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DIMENSIONAL STABILITY AND STRUCTURAL PROPERTIES OF CORK-BASED MATERIAL FOR SUSTAINABLE FASHION APPLICATION

Purpose. *The purpose of this research is to evaluate the effects of repeated washing cycles on the dimensional stability, structure, and performance of a cork-based material. Understanding these changes is essential for determining the material's long-term durability and suitability for use in sustainable fashion applications.*

Keywords: *cork, sustainability, leather alternatives, dimensional stability.*

Objectives. The objective of this study is to investigate the dimensional stability and structural behavior of a cork-based material after multiple washing cycles, in order to evaluate its durability and potential application in sustainable fashion products

Methodology. The experimental research was conducted to evaluate the dimensional stability and structural behavior of a cork-based material after multiple washing cycles.

Research. Recently, the textile and clothing industry has been facing increasing sustainability challenges. The high consumption of clothing generates a large increase in resource consumption and waste generation, which places the fashion industry on the list of industries with the largest economy, but also with a large negative impact on society and the environment. The life of garments begins with raw materials and textile production, and continues with design to production, transport, distribution, consumption and reuse and recycling, and becomes a new textile or other product. In order to achieve a circular production cycle, it is necessary that shoes, clothing and fashion accessories are made from bio-based, renewable, recycled or biodegradable fibers and sources. By choosing the products made from these materials, it is possible to achieve minimal climate impact. Given that synthetic fibers account for about 57% of the global fiber market, according to 2024 data, and they have a very large negative impact on the environment, we should increasingly use the new biodegradable natural textile materials (1 - 4).

Materials derived from natural sources such as pineapple leaves, apple residues, and cork have emerged as promising sustainable solutions. Their renewable origin, biodegradability, and reduced environmental impact make them suitable for replacing conventional animal and synthetic leathers in apparel and accessories.

Natural leather obtained from cattle (cows, sheep, goats) is tanned with chemicals that include chromium, lead, arsenic, other heavy metals and toxins, adversely affecting the health of workers in this industry. It is characterized by high porosity, air permeability (through the pores), easy absorption of liquids and odors. Washing cannot be done at home and needs care. With adequate maintenance, this material can last for decades, where it gains patina and visual attractiveness over time (3,4)

Synthetic leather is available in a wide range of colors, the pores on its surface are uniformly distributed. The edge is uniform, clean and consistent. It is thinner, lighter in weight, waterproof, has a lifespan of about one year, and its wear and tear are indicated by cracking of the surface. Artificial material does not allow the human skin to breathe, and the garments are less comfortable to wear.

Analysts from Infinitum Global predict that demand for vegan leather will increase by 49.9% by 2025 (5). Vegan leather is approximately three times cheaper than traditional animal leather, which explains its strong appeal, particularly among middle-class consumers (5)

There are two groups of leather alternatives:

1. Vegan leather that contains PU and PVC (with a plastic coating) (releases dioxins that are easily flammable and dangerous indoors) and
2. Alternative eco-friendly materials. (3,4)

There are many sustainable brands: Corkor, which use cork in the production of leather goods, sneakers made from pineapple fibers are an ethical product of the company Nae Vegan Shoes (6, 7)

Cork material is an innovative, sustainable, vegan and environmentally friendly solution, as well as a renewable alternative to animal skin. The material is made from the outer bark of the cork oak (*Quercus suber* L.), which has been collected from this plant species for more than five millennia. Cork oak is native to the western Mediterranean basin, with the largest cork production areas in Portugal (Alentejo region) and Spain, followed by Italy, France and North Africa (Algeria, Morocco and Tunisia). The trees of this plant species are of medium height (15–20 m), with a wide canopy (8,9).

The cork is compressed into large blocks, which are then cut into thin sheets and it can be combined with a textile backing (laminated), usually cotton, linen or hemp, to increase durability. This process of joining

the substrate and the cork is done using suberin - a natural glue. Cork leather alternative can be painted by full immersion in paint before applying the base. Manufacturers usually use vegetable dyes and organic substrate in order to produce a completely ecological biodegradable product (6,7)



Fig. 1. Cork leather alternative (photo taken by authors)

The experimental investigation was carried out on a cork-based material. The sample consisted of 100% cork sheet. The key physical parameters of the material are presented in Table 1.

Material	Composition	Surface mass (g/m^2)	Thickness (mm)
Cork	100% cork	144,8	1,18

The material thickness was measured using a thickness gauge with two parallel metallic plates under a pressure of 50 cN/cm², following ISO 9073-2:1995.

The dimensional stability of the cork material was examined to evaluate its linear dimensional changes after repeated washing and drying cycles. This property reflects the internal stresses introduced during production and the material's resistance to shrinkage or elongation under the influence of water and mechanical action. The test was conducted according to ISO 3759:2011. Each sample measured 500 × 500 mm, with edges cut parallel to the warp and weft directions. The samples were laid flat on a smooth surface without stretching, and reference marks were applied using a ruler, as illustrated in Figure 2.

The washing and drying processes were performed in accordance with ISO 6330:2012 (Textiles – Domestic washing and drying procedures for textile testing) (10). Samples were washed in a Gorenje WA 583 domestic washing machine, using the wool/delicate cycle with a high-water level and gentle agitation, at a temperature of 40 °C for 30 minutes. After

washing, the samples were placed on a flat, smooth surface and air-dried at room temperature (20 ± 2 °C) for 5 to 20 hours.

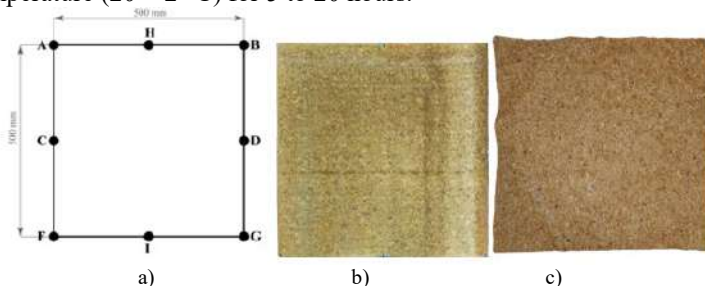


Fig. 2. a) Reference points b) Cork material before washing;
c) Cork material after three washing cycles

Dimensional changes were determined by measuring length and width before and after each washing and drying cycle. The original dimensions of the samples before testing (L_0) were 500×500 mm. Measurements were then taken after washing (L_1) while the samples were still wet, and after drying (L_2).

The dimensional change ($\Delta\%$) was calculated according to the following equation:

$$\Delta (\%) = \frac{L_1 - L_0}{L_0} \cdot 100[\%]$$

Measurements were conducted in both horizontal (AB, CD, FG) and vertical directions (AF, HI, BG). After the initial test, the samples were subjected to two additional washing and drying cycles.

The dimensional stability values obtained after each cycle are presented in Tables 2.

	Change of dimensions horizontally [%]	Change of dimensions vertically [%]
I wash	+0,367	-0,533
II wash	-0,365	-0,402
III wash	0,000	-0,101
Total	+0,001	-1,036

Conclusion. The conducted research focused on evaluating the dimensional stability and structural behaviour of a cork-based material after multiple washing and drying cycles under ambient conditions.

The obtained results indicate that after the first washing cycle, a slight dimensional increase in width (+0.367%) and minor shrinkage in the vertical direction (−0.533%) were recorded. During the third washing and

drying cycles, no additional changes in the horizontal direction were observed, and a minor shrinkage is observed in vertical direction. The total shrinkage in the vertical direction reached approximately 1%.

Based on the overall findings, it can be concluded that the tested cork-based material demonstrates satisfactory dimensional stability, with total shrinkage or elongation not exceeding 1.7%. Such performance confirms its potential suitability for use in sustainable fashion and design applications, including accessories (bags, wallets), footwear, apparel components, and furniture upholstery.

The material's stability, combined with its renewable origin and biodegradability, positions cork as a promising eco-friendly alternative to animal and synthetic leathers, supporting the development of circular and sustainable production models within the textile and fashion industries.

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