



Kombucha Leather

Why Kombucha Leather?

Leather from animals is an increasingly problematic material in terms of sustainability. The global livestock industry is a major contributor to greenhouse gas emissions and the tanning of hides for leather uses many toxic chemicals and large quantities of water. There is also the issue of animal welfare. Many people choose not to buy leather items because of their love of animals or because they are vegan (a person who does not eat or use animal products).

Microbial leather is a potential substitute for animal leather and can be sustainably produced by growing microbes (a Symbiotic Community Of Bacteria and Yeast, also known as a SCOBY) in a solution of tea, sugar and apple cider vinegar.

This is the same recipe used for the health drink kombucha, but in this process, only the skin (not the liquid) produced by the SCOBY, is harvested, dried and used as a leather alternative. Biofabricated materials like microbial (kombucha) leather can be grown in infinite amounts as long as provided with sufficient food. This is a generative material, unlike steel or plastic whose ingredients must be extracted from the ground as ore or oil, which only exist in limited amounts and whose production is energy intensive with many negative effects on the environment such as climate change and pollution.

Creating a Design Statement

What might you create using your microbial leather?

Some ideas might be clothing, lampshades, drawing material, origami, or sculptures. Microbial leather can be folded, cast over forms when damp, dyed, drawn on, sewn and bonded together by moistening it. One of the unsolved problems with microbial leather is that it isn't waterproof. (See the link to Susanne Lee's video below in Key References) Can you come up with a way of solving this?

Health & Safety:

All ingredients in this lab are safe to use, however it is important to follow a sterile protocol so as not to contaminate the microbial leather culture with unintended organisms such as mold. So it is necessary to use the disposable gloves or freshly washed hands when preparing the experiment and handling the SCOBY. If there are visible signs of mold contamination in the culture, the liquid and SCOBY should be discarded, the container thoroughly cleaned and the experimented restarted with a new SCOBY and freshly brewed tea/sugar/vinegar solution.

Kombucha Leather Step by Step Protocol

Ingredients & Equipment

Included in the kit:

- SCOBY (sealed in plastic pouch)
- One cup of sugar
- Six teabags
- A strip of pH testing paper
- A pH chart
- 2 oz. condiment container of apple cider vinegar
- Disposable gloves
- Plastic container with a lid in which to grow the kombucha leather.

You will need to provide:

- A measuring cup or some other way of measuring a gallon of water, which is 16 cups or 4 liters.
- A pot or kettle in which to boil 1 gallon of water and brew the tea/sugar solution. You will

need access to a stove or hotplate or at least an electric kettle.

- A wooden board on which to dry the SCOBY. An ordinary cutting board is fine but the Making Center has small pieces of plywood available for this purpose to borrow.

- Access to a sink to wash your kombucha leather and to clean all the utensils after you are done. Dish soap will be helpful.

- An undisturbed location, warm if possible, where the SCOBY can be left to grow for at least 2 weeks. Students have had good success locating the SCOBY container beside a radiator or on top of a fridge. Optimally, the temperature should be above 75F (24 C). During the colder time of the year, the Making Center has heat mats for you to borrow on which you can place the SCOBY culture.

• Step 1.

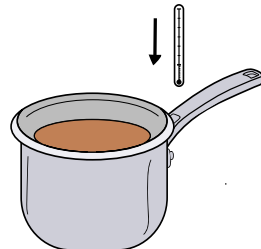
Bring one gallon of water to a rolling boil. Add 1 cup of white sugar and 6 teabags. The sugar is pre-measured so just use the amount provided in the kit.

The Science: The tea will supply nutrients to the SCOBY (Symbiotic Community Of Bacteria and Yeast) and the sugar gives it energy.



• Step 2.

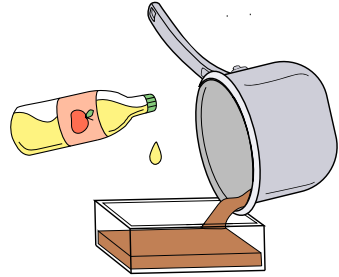
Allow the steeped tea and sugar mixture to cool to approximately room temperature. Remove the teabags and discard them.



• Step 3.

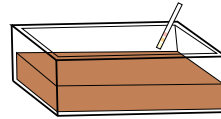
Pour the tea/sugar mixture from the pot into the plastic container. Add the 2 oz of apple cider vinegar that is included from the small condiment container.

The Science: Apple cider vinegar lowers pH (making the liquid more acid) which is more favorable to the SCOBY and discourages competing organisms such as mold from contaminating it!



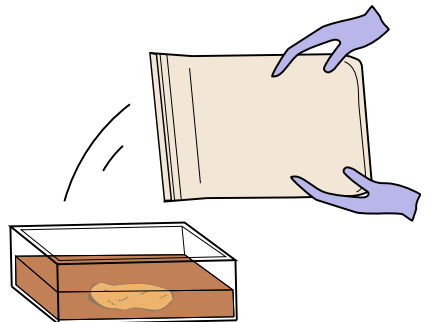
• Step 4.

Test the pH using the included litmus paper. Dip the litmus paper quickly into the tea/sugar/vinegar mixture and compare the color of the paper to the included chart. The pH shouldn't be much higher than 4.0 for the best chance for success. Record the starting pH.



• Step 5.

While wearing gloves, add the SCOBY and the liquid it was packed in to the cooled tea/sugar/vinegar mixture. The SCOBY is a living culture and thrives in a limited temperature environment. Don't toss it into the hot liquid as this will kill it. The SCOBY is round and rubbery and is packed in a plastic bag inside an envelope.

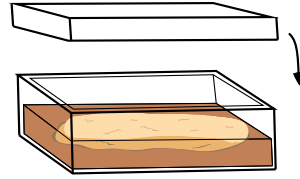


• Step 6.

Put the lid on the container and store in a dimly lit place.

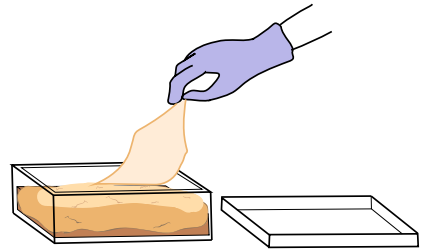
If your temperature is much below 75 degrees F, (24 C), put the plastic container on one of the heat mats (available to borrow from the making center store) to maintain a stable environment inside the container, above 75 degrees F. A warm kombucha culture will produce results more quickly.

Over the next two or three weeks, a thin layer of kombucha leather will begin to form on the surface of the liquid, which will gradually thicken as the SCOBY continues to feed and grow.

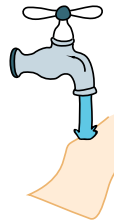


• Step 7.

Wearing the disposable gloves or with well-washed hands, remove the leather when it is thick enough to handle. Rinse well with water and then allow to dry on a piece of wood or a cutting board. Flip leather twice a day to keep it from sticking to the board.

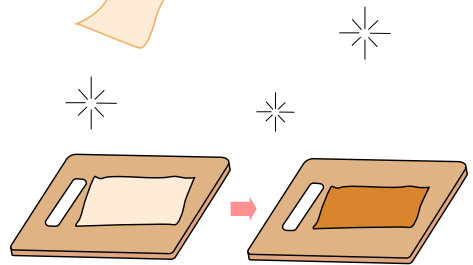


The Science: The SCOBY converts the brewed tea and sugar mixture into microbial cellulose (kombucha leather) as it grows. This is a process of fermentation (similar to the making of pickles, beer or wine), which produces a small amount of alcohol and carbon dioxide. The change in density will cause the original SCOBY to float after a few days.

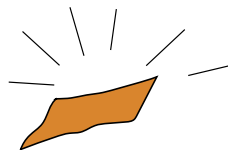


• Step 8.

If you want to grow more leather, save the liquid in your container and more will grow using the same procedure. You may notice some small SCOBY suspended in the liquid. You can use these to start new kombucha leather cultures in new containers using the above tea/sugar/vinegar recipes. If you want to grow larger pieces of leather, just scale up the recipe proportionately. The size of the leather is only limited by the surface area of the container!



Voila!



When leather has dried, it can be sewn, dyed or drawn upon. In order to fold it or mould it around a form, spray with a bit of water to soften it up.

Key Words:

BIOFABRICATION: Biofabrication can be defined as the production of complex living and non-living products by culturing organisms such as mycelium, bacteria and other microbes.

CELLULOSE: is the substance that makes up most of a plant's cell walls. Since it is made by all plants and many microbes, it is probably the most abundant organic compound on the planet. Wood, cotton, paper and flax are all examples of materials made from plant cellulose. Kombucha leather is microbial cellulose.

CLONING: Cloning is the process of producing genetically identical individuals of an organism either naturally or artificially. In nature, many organisms produce clones through asexual reproduction.

FERMENTATION: is the conversion of sugar into acids or alcohol with the help of bacteria or yeast under anaerobic (no oxygen) conditions. Carbon dioxide is also produced. Fermentation is used to produce pickles, soy sauce, vinegar and alcoholic beverages such as wine and beer.

GENERATIVE: having the power or function of propagating or reproducing

KOMBUCHA: (also tea mushroom, Manchurian mushroom, formal name: *Medusomyces gisevii*[1]) is a variety of fermented, lightly sweetened black or green tea drink commonly used as a health food. Kombucha is produced by fermenting tea using a "symbiotic culture of bacteria and yeast" (SCOBY). The microbes in kombucha are considered 'probiotic' which means good for the human digestive system.

MOLD: a blue or whitish fungus that grows on food or in between bathroom tiles etc., it is often found in damp areas. In order to prevent mold contamination of your SCOBY, wear gloves when handling, make sure to keep pH of the liquid at 4 or below by adding the included vinegar and brewing the tea strongly, keep lid securely closed on the growth container and maintain the temperature above 75 Fahrenheit (24 Celsius)

MICROBE: A microbe is a tiny, microscopic organism, which may exist in its single-celled form or in a colony of cells.

MICROBIAL CELLULOSE: sometimes called bacterial cellulose, is a form of cellulose that is produced by bacteria. Kombucha leather is largely made up of cellulose.

pH: is the relative acidity or alkalinity of a substance. Vinegar is acid. Substances like baking soda or bleach are alkaline. The SCOBY grows best under slightly acid conditions (pH 4) which is why we add a little apple cider vinegar to the brewed tea and sugar solution. A reading of pH 7 is neutral, i.e. neither acid or alkaline.

SCOBY: (Symbiotic Community Of Bacteria and Yeast) a living, symbiotic community of bacteria and yeast. This is the culture that transforms the tea/sugar and vinegar mixture into Kombucha leather. Microbial populations in SCOBY cultures vary. The leather produced by the SCOBY isn't the same as animal leather and is composed primarily of cellulose.

SYMBIOTIC: any type of a close and long-term biological interaction between two different biological organisms. The SCOBY culture is made up of both yeast and bacteria growing together.

TANNING: The process of converting animal skin into leather, often involving chemicals.

Reference Images:



Suzanne Lee, Bio-Couture Jacket and Blouse



Kombucha Card Holder
<https://www.instructables.com/id/Kombucha-Card-Holder/>



Suitcase by Dean Brough, Alice Payne, and Peter Musk.
<https://eprints.qut.edu.au/93547/>

Key References:

1. Environmental Problems with Leather

<https://gizmodo.com/how-leather-is-slowly-killing-the-people-and-places-tha-1572678618>

2. Suzanne Lee's TED Talk

https://www.ted.com/talks/suzanne_lee_grow_your_own_clothes

3. Kombucha: What Is It?

<https://en.wikipedia.org/wiki/Kombucha>

Experiment Reflection:

RESULTS/ INTERPRETATIONS:

1. Did the work come out as expected (or as you hypothesized)?
2. Did your microbial leather mature over time? Did you manipulate different things over time?
3. Did you reuse the liquid to grow more microbial leather after harvesting the initial crop?

REFLECTIONS:

1. What new questions do you have?
2. What would you do differently next time?
3. What is unique about microbial leather as a material?
4. Did you have any difficulties with contamination? Controlling temperature? Etc?

What do you think?

[illegible]

Sustainable Systems

