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STUDY OF LEATHER ALTERNATIVE FROM BACTERIAL CELLULOSE- A REVIEW

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ABSTRACT

Leather study is a field in archaeology. This study focus on the production of vegan leather from SCOBY (symbiotic culture of bacteria and yeast). SCOBY requires carbon source, oxygen and statistical conditions for fermentation, it is kept especially away from direct sunlight because it effects fermentation process. First process is culture of SCOBY called mother SCOBY and end product is baby SCOBY produced from mother SCOBY. Vegan leather has many advantages as they are eco-friendly, zero waste producing, sustainable, biodegradable, non-toxic, low cost product, and have low carbon footprint. Vegan leather is alternative source of plastic packaging material. In this review efforts have been made to explore the wide scope of vegan leather and practices in this field across the world.

Keywords: Leather, vegan, SCOBY, biodegradable

1. INTRODUCTION

Generally leather is made up from animal skin like cow, goat, sheep, deer, crocodile, pig etc. Animal leather is utilized in garments, accessories, furniture, and upholstery because of its distinct properties, which include a more aesthetic, rich appearance, as well as flexibility and durability. About a quarter of all leather produced is used in the automotive industry is a term that is used in the footwear industry (Rathinamoorthy and Kiruba, 2020). Tanning is process from making leather. Leather is tanned material. If an animal's skin is left untreated for several days, it will quickly rot. The removal of the subcutaneous fatty layer and drying of the wound will minimize the action of hazardous bacteria and slow the rate of degradation. Animal skins are only cured, tanned, or dressed after a more time-consuming process to produce a stable product (Harris, 2014; Hodges, 1995; Reed, 1972; Sharphouse, 1983). The leather industry's principal goal is to turn animal skins or hides into useable materials for a variety of applications. This procedure is known as tanning, and it involves subjecting the skin or hide to a series of chemical and physical treatments (Rathinamoorthy and Kiruba, 2020).

1.1 Eco-friendly Faux Leather

The clothes and textiles (C&T) industry has long worked to improve the functionality of environmentally friendly textile goods. Following the breakthroughs of bio-based polyurethane and nano cellulose, eco-friendly faux leather (EFFL) has been produced in recent years (Jung et al., 2014). Consumer acceptance of products has been delayed, according to past studies, due to
the limited functionality and high cost of organic fabric, recycled materials, and eco-friendly manufacturing methods (Jackason, 2005; Lee et al., 2015). Due to the intricacy of this type of consumption, customers may participate in a complex decision-making process when considering the adoption of eco-friendly items (Moisander, 2007). Environmental activities have been undertaken by the C&T field in order to develop markets for environmentally acceptable products (Gam et al., 2010; Peterson et al., 2012). Eco-Friendly Faux Leather (EFFL) has recently been developed to minimize harmful environmental impacts; this product also has a low carbon footprint (Kim et al., 2016). A reduction in the adverse consequences of consumption is critical from an environmental standpoint for attaining the international community's sustainability goals, as well as for personal and societal well-being (Jackason, 2005). Environmental concerns and ethical issues are socially constructed (Stern et al., 1995) Have enhanced our awareness of personal values associated to fair trade product campaigns, but knowledge and understanding of collective acceptance of environmentally friendly items, as well as the availability of such products, remain limited. The gap in our knowledge of consumer attitudes toward environmentally friendly items (Jansson, 2011; Kim et al., 2016). Given the newly developed EFFL products, a description of what influences consumer support for EFFL as well as a proposal for developing and evaluating interventions to change consumer attitudes toward eco-friendly products must be presented for practical application and theoretical validation within the C&T field. The goals of this research are to investigate the impact of the VBN process on consumer attitudes toward EFFL products; and investigate the moderating effect of country in relation to the hypothesized model and last is test the effects of personal values, beliefs, and norms in terms of the VBN framework (Kim et al., 2016)

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2. HISTROY OF LEATHER

One of man's earliest and most beneficial inventions is leather. To defend oneself from the elements, our forefathers used leather. Primitive man hunted wild animals for food, then used the hides to make clothes, footwear, and primitive tents. Today's hides, like those utilized in the past, are a by-product. Animals are not raised for their hides; they are raised for the meat, dairy, and wool sectors. Shoes account for roughly half of all leather manufactured today, while clothing accounts for around a quarter. Upholstery accounts for about 15% of the entire output. Leather was used for shoes, garments, gloves, buckets, bottles, shrouds for burying the deceased, and military equipment, according to wall murals and objects found in Egyptian tombs going back to 5000 B.C. The ancient Greeks are credited with discovering tanning techniques that preserve leather by soaking particular tree barks and leaves in water. This was the first mention of vegetable-tanned leather, which grew in popularity in Greece around 500 B.C. Vegetable tanned leathers are still made today and are being used in current tanning processes. Leather was widely used by the Romans for footwear, clothing, and military equipment such as shields, saddles, and harnesses.In the 18th and 19th centuries, the growth of industrialization created a demand for new types of leathers, such as belting leathers for driving machinery. A need for soft, supple, colorful leather arose as a result of the creation of the vehicle, the demand for softer, lighter footwear with a trendy appearance, and a general rise in the standard of living. Traditional vegetable-tanned leather was too stiff and thick for these needs, so chromium salt was used instead, and chrome tanning became the industry standard for modern footwear, fashion, and upholstery leathers.

Leather's origins can be traced back to Haxne, England, some 4000000 years ago. Its evolution may be tracked all across the world, through the stone age, bronze age, iron age, ancient times, mediaeval ages, renaissance, industrial revolution, and current times.

2.1 Leather's origins can be traced back to the Stone Age.

One of the longest periods in recent history is the stone age. It spans millions of years, yet evidence of leather crafting and the birth of leather craft can be found around 400,000 years ago. Around

3.3 million years ago, the first stone tools were discovered. They were stone flakes, most likely for cutting. These stone flakes could have been used to peel animal hides and scrape them clean during the tanning process. Though we don't start seeing evidence of leather-specific tools until roughly 400,000 B.C.

2.2 Leather's History in the Bronze Age (3000 BC–1200 BC)

In the Bronze Age, stone tools, including those used for leatherworking, were still quite popular. Although technological and tool advancements ushered in a trend toward specialization and trade. A group with the expertise and tools to do one thing exceptionally well (for example, farming) may manufacture items and trade them with another group with the resources, knowledge, and aptitude to make something else. With growing trade, the process of tanning animal hides into leather evolved further. Advances in tanning were accompanied by developments in leather craft. Leather would be utilized for a wider range of items, including shoes, capes, belts, headgear, arm protectors (for bow shooting), shields, and shelters, among others.

2.3 Leather's History in the Iron Age (1200 BC–550 BC)

During the Iron Age, the community and population continued to grow. Farming got more advanced, allowing for more efficient food production and family support. As the population grew, so did the need for commodities, notably leather items. Small towns rose in size, there was more free time, and certain apparel became more colorful. Leather shoes and sandals with leather laces, as well as belts, capes, and even jewellery, remained popular.

2.4 Leather's History in Ancient India (3000 BC–600 BC)

Indian culture is rich in history and intricately linked to global events. In ancient India, leather was also highly prized. The Vedas are a collection of early Hindu scriptures written in the Sanskrit language. There is a reference to leather objects in the Rig-Veda around 3000 BC. Bottles and water-carrying bags known as 'mashaks' were among them. Leather bands, straps, laces, and similar cord-like tools were also described in other literary references from the time period. During this period, it was apparent that leather was highly valued and required.

3. HISTORY OF KOMBUCHA

A brief history of kombucha, the world's favourite fermented beverage, dating back over 2,000 years. The 21st of February is World Kombucha Day. The exact origins of kombucha are unknown, however the first recipes are supposed to date back to 221 BCE, when China's Qin Dynasty began.

(This is why World Kombucha Day is celebrated on February 21st.) Brewers in northern China and Korea discovered how to ferment sugared tea using symbiotic cultures of bacteria and yeast (which form a gelatinous disc known as a SCOBY). They dubbed it the "Tea of Immortality", and they believed it had some merit. A Korean doctor is said to have brought the kombucha production technology to Japan in around 414 BCE, when he served on the court of Ingy, Japan's 19th emperor, and lauded the drink's advantages.

That doctor's name, according to mythology, was Kombu. If he existed, he was theoretically the one who came up with the name. However, kombucha in Japanese refers to a kelp tea, which is a completely distinct beverage.

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The remainder makes sense when you combine the Japanese words for kelp (kombu) and tea (cha). The legends surrounding this historic drink have ebbed and flowed throughout time, but for kombucha fans, the feeling of mystery is part of the appeal.

4. SCOBY- SYMBIOTIC CULTURE OF BACTERIA AND YEAST

Bacterial cellulose (BC) is an environmentally benign natural polymer made from microbial organisms that has been hailed as a material of the future. Due to its distinct physicochemical and mechanical characteristics BC has been used in medicine for a long time. Wound dressings that are antibacterial (Portela et al., 2019)**.** In the presence of possible nitrogen and carbon sources such as yeast extract, peptone, glycine, glucose, sucrose, mannitol, fructose, and other dietary derivatives, microorganisms metabolize, resulting in increased growth, development, and formation of gel-like cellulose membranes (Hussain et al., 2019; Thorat and Dastager. 2018). The beverage is made by fermenting tea leaf infusions or decoctions with the help of a symbiotic association of bacteria and yeasts known as SCOBY (symbiotic association of bacteria and yeasts) (Chen et al., 2000). Payne, 2016 stated that they had created a cellulose form of kombucha for use in the production of footwear. They used wax to improve the hydrophobic qualities of the created cellulosic fabric without altering its tensile properties or comfortability. They've created footwear employing bacterial cellulose as an alternative to leather as a result of their product.

According to their findings, bacterial cellulose may be created in custom shapes and used as a zero-waste manufacturing material (Payne, 2016). Glucose is converted to cellulose through a series of intermediary molecules, including glucose-6-phosphate, glucose-l-phosphate, and uridine-5-diphosphate glucose. (Rathinamoorthy and Kiruba 2020). Scientists are currently obtaining valuable products by combining natural/waste resources with better biological synthesis technologies in order to build a "zero waste" society and economy (Mateo and Maicas 2015)

5. KOMBUCHA SCOBY LEATHER

Kombucha tea system was maintained in our laboratory according to Bhattacharya et al. (2013). A total of sixteen 200 mL Kombucha tea batches were kept to determine the structure and dynamics of the microbial population. These 16 batches were divided into four sets, each with four Kombucha tea systems replicated. Four replicates were made, each of which was totallycollected when the fermenting period was completed. After 3, 7, 14, and 21 days of fermentation, the grapes were harvested. One set was for yeast, two for bacterial T-RFLP, and the final set was for bacterial next-generation sequencing. The batches were kept at a constant temperature (28–30°C). A gelatinous layer was formed as a byproduct after 2-3 weeks.

As a result, SCOBY-derived microbial cellulose could be a viable alternative to plastic polymers. According to the findings, SCOBY packaging has no negative impact on the outward look of packaged food or its nutritional content. Furthermore, one of the most significant advantages is that it is easily deteriorated. As a result, using SCOBY as a packaging material could help to solve the environmental issues associated with plastics. However, it must overcome two key limitations: its ability to absorb moisture and soften, as well as the issue of excessive drying. SCOBY can be used on a wide scale with more research and improved procedures (Chakravorty et al., 2016; Aduri et al., 2019).

According Freeman, 2016 and his fellow researchers Kombucha culture is made up of a variety of yeasts and bacteria. This culture, like Candida albicans, is an opportunistic infection that can cause problems for people who wear clothing made from this material. To improve the wearer's safety, these two cultures must be inactivated or completely removed. If culled and rotten sweet potatoes are to be used as the sugar source, their preparation could have a considerable impact on the Kombucha cultures' performance, necessitating some trial and error. The majority of internet recipes called for 200 milliliters of organic cider vinegar, 200 grams of granulated sugar, one live kombucha culture, and two green tea bags. Tea was steeped for 15 minutes in 2 liter of boiling water using this method. Following that, dissolve 200g of sugar, then add vinegar and culture once the mixture has cooled to 86°F. The culture was covered and stored for three weeks without being disturbed. The "leather" was removed at the end of the process, rinsed in non-abrasive liquid dish detergent, and stretched across cedar boards for drying and moisture transfer. Granulated sugar was replaced with harvested sweet potato sucrose in a variation of a popular recipe. A commercial juicer was used to extract the raw juice, which was then cooked for 60 minutes with grain to 170°F. The liquid is referred to as wort once it has been strained, whereas the objects strained are referred to as mash. Water is poured uniformly over the mash to extract the fermentable carbohydrates required for kombucha culture interaction. Enzymes are added to the mixture to speed up the process, although not adding enzymes resulted in a thinner leather sample during testing. The objective is to use heat to reduce long-chain starches into simple fermentable sugars. These fermentable sugars are then chilled and used instead of granulated sugars.

Domskiene et al., 2019 concluded that BC film was created using the kombucha fungus. 1 liter of water, 4 g of green tea, 100 g of sugar, and 100 ml of 6% yeast extract were used to make the culture medium. It was cultured with Kombucha fungus and fermented for seven days in static cultivation conditions (20-24 °C temperature and

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45-50 % relative air humidity). By floating on a medium-surface gel-like substance, BC film was created. The removed film was rinsed with distilled water multiple times and squeezed to minimize its water content.

The BC0 control sample was dried in the laboratory oven at a temperature of 24 to 26 °C. After the drying process, the properties were estimated, The BC1 sample was dried at 24 to 26°C and stored at room temperature (20-24°C, 45-50% humidity). After 10 days, 20 days, and 30 days, properties were estimated and the BC2 sample was dried at 24 to 26 °C and stored in a cool, controlled atmosphere (+4 °C, 80% humidity). After 10 days, 20 days, and 30 days, properties were estimated. Following conclusion were observed:

(1) BC film can be made from a gel-like substance or a Kombucha beverage byproduct. Because this material has a unique set of qualities, it is only now being investigated for use in the fashion sector. Experiments have shown that BC film has favorable deformation properties, indicating that the material is not long-lasting.

(2) Because of its elasticity, it is better to use a wet BC film for the best shape. BC film is sensitive to drying temperature, according to tensile test results. Lower drying temperatures aid in the preservation of BC material's porous structure, strength, and deformation qualities. When BC material is dried at low temperatures (about 25 °C), the best deformation properties are retained.

(3) The ageing experiment confirmed that untreated BC film products are only good for a short time and that the film's qualities can alter dramatically with time. Tensile strength and elongation studies showed that material stored at +4 °C had fewer variable qualities than material stored at ambient temperature (20-24 °C temperature and 45-50 percent humidity). To extend the life of BC film and maintain its tensile and thickness properties, it is advised that it be stored in a controlled environment at a low temperature.

(4) Because it is feasible to acquire BC film qualities that are similar to those of clothes, manufacturing by natural fermentation is highly dependent on a number of variables, making it difficult to ensure an even structure, consistent thickness, porosity, and mechanical parameters. Further research is needed to determine the capabilities of BC film as a cellulose nanofiber structure, modification, controlled qualities, and a durable material with good deformation and comfort features. For fashion products, the visual aspect of the material is extremely crucial, therefore look for materials with fascinating surfaces and colors.

Rathinamoorthy and Kiruba, 2020 conclude that 50 grams of sugar and one liter of drinking water, after 5 minutes, remove 5 grams of tea leaves through the filter. Bring the mixture to room temperature before using. Reduce the pH by adding Kombucha that has already been made. To encourage fermentation, cover the beaker with muslin cloth. Ensure that the liquid receives enough oxygen through the fabric. Incubation temperature: 20–22°CThe fermenting process will begin in a week. (The production of gas bubbles within the liquid and the smell of fermentation are indicators)The new SCOBY used to float on top of the water (can be used for next batch preparation) for a complete fermentation, allow 10-14 days. A 1.5–2cm thick cellulose layer will emerge on the top after 10–14 days (Known as baby scoby). They summarized Bacterial cellulose is one of the few biomaterials that is completely sustainable both in terms of production and in terms of nature. Due to the current state of affairs in the foreseeable future, the leather and footwear business is looking for an acceptable and viable substitute. Though the bacterial cellulose has a similar feel and appearance to leather, technically, material qualities fluctuate depending on the manufacturing environment. Regarding the nutrient sources used in the manufacturing process In terms of commercialization, many researchers tried to boost the production and characteristics of the industry. The research to optimize the production parameter is still ongoing in order to obtain the standard production procedure similarly, there have been no successful efforts. On the use of alternative feedstock, such as diverse industrial wastes all of the data was in its infancy, and there was no attempt at large-scale production. Once these restrictions are overcome, the cellulose material generated from bio- sources will be next-generation leather as a replacement for animal leather, and imitation leathers will be available on the market (R. Rathinamoorthy and T. Kiruba).

Grey, 2020 article explain that bring the water and tea leaves to a boil in a big pot, then steep for 15 minutes. Allow the tea to cool before adding the sugar and mixing until it is completely dissolved. Cut a 3 inch square hole in the container's lid and cover it with the cloth patch. To keep it in place, use duct tape. Allow the rubbing alcohol to evaporate after sterilizing the non-porous container and lid. Fill the container with freshly brewed and sweetened tea. Combine the SCOBY and the starting tea in a teapot. Set the temperature to 75 degrees Fahrenheit and gently place the container on top of the seedling heating pad. The SCOBY will have grown to about an inch thick in about 4 weeks, which is the ideal thickness to work with .Lift the SCOBY gently from the container and immerse it in the dye of your choosing. Allow the colored SCOBY leather to dry on top of the wooden board. Allow the SCOBY to dry completely until it is a soft sheet. Grey conclude although much progress has been made in creating a biodegradable and environmentally viable alternative to leather, much more effort remains. We anticipate that SCOBYs will aid in the development of a more robust hybrid SCOBY or a manufacturing process in the coming years.

According Sanjee article bring 2 liters of water to a boil and prepare a regular tea brew as usual (no milk). This can be green tea, black tea, or a blend of the two. Tea bags can be used, however they must be discarded after the brew is ready. For a batch of 2 liters, 2 tea bags will enough. Stir in around 200g of sugar until it dissolves in the

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brew. If you prefer, you can use jaggery instead of sugar. Allow for cooling of the liquid. Transfer the liquid to a well cleaned and dry glass/ceramic/plastic tumbler or a tub when it is lukewarm or at room temperature. If at all feasible, choose a transparent container so you can check on it without disturbing the liquid. Metal containers should be avoided. The leather will mold itself to the shape of the container in which it is grown. I went with a square, clear fiber container. To this liquid, add SCOBY. You can also add a cup of kombucha to the brew if you have some on hand. You may also add some apple cider vinegar to it (optional). Cover the container with cheesecloth or any other light, breathable cloth; don't use a cover because your SCOBY requires oxygen to grow. Rubber bands or pins can be used to keep the fabric in place over the top. Maintain perfect hygiene throughout the process and when working with SCOBY. Mold can grow as a result of contamination. The fermentation process can take anywhere from 10 days to 3 weeks, depending on the season and the typical climate temperature in your area, or longer depending on the thickness of the cellulose you're going for. It took up to 3 weeks for my leather mat to reach a thickness of 2 cm, at which point I harvested it. Store the container in a warm place away from direct sunlight, where it will not be disturbed, to ensure safe and speedy fermentation. When you notice bubbles and a transparent layer growing on top, you know the fermentation has started. Harvest the leather: You can harvest the leather after the cellulose has reached the proper thickness. Remove it from the container and thoroughly wash it with cold water. Sanjee, in her article concluded that the SCOBY leather is surprisingly tensile and malleable, yet it is neither waterproof nor water-resistant. That is to say, it loses structural integrity when exposed to moisture, sweat, or water. Oiling and waxing can help with this, although it could take a few tries to get it perfect.
According Constantas and Hatle, 2020 thirty bacterial cellulose pellicles were produced under the identical circumstances as the others, but with different sugar concentrations. In reverse osmosis filtered water, three 3.78L batches of black tea were brewed. After cooling to 25°C, an inoculant of 32oz (0.946L) of GT's Gingerade Kombucha was added, resulting in a total volume of 4.726L. The volume of 15oz (0.444L) was divided into 10 bottles, each labelled with the batch number. Bottles were sorted in a sequential order so that no neighboring bottles were placed directly next to bottles from the same group. After three weeks of natural light, the temperature remained constant. Bacterial cellulose at 18°C-22°C. The pellicles on the surface of each bottle were removed and then divided into groups and let to dry a sheet of wax paper.
Constantas and Hatle, 2020 Discussed that there were statistically significant differences in durability across the groups. The sugar group with the greatest max newtons also had the highest max newtons, and two of the pellicles in that group maxed out the force transducer without tearing and were unable to be measured. Further study questions would be to evaluate the strength at various time intervals to see if the measurements gradually became more comparable, or if they had hit their peak in the three weeks they were growing. Other substances that are critical for bacterial development could be regulated and their effects studied in addition to sucrose. More information on the structure of the pellicle can be gathered by staining for chitin.

6. ADVANTAGES OF SCOBY LEATHER

This advantages are taken from the experiments done by different scientists which are reviewed here:

6.1 According to Somnath Chakravorty, 2016 and his fellow researchers the SCOBY can be used as an alternative of plastic polymers of packaging different materials.

6.2 According to freeman, 2016 and his fellow researchers is emerging as a sustainable leather product for eco-conscious consumer which can be used for making apparels and in textiles industry.

6.3 Domskiene, 2019 and her colleagues in their experiment demonstrated that BC film can be used in making future fashion products by modifying some of its mechanical properties and parameters like color surface and even thickness.

6.4 Rathinamoorthy and Kiruba, 2020 suggested that the BC film which has similar feel and appearance of a leather it can be a better replacement for animal leather that can be used as imitation leather and in footwear business. Thus, it can be said as next-generation leather.

6.5 Sanjee demonstrated that the SCOBY is not water proof material and also it can loses its integrity when exposed to moisture but it can be overcome through oiling and waxing for making better product for the market.

7. CONCLUSION

Plastic polymers could be replaced with microbial cellulose produced from SCOBY. Sour whey, apple juice, and brewed wasted grains were all helpful in enhancing SCOBY membrane synthesis, with no significant differences in features when compared to cellulose made from conventional Hestrin and Schramm (HS) medium. According to this research, SCOBY packaging has no negative impact on the outward look of packaged food or its nutritional content. Furthermore, one
of the most significant advantages is that it is easily deteriorated. As a result, using SCOBY as a packaging material may help to solve the environmental issues associated with plastics. The use of SCOBY aids in tensile strength, resulting in an increase in elastic modulus or form stability. However, it must overcome two key limitations: its ability to absorb moisture and soften, as well as the issue of excessive drying. Bee wax has been

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used in a variety of ways to prevent moisture absorption.

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