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Environmentally friendly and vegan leather: fabrication and sustainable product characterization

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Abstract
Environmentally friendly also known as "vegan leather" or "environmentally friendly leather" is an alternative for biomaterial products without the use of animal slaughter and its components. The biomass material produces traditional leather with similar physic-chemical with mechanical properties. The recent studies show materials made from vegan leather as a gradual growing business keeping the environment in mind. In the present study shows the preparation of such biobased material using Agro-waste component is accomplished. Different leather components of the leather were successfully used for making vegan leather like the maple leaf waste (6-10%) apple fruit (0-10%) kombucha biomass (25-45%) polymers (0-15%) and plasticizers (5-20%). The prepared bio composite material is characterized for mechanical, water absorption,SEM result for its pores and tensil, stretchability for its flexibility and strength concern. This material is considered as an alternative for application in leather accessories and book covers.
Keyword*: Animal Cruel Free, Vegan Leather, Biofriendly, Environmentally Friendly*

Introduction

Over years of gradual growth towards the development of leather with analogue scientific natural materials in the fashion industry, leading designs of various synthetic and natural materials (*Fernandes, M., M. Gama, F. Dourado, and A.P. Souto*, 2019) the fashion industry with ever changing trends and style tries to give affordable products in the market to attract the customers, the buyers are mostly the ones without the product need so this is a major reason for global pollution through business. Large amount of water and waste are created over the soil globally creating pollution that cannot be avoided or cleaned completely (*Rathinamoorthy, R*, 2019) the increase of manufacturing of leather fashion products from natural resources other than animal skin which is a critical issue with the nature and the future generation. Development of alternatives that are more natural and eco-friendlier is very essential (*McNeill, L. and R. Moore et al, 2015,2016*)

Artocarpusnanca Noronha otherwise called as "Jackfruit" produced largely in Kerala and also the largest exporter in India on the other hand people consume this fruit from all parts except the stigma of the fruit which always remain as a waste thrown over the lands forming land pollution. Promising the use-age of this land waste as an alternativeleather for sustainability material design in the fashion industry. This biopolymer, possesses enhanced mechanical properties and presents several distinct advantages such as no lignin, hemicellulose or pectin contents, unique porous interconnected structure, high crystallinity, high water holding

capacity, and high in situ and ex situ moldability. As such, these unique features have contributed to the wide applications of Jackfruit in biomedicine, pulp and paper, foods and composites industry (*Iguchi, M., S. Yamanaka, and A. Budhiono, 2014*)
Jackfruit parts were used as a reinforcement or filler matrix for production of leather material (Nam, et al, 2016) recent study says that multi layers were prepared as a composite material supporting hemp fibres as a substitute (N am, C. and Y.A. Lee, 2019). In addition, "Malai" a company which created vegan leather from coconut water in India moulding a 3D assembly (Material District.Malaibiocomposite. 2019). The materials prepared soft hardness and goodness of conventional leather in the growing leather market showing better interest and commercial alternative material with better development and avoid limitations. The combination of making this preparation simple, eco-friendly and low in cost was investigated to produce animal cruel free leather material. In studies says that kombucha (KBC) maple leaf (MLP) apple (AP) are all agro waste from local lands, with bio-polymers and bio-composite material.

Experimental

Preparation of KBC, MLP, AP was from black tea and waste juice extracts, on the same hand here we have produced extracts from Jackfruit waste by autoclave at 120°C for 15 min and later transferred into 1% (v/v) suspension of Gluconacetobacterxylinus CCM 3611. The mixture was statically incubated at 30 °C for 15 days, forming KBC membranes that were harvested and washed with distilled water and stored at 4 °C for further usage.
Maple leave pulp (MLP) was extracted via an alkali treatment process as previously reported with slight modifications (*Chen, H., Y. Yu, T. Zhong, Y. Wu, Y. Li, Z. Wu, and B. Fei, 2017*) Dried jackfruit stigmas were treated with 8-12% NaOH solution for about 1-2hrs later washed with neutral pH, blended with a blender using a Thermo Scientific™ Sorvall Lynx 4000 centrifuge (Waltham, MA USA). The mixture was collected and oven dried at 50 °C overnight to constant weight and stored for further use. The animal free leather was blended with percentage formulated with physical and chemical properties.

TABLE 1: Animal free leather compositions

Components and weight % of each composite					
Sample	**MLP**	**KBC**	**AP**	**JCK**	**PCL**
S1	35	10	-	20	5
S2	30	10	-	15	5
S3	25	5	10	10	20
S4	40	5	-	20	10

Table 1: Basically, the samples S1, S2, S3, S4 of various composite were investigated in this study. All the four samples include blending two separate pre-mixtures. MLP, KBC, AP fibres are mixed using a micro ball used in mill Labs. The second JCK and PCL are uniform blend, moulded using gentle pressure machine forming sheet with a temperature of 120^{o} C for 30min.

Methodology

Properties prepared using bio composite materials using instruments like Nova Nano SEM with a voltage of 5kV and modules using thermal transition for preparing samples with a

dimension of 50mm and 7mm width. Dynamic mechanical analysed using DMA TA instrument with a temperature of 25-150^{o} C. Tensile strength was tested for checking the elongation and break performance using the pull off method ASTM D 4540 Elcometer. The sample was taken for 15mm x 20mm length, cut into pieces immersed in distilled water for

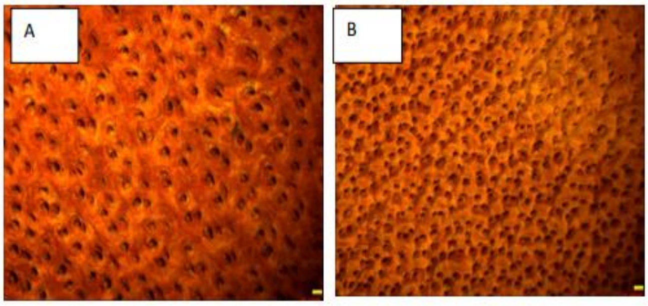
24hrs to reach good absorption. The water absorption was calculated using the equation below

$$\text{Water absorbance } \% = \frac{W_o}{W} \times 100$$

$W_o$and W are the weight of the sample before and after immersion (g)

Result and Discussion

Table 1 The morphologies of the polymers S1, S2, S3 and S4 were evaluated by SEM. Fig 1, the image represents good interaction between the blends of the fibre and mixtures components. The uniform dispersion of components with high stable adhesion and good mechanical properties (*Kong, I., J. Shang, K. Tshai, et al, 2016*). The result shows the pores of all investigation polymetricmatrix. The prepared sample was further analyzed with Bendtsen tester apparatus N3500 while obtaining results as sample provided. **Table 2** the material sample pores are recorded airflow through them in the material, the comparison of the PU and vegan leather was done and as a control airflow was recorded indicating the material was breathable and was suitable for making fashion products. The samples were compared and JCK sample gave good uniform results with smooth surface.



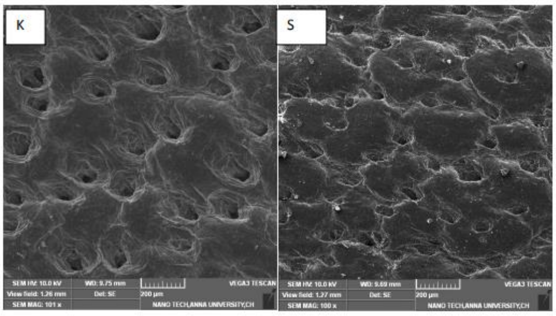
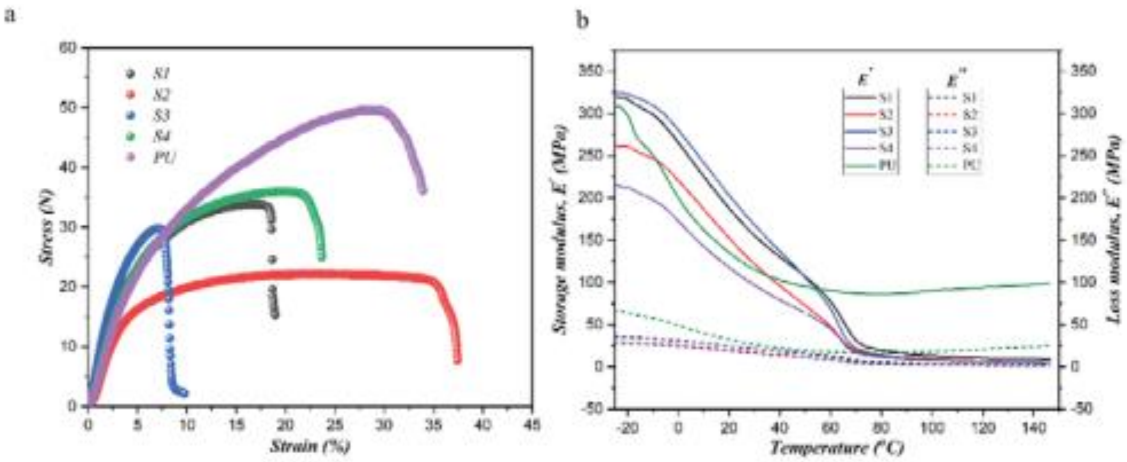


Figure 1: Cross section and pores of the surface vegan leather

echanical property analysis



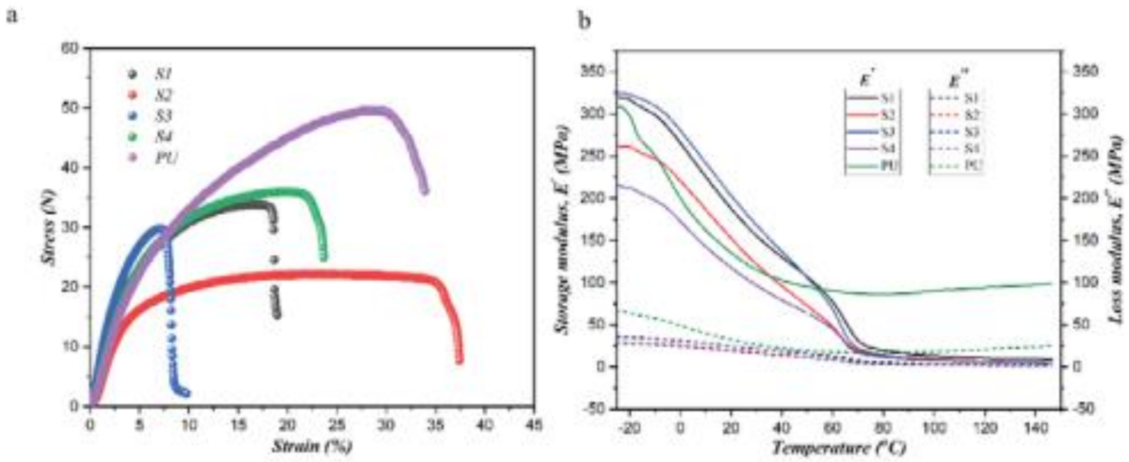


Figure 2: The stress plot areas prepared and the stiffness compared between the samples

Comparsion of prepared samples with PU based leather shows the tensile parameters that value PU as provided. **Table 2**shows the higher material present in the study and improved mechanical property. The mechanical property shows the response from tension and temperature elastic property from the sample was stated good. **Figure 2** As recorded shows the gradual decrease when increase in temperature with sharp decrease between 50-70 ^{o} C with relaxation to PLA and JCK. KBC polymers could observe increase amount S1 and S4 modules are decreased compared to S2 and S3 samples. KBC motion shows chains of stiffness in the material, mostly related ability to interface. As described in a previous study by *Kakroodi et al.* on the enhancement of elastic modulus following the mixing PCL and PLA, it can be mentioned in the present study that the inclusion of PLA in the polymer matrix, greatly affected the overall elasticity following the elastic modulus obtained especially for S4.

TABLE 2: Test and which in turn increased the strength of the materials.

Sample	**Tensile strength (Mpa)**	**Elongation (%)**	**Tear strength (N/mm)**	**Elastic modules (Mpa)**	**Porosity (mL/min)**
S1	1.59	14.70	23.95	104.10	1360
S2	1.35	19	20.51	132.05	1520
S3	1.40	6.95	19.20	140.21	812
S4	1.68	16.40	25.20	84.20	650
PU	5.20	31.05	72.03	104.20	0

Adhesive Property Analysis

The strength analysis shows the evaluated de-cohesion or de-adhesion effect in the prepared samples. Strength analysis was evaluvated with the prepared sample material, In brief, when sample failure occurs between the coating and the substrate, the failure mechanism is denoted as de-adhesion, while occurrence within the coatings is described as de-cohesion [15]. Figure 3 all the samples were investigated showing 100% result, the sample S1, S2, S3, S4 and PU.

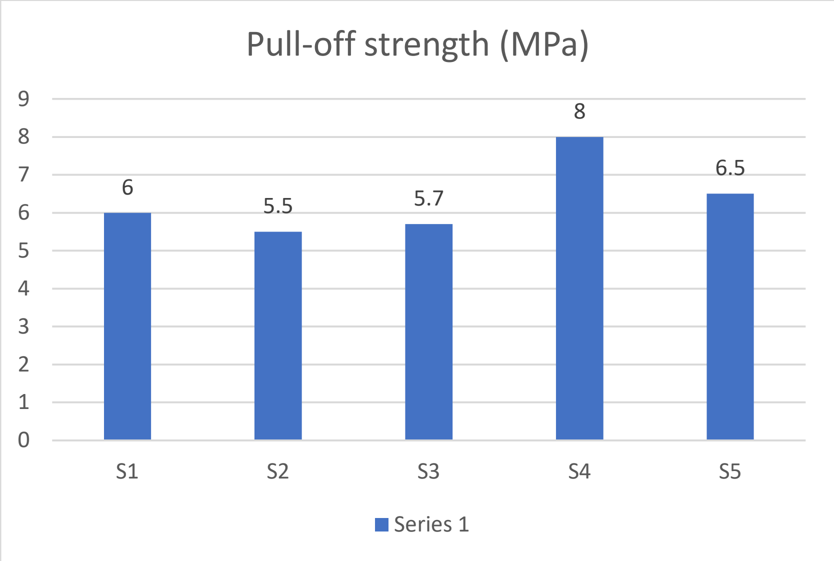


Fig 3(a): Pull off strength for different samples

Water absorbency property

The samples show good water absorption performance with practical application of vegan leather. The water absorption property was analyzed for further charecteristics. **Figure 3** shows the water capacity of the sample with 24hrs interval andmaterial quality. Results obtained shows the absorpancy from range 25-50% and the lowest for S2 and S3. Low water absorbancy was achieved from all the samples indicating good adhesion and strong presence of hydrogen interaction.

In the below study environmentally friendly vegan leather was produced using Jackfruit and successfully characterized. The material produced from agro-waste with comparision with KBC, maple leaf pulp, dry waste and bio polymers. SEM analysis shows the material pores and breathability. The tensile strength test shows the sample flexibility and mechanical property. The amount of KBC, PVA, PCL and PLA with mechanical stability in the samples.The water absorbancy indicates the value obtained slightly higher than required. The sample shows the progress towards performance with material leather alternative in fashion industry.

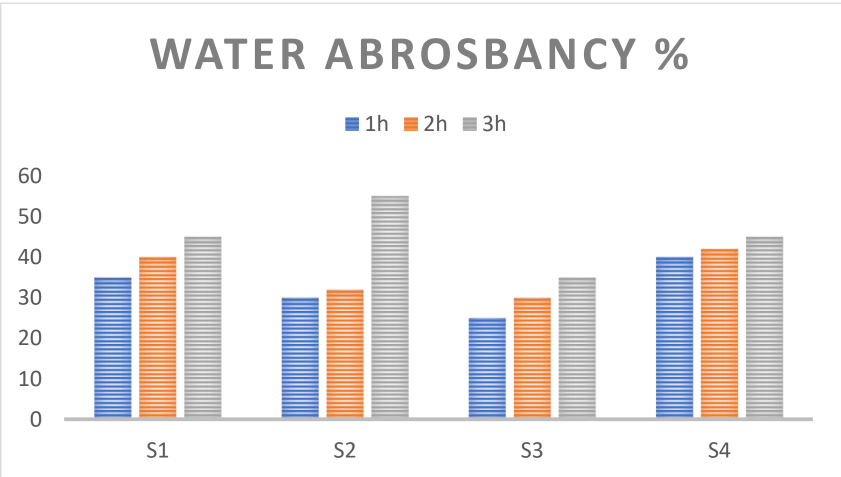


Fig 3: Water absorbance % of the sample material

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