin, and agar powder in a saucepan
2. stir ingredients until the agar dissolves
3. heat the mixture to 95° C (just before boiling), gently stirring without creating bubbles the entire time
4. remove the liquid from the heat
5. let liquid cool at air temperature for 5-10 minutes
6. fill a mold or dehydrator tray with scrap bioplastic. slowly and carefully pour 3-8mm of liquid on top and pop any air bubbles with a pin or toothpick
7. dehydrate the plastic at 35° C for 1-2 days, or air dry for 3-4 days

★ to prevent mold growth on air-dried bioplastic, you can spray a solution of 3-parts water, 1-part vinegar, and a few drops of peppermint essential oil on the top as it dries.

TOOLS & EQUIPMENT

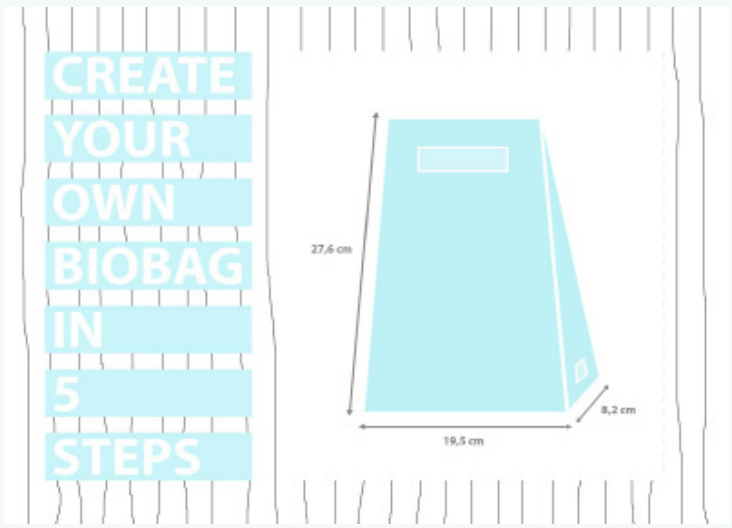
mold
liquid measuring cylinder
water dropper / pipette
degasser
liquid measuring cup
storage container / bowl

INGREDIENTS

840ml filtered water
8g organic agar powder
5ml organic glycerin
scrap bioplastic

APPLICATIONS

In addition to hand processing biomaterials through traditional methods like scoring, folding, cutting, casting, sewing, and gluing, architects, designers, artists, and chefs are employing rapid manufactured biomaterials in their creative practices. Included in this section are several examples of employed biomaterials.

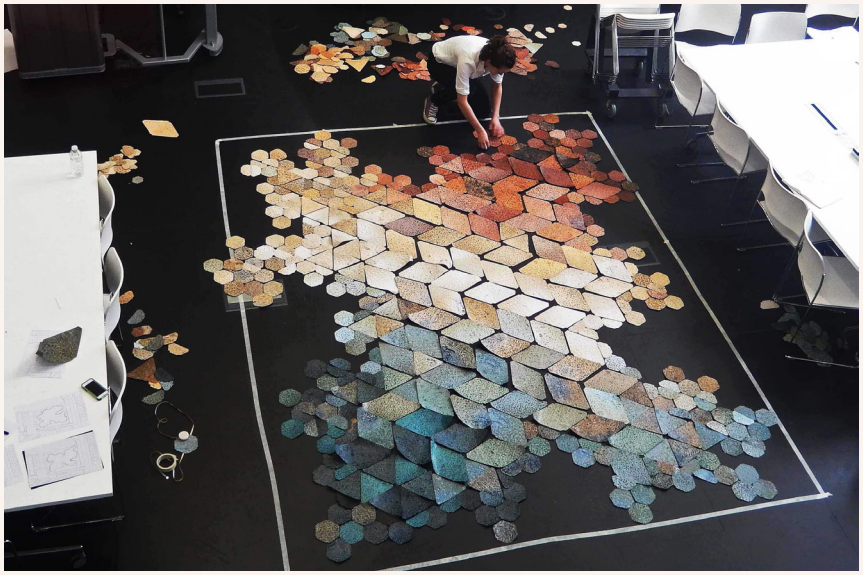


CLARA DAVIS

Independent Artist and Textile Designer Clara Davis is one of several who has worked with bioplastic to re-envision traditional petroleum-based plastic objects into biodegradable alternatives. Biobag is an open-source material recipe and bag pattern available online for anyone to resource for the creation of their biobag. Davis' biomaterial recipe combines water, glycerol, and gelatin. After cooking the ingredients, the bioplastic is dried for one week to dry.

LIONNE VAN DEURSEN

Bacterial cellulose sheets are folded into beautifully crisp tessellating patterns in *Unfold*, a series of biofilm studies conducted by dutch designer Lionne Van Deursen. The designer says, “It’s biodegradable, strong, has a high flexibility, and can easily be shaped and folded in any desired shape” (Van Deursen, 2020). By exploring relief surfaces and 3-dimensional objects, Van Deursen demonstrates the material’s malleability and stability while leaving room for a creative mind to feast on the possibilities.



HANNAH ELISABETH JONES

Multidisciplinary Artist and Designer Hannah Elisabeth Jones creates innovative textiles through which she expresses her interest in natural materials and passion for developing an ethical ecologically-sensitive art object. BioMarble, patent-worthy material, has an intriguing surface texture and pattern, but most important is the inclusion of waste-paper material as aggregate. Jones creates the BioMarble by stitching an ombre of naturally dyed bioplastics into a 3-Dimensional tessellation.

PIÑATEX

“Take time for reflection before action.”

Developed by Dr. Carmen Hijosa, Piñatex is a non-biodegradable plant-based leather made from cellulose fibers extracted from pineapple leaves, PLA, and petroleum-based resin. Sustainably manufactured in the Philippines through a partnership with Dole Speciality, waste generated from pineapple processing is harvested and upcycled into a luxury fabric and then shipped to Italy or Spain for specialized finishing.

“Working closely with the Dole Speciality Ingredients team on the ground helps us to create a wider positive social impact among farming communities and to continuously reduce our environmental footprint by valorising waste at scale.” (Ananas Anam 2021 Sustainability Report)

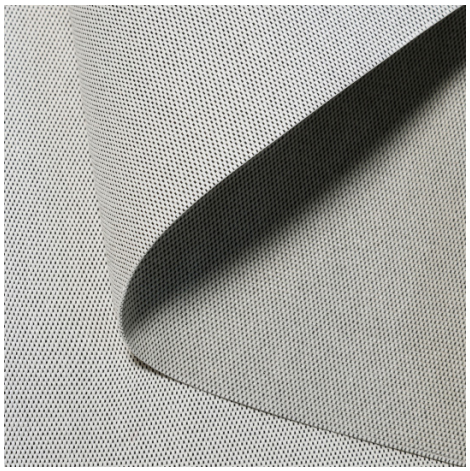
Artists and designers have employed this plant leather in practice for garments, luggage, and furniture.

Rich throughout the culture of Ananas Anam and embedded in the fibers of Piñatex is mindfulness in action. The fabric asks one to consider, “have we considered every aspect of what we are creating?” and “How can we more mindfully utilize all aspects of our resources?”

BOHEMA

Bohema designers Wiola and Sebastian work together to create streetwear dressed in innovative plant materials. Several of their shoes feature vegetable leather such as Piñatex pineapple leather, apple leather, or Vegan grape leather. Their products are exquisitely crafted, materially innovative and contemporary, and timeless in design.

BANANATEX®



Bananatex® is a durable, technical fabric made from the Abaca banana plant's cellulose fibers. Abaca banana plants are self-sufficient, require no pesticides, fertilizer, or extra water, and are sustainable to harvest in the Philippine highlands. Bananatex® fabric came through material research and development by the design team known as QWSTION. QWSTION, founded by Swiss designers Christian Kaegi, Matthias Graf, and Hannes Schoeneggerf, focuses on and creates durable, sustainable, and ethically produced products.

INUIKII

Inuikii designers have featured Abaca Bananatex® in their sneaker designs “Abaca Black” and “Abaca White.” These shoes feature Bananatex® outer construction and a non-slip eco-rubber 100% recycled rubber sole. Inuikii founder Cinzia Maag, focuses on creating pieces to feel stylish and comfortable, but most importantly, pieces that create an individual personal fashion statement that is all their own. “Aesthetics is my passion and what I adore” - Cinzia Maag (inuikii, 2022).

RESOURCES

Bananatex®

Clara Davis

Green Chemistry Principes

Hannah Elisabeth Jones

Inuikii

Lionne Van Deursen

Materiom

Piñatex

Stevens, E. (2002). Green Plastics: An Introduction to the New Science of Biodegradable Plastics Princeton University Press

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