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Synthesis of Vegan Leather Using Plant-Based Substrates: A Preliminary Study

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Abstract. Cow leather is a widely used material. Even though durable, it causes ethical, social, and environmental issues. The synthesis of vegan leather, using a symbiotic culture of bacteria and yeast (SCOBY), could be explored for an alternative to cow leather. Presently, there are limited studies on the different substrates used to produce vegan leather using this method. Hence, this study aimed to produce plant-based vegan leather, using various plant-based substrates such as black tea, green tea, black and green tea, coconut water, and fruit pulp with five replicates per substrate. All the substrates used in the experiments were able to produce cellulose upon inoculation. The overall results indicate that the substrate consisting of a mixture of black and green tea was the most effective in producing vegan leather in terms of yield and cost.

Introduction

The fashion industry is a multi-trillion US Dollar business [1], and it makes up for 2% of the world's domestic product [2]. Leather is one of the animal products used in fashion industry for textile, bags and footwear. However, this sturdy and versatile material, for example cow leather, was reported to be the most environmentally damaging material because it causes eutrophication followed by chemical release, global warming, water scarcity and abiotic resource depletion caused by leather tanneries [3]. Arsenic, for example, is a common tannery chemical which causes lung cancer amongst tannery workers [4]. The Centres for Disease Control and Prevention of the United States of America has discovered that individuals living close to tanneries were much more likely to be infected with respiratory diseases like leukaemia, sinus and lung cancers [5]. In addition, a study had reported that leather-tannery workers in Sweden and Italy have 20% to 50% higher risk of developing cancer, and 17% of tannery employees in Sweden were diagnosed with cancer [6]. Other toxic chemicals such as formaldehyde, lead, cyanide, and chromium, found from various tanneries around the world, are released into open waterbodies which endanger aquatic lives [7].

Furthermore, in the production process from the tanneries up until the dye house, the leather receives multiple applications of chemical preservatives, dyes, and treatments to achieve the desired leather properties [8]. These treatments and additives are known to not only cause pollution to the environment, but also be harmful to human health. In addition, they make the materials not biodegradable causing them to pollute the environment for thousands of years [5, 9].

Due to these environmental, human health and social issues, the fashion industry is constantly under pressure to look into other sustainable materials and therefore the synthesis of vegan leather has a promising future [10]. One way to make this possible could be through the synthesis of vegan leather using microorganisms and plant-based materials, which is compostable, thus could be more sustainable [11] and environmentally friendly.

Kombucha is a probiotic beverage that is known to have some health benefits. This drink is made by a fermenting process in which sweetened tea is fermented with the addition of a jelly-like biofilm known as SCOBY (symbiotic culture of bacteria and yeast) [12]. The main bacteria that have been previously isolated from SCOBY include *Komagataeibacter xylinus (syn. Gluconacetobacter xylinus,* formerly known as *Acetobacter xylinum)* and *Gluconobacter* sp.[13] and the major yeast is *Saccharomyces* spp. [14]. Synthesis of bacterial cellulose using SCOBY has been reported by Chusna