

Vegan Leather from Kombucha Tea and Scoby

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Abstract

Cow leather, an animal product, is a common material. Despite being robust, it raises moral, social, and environmental concerns. The world is warming up, plant habitats and plant origins are being destroyed, artificial colours have an adverse effect on the environment and human health, and animal products and hair are utilized to make various types of leather and pricey fashionable clothing. Vegan leather, which was produced by recreating leftovers or growing living cells, may be a recent innovation for the manifesto on sustainable fashion. Another biomaterial manufactured without fleshing any animal is environmentally friendly and animal free leather, often known as “vegan leather” or “artificial leather”. As an alternative to cow leather or other animal leather, the creation of vegan leather using a symbiotic culture of bacteria and yeast (SCOBY) can be investigated. There is currently few research on the several substrates that can be used to create vegan leather using this process. In order to provide plant-based vegan leather, this paper used a variety of plant-based substrates, including SCOBY and kombucha tea. To sum up, this substance might also be thought of as a potential leather substitute for use in leather accessories like handbags and upper shoe soles.

Keywords: Cellulose; Fleshing; Kombucha Tea; SCOBY; Sustainable

Introduction

The topic of sustainability is crucial for both the present and the future generations. It is unacceptable to hold the common view that natural resources are limitless and that Mother Nature can regenerate and make up for all human activity. Additionally, sustainability concerns will have a direct impact on all organizational aspects of human life from an economic, political, social, and environmental perspective. A leather-like material that isn't created from an animal's skin is called vegan leather, often referred to as faux leather or a leather substitute. Instead, vegan leather is produced using a mix of plastic and plant elements, including polyurethane, a polymer that lends some structure to the material, and plant materials like pineapple leaves, cork, apple peels, and other fruit waste, to make goods that put a stop to animal cruelty. Over the past few decades, the footwear industry and scientific researchers have gradually pushed for the development of leather alternatives, leading to the design of numerous natural and synthetic materials [1]. Many individuals throughout the world are fascinated by the fashion industry, and numerous businesses are successful because of its various stylish approaches. However, this leather sector has expanded greatly as a result of public demand. Because of the enormous amount of waste that these businesses produce, this is one of the main factors contributing to global pollution [2]. One of the animal products utilized in the clothing, bag, and footwear industries is leather. However, the durable and adaptable cow leather was said to be the most environmentally harmful material since leather tanneries contribute to eutrophication, chemical release, global warming, water shortages,

and the depletion of abiotic resources. However, the rising market interest and economic viability of such alternative materials have been severely constrained due to the high cost of production, low breathability, and other limitations. Here, a novel formulation approach was explored to create animal-free leather goods that combine simplicity of preparation, cost, and environmental friendliness [3], Kombucha leather is not constructed of synthetic materials like plastic, in contrast to conventional vegan leather. Instead, it is supported biologically by yeast and bacteria. Due to its biodegradable nature, it is actually perfect for things with a shorter lifespan like handbags, shoes, gowns, and decorations as it can easily last at least a year. Anything that doesn't need to last for decades can be fine with kombucha. Additionally, as a product reaches the end of its useful life, it can be composted [4]. One option to achieve this is to create vegan leather utilizing microorganisms and materials derived from plants, which is biodegradable and might be more sustainable and kinder to the environment. Kombucha is a probiotic beverage with some established health benefits. This beverage is produced by fermenting sweetened tea with the SCOBY, a biofilm that resembles jelly (symbiotic culture of bacteria and yeast). The two main bacteria that have previously been isolated from SCOBY are *Komagataeibacter xylinus* and *Gluconobacter* sp (syn. *Gluconacetobacter xylinus*, originally known as *Acetobacter xylinum*). Consequently, in recent years, research has been done on the technique of producing and using kombucha cellulose as vegan leather through collaboration between the Fashion department, Queensland University of Technology, and others.

Literature Survey

It is anticipated that the hydrophobic based may find interesting applications in design, such as the application of textile material in clothing, flooring, and other interior design materials, according to the paper "The role of technology towards a new Bacterial-Cellulose based material for fashion design" [6]. The authors of "Understanding Kombucha Tea Fermentation: A Review" recommend conducting scientific studies to better understand the connections between kombucha tea's fermentation and its biological activities. This will help Kombucha tea become recognized as a useful beverage with clear evidence of both its benefits and drawbacks. The ideal fermentation conditions must be determined by measuring, controlling, and experimenting with a variety of parameters and modifications [6]. A review of the microbiology, composition, fermentation, health benefits, toxicity, and tea fungus of kombucha tea. It inspired us to compile the kombucha related scientific papers that were provided in the form of this review. Based on the research that is currently accessible, the goal of this review was to look into the microbiology, fermentation, composition, health benefits, and uses of tea fungus biomass [7]. These leather-like products, such shoes and bags, need to be reinforced and finished to increase durability, just as animal-based leathers. Shoes range from simple slip-ons to more creative designs with handcrafted hardwood heels and soles. These concepts and goods are already in the market and made from vegan leather utilizing a variety of techniques [8]. In this article, the authors discuss the mistreatment of helpless animals, raise awareness about the use of genuine leather, and discuss the value of vegan leather from the viewpoints of both animals and the environment [9]. According to the research presented in this paper, kombucha is a low-alcohol beverage that contains a significant amount of bioactive substances generated from plant material (tea, juices, and herb extracts), as well as the metabolic activity of microbes (acetic acid bacteria, lactic acid bacteria and yeasts) [10].

In this article, they have extensively researched Kombucha, a traditional beverage made from fermented, sweetened green tea and tea fungus. This study also focuses on growing pure Kombucha and thoroughly examining its chemical and physical characteristics [11]. In this study, the author produced a material called Multi-layered Cellulosic Material (MCM) and looked at its wettability, tensile strength, thermal comfort, and air permeability. The qualities of the tested materials are then contrasted with commercially available leather manufactured from pig and cow skin [12]. The researcher who conducted this study kept tea fungus under observation for 60 days in order to study prolonged fermentation. The quantities of yeast and acetic acid bacteria in broth were frequently higher than those in the cellulose pellicles. The residual sucrose concentration decreased linearly over time, even though the pace began to reduce after the first month [13]. The aim of this research is to investigate, both theoretically and empirically, why it is necessary to apply and implement ethical standards and to address the challenges being faced in how animals are used in these industries [25].

Materials and Methods

The Kombucha fungus, also known as SCOBY (Symbiotic Culture of Bacteria and Yeast), and tea were used to create this vegan leather. A SCOBY Disc, 1L of water, 4g of tea (either green or black), 100g of sucrose (sugar), and this quick method were the materials [14]. Steps taken to create this leather include:

1. Firstly, we used hot water to sterilize every component that will be used to create the vegan leather. It kept SCOBY healthy and shields it from all types of infections.
2. Tea, sugar, and water were combined after sterilization in a container with boiling water to make tea mix as shown in Fig. 1.
3. Later the SCOBY was added to it as shown in Fig. 2, once the mixture was at room temperature. It was then allowed to rest in a glass jar so that the mixture would gain sufficient amount of sunlight.
4. After resting for seven to eight days, a thick film was formed on the mixture's surface as shown in Fig. 3. This film was then taken from the tea mixture and was repeatedly cleaned with distilled water, and the excess water was squeezed off.
5. Now that it had been grown thickly, the SCOBY was wrapped in the newspaper in order to make it dry with a heavy enough load on it to drain the water out of the leather. It was taken out 8 to 10 days later when all the water had been drained and all that was left was a thin dry film of SCOBY.
6. Two identical samples were made, one of which had an oil brush applied to it at the completion of the procedure to assure that the leather would retain its flexibility, and the other which had been fully dried without the oil brush.

On both leather samples, a test was conducted in order to compare various parameters.

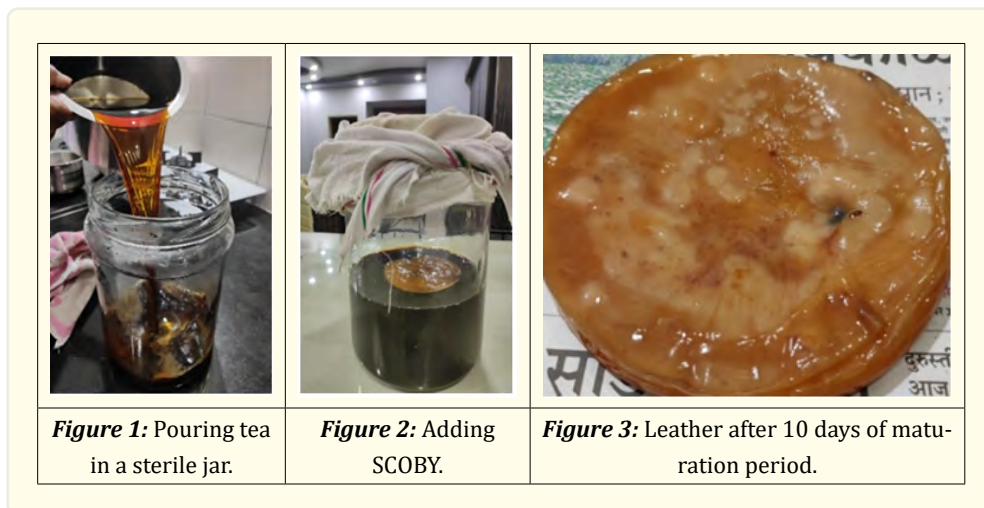


Figure 1: Pouring tea in a sterile jar.

Figure 2: Adding SCOBY.

Figure 3: Leather after 10 days of maturation period.

Results and Discussion

After following the methodology, we successfully prepared two prototypes of leather, one without oil and another one with oil. The tests were carried out in a lab where we experimented on certain parameters. A Star Testing System's (STS) Universal Strength Testing (UST) machine with the model number STS-248 was utilized for the testing. Table 1 presents the results. The STS-248 has also plotted Load vs. Displacement graph which can be seen in Fig. 4 & 5.

<i>Prototype</i>	<i>Tensile Strength (MPa)</i>	<i>Elongation (% on 50mm gauge)</i>	<i>Thickness (mm)</i>
Without Oil	22.17	05.80	0.250
With Oil	04.10	10.80	0.300

Table 1: Physical properties of Vegan Leather.

So we brushed the one prototype of leather with oil to lock the moisture, it affects the tensile strength of the prototype but increase the elongation and thickness a bit.

Research was conducted in which bacterial cellulose Film same as our vegan leather was developed from the same raw materials as of ours. A total of three samples were made at different temperatures such as 25°C, 50°C and 75°C with the help of an oven. They conducted a number of tests using the TINIUS OLSEN H10 KT tensile test machine, comparing various parameters as they went. The sample that was dried at 25°C and had a tensile strength of 27.9 MPa provided the best result among the three samples [14]. In Table 4.2, the comparison research is shown. Since the sample dried at 25°C produced the best results and 25°C is considered room temperature, we decided to avoid the cost of an oven and eventually the cost of power used to run one, which would reduce the overall cost. Table 2. Comparative Study Our Prototype Reference [14] Prototype Tensile Strength σ , MPa 22.17 27.9 As shown in the above table, Tensile strength of both the samples is near about same. In spite of less cost of leather, the product shows almost similar properties.

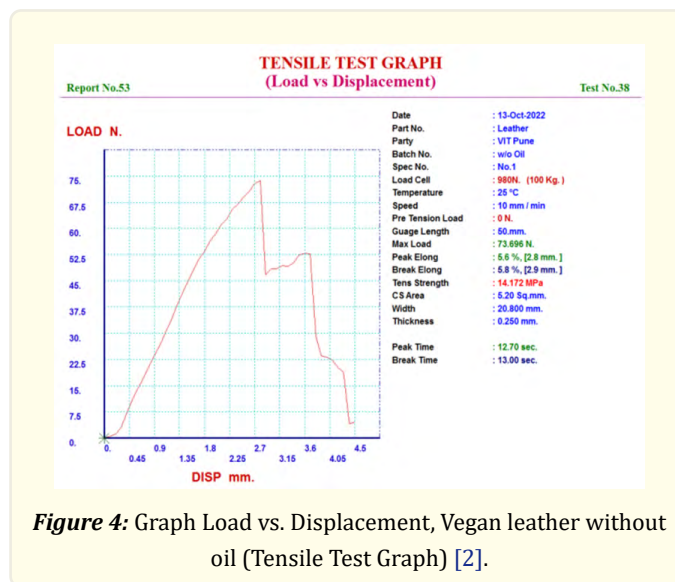


Figure 4: Graph Load vs. Displacement, Vegan leather without oil (Tensile Test Graph) [2].

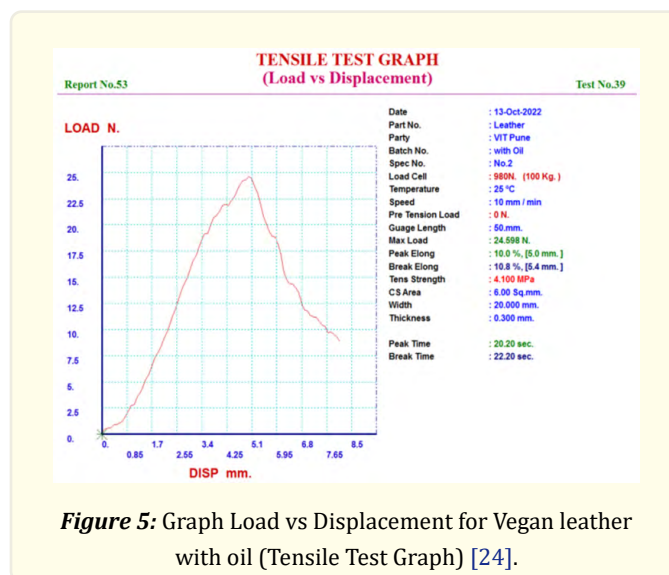


Figure 5: Graph Load vs Displacement for Vegan leather with oil (Tensile Test Graph) [24].

The overall manufacturing cost for the leather of area 190.5 cm² is USD\$ 5.63 and it can be further reduced when we adopt bulk production of vegan leather because SCOBY is reproducible making it one time investment. By reproducing the SCOBY, we can reduce the cost of production by more than 60%.

Conclusion

Since vegan leather is produced entirely organically without the use of expensive machinery, it has the same strength as genuine leather but is much more affordable and animal-friendly, preventing the need to kill animals for fashion. Genuine leather is made from an animal's skin, whereas vegan leather is the complete opposite because it is made out of an animal's skin. As a matter of fact, vegan leather is more degradable and lasts as longer as genuine leather. There is a lot of research going on, regarding the manufacturing of vegan leather, but the way we have manufactured the leather is not so common, whereas using some polymers and different organic matter is becoming quite common nowadays for the production and manufacturing of vegan leather. Symbiotic culture of bacteria and yeast, or SCOBY, comprises a variety of bacteria that consume organic material like sugar and produce energy in a wholly anaerobic manner. Additionally, because there are no phthalates or other harmful chemicals used in the tanning process here, the leather has the natural color thanks to the tea used as a dye. SCOBY and tea-based vegan leather is durable enough to sustain daily use and is competitive with genuine leather in many ways.

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