Leather: Often copied, never equalled

Leather is leather! In the European Union, "*leather*" is not a legally protected term. As such, the numerous alternatives use this term in their descriptions, in an attempt to appropriate the unique properties of the original. The umbrella organisation of European tanners' associations, COTANCE, wanted to know whether these alternatives can actually claim to have the same advantages as the original.

For this purpose, samples were procured and made available to the independent Research Institute for Leather and Synthetic Materials (FILK) in Freiberg. FILK was able to **examine the material properties of ten of the most frequently referenced alternatives** to leather. The result of this study "Trend Alternatives for Leather" is now available. **None of the tested substitutes exhibited all of the performance characteristics of leather** and some contained chemicals of concern.

Why is leather so worthy of imitation?

The fascination for one of the oldest natural materials in the world remains unchanged. No wonder, because the material is a true all-rounder. It not only lends a noble touch to fashion, footwear, accessories and furniture, but brings many functional properties such as durability, tear resistance and breathability.

Leather comes from a by-product of the food industry; European tanneries process the hides and skins that are left over from food production. If this further processing did not exist, they would have to be disposed of. No animals are killed for leather production in the EU.

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The manufacture of leather is a complex and technical process, involving a great deal of manual skill. It is therefore, often more expensive to produce than its imitators. In addition, it is not available in unlimited quantities. For these reasons, research and development of substitutes for leather is being carried out at full speed. In recent years, renewable raw materials have become the focus of research and development activities.

According to the study, **these newly developed materials can be divided into three groups:**

- Materials with a predominantly natural base, such as "*MuSkin",* which do not require plastics.
- Those that are predominantly made of plastics.
- Products made exclusively of plastics, such as classic PVC or PUR.

An example of the products found in the middle group is "*Desserto*", a mixture of natural raw materials (cactus fibres) and plastic (textile carrier fabric made of polyester, with two layers of polyurethane on top); in this case the product is 65% polyurethane.

These materials are advertised as a more environmentally friendly alternative to leather. However, there is **often a lack of transparency**, with concrete information on the respective ingredients and material properties simply omitted. This is where the current study "*Trend Alternatives for Leather*" enters into play.

Put to the test: material properties of leather and substitutes.

On first inspection, some of these substitutes hardly differ from a leather product. In addition, their product names often use the word "*leather*", which many buyers associate with the positive quality characteristics of leather.

The study examined the nature and physical attributes of these alternative materials. The FILK **experts carried out various standardised physical and chemical tests on eight recent substitutes**, plastic alternative and, as a reference, also on genuine leather.

The original is always better than its copy.

Within the test series, the experts also took a close look at the typical characteristics of leather such as cracking strength, tear resistance, water vapour permeability and the absorption of water vapour, for all the materials.

They found that none of the tested substitutes can truly be called an "alternative" for leather.

Technical progress has achieved that individual properties of the tested substitute materials are similar here and there, but this was by no means true for all of them. In particular, water vapour absorption and water vapour permeability scored significantly lower than leather.

Leather is also superior to its competitors in terms of longevity and useful life, as shown by its superior performance in tests of durability such a flex and tear resistance.

The study result documents that so far, leather is far superior to its substitutes with all its natural properties. No substitute can claim them all. Without a doubt, the different materials tested cannot replace the original.

It is important that customers and consumers understand the performance deficit of the alternative materials and give this proper consideration to ensure that the products they buy will perform as they expect them to.

Read the scientific paper from FILK here: https://doi.org/10.3390/coatings11020226

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Annex: Summary of the FILK Study on Leather and alternatives

Study 2020/21: *Trend substitutes*

Contents

The study was carried out in accordance with the appropriate European standards. You can read the results in FILK's final report on the study here: https://www.mdpi.com/2079-6412/11/2/226.

1. Nature of Materials

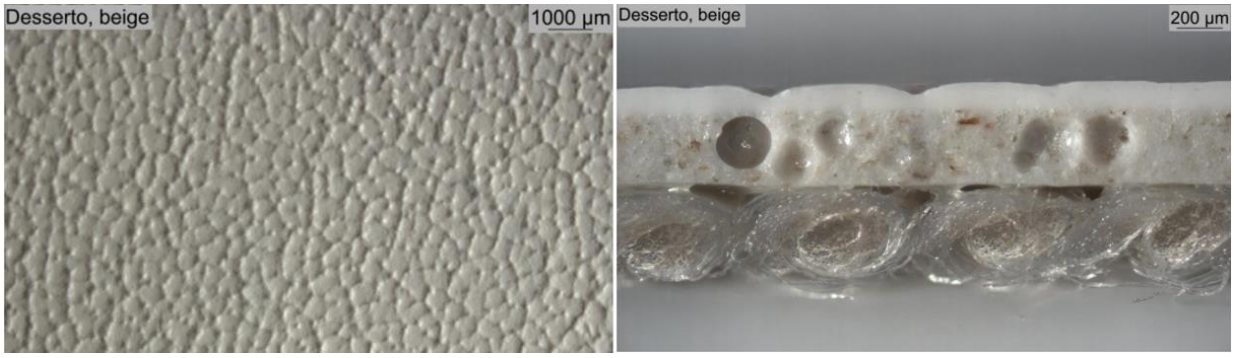
Desserto

According to the manufacturer: made from vegetable matter, using dried cactus material, mixed with non-toxic chemicals; mouldable; polyester-cotton fabric (knitted or woven) on the reverse side; no further details on the ingredients.

We found: PUR-coated textile with solid and partially foamed layer underneath; the foamed layer is filled with heterogeneous particles of polyacrylate of organic origin; made by reverse coating process; the textile backing is polyester.

How it feels: soft and malleable, but the surface comparatively rough and artificial.

(Photos of the surface and the cross-section, light microscope, Desserto)



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Pinatex

According to the manufacturer: non-woven fabric made of pineapple leaf fibres and PLA (polylactic acid); coated with pigmented resin or over-moulded with a high-strength PUR film.

We found: Non-woven fabric made from natural fibres; coated with a thin polymeric layer (similar to polyacrylate).

How it feels: stiffer material with a surface that is perceived as uneven, hard and artificial.

(Photos of the surface and cross-section, light microscope, Pinatex).

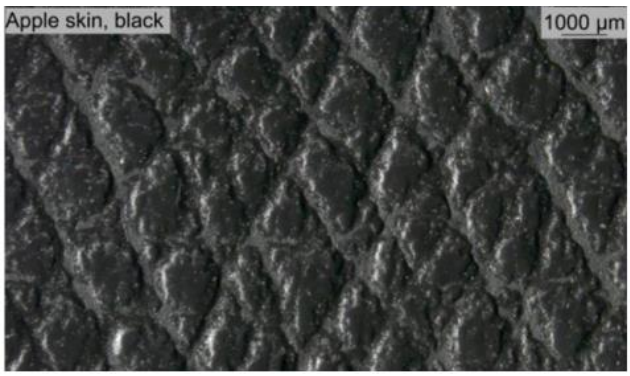
Apple leather

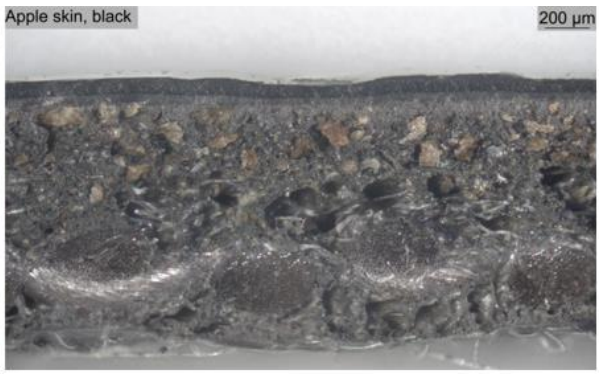
According to the manufacturer: coated fabric produced by a coagulation process; coating filled with 50% dry powder from apple residues from juice production; breathable, smooth, durable.

We found: a textile (polyester) impregnated with PUR; coated with a foamed layer (PUR); filled with organic particles; finished with thin compact layers (PUR).

How it feels: malleable material; evenly structured surface.

(Photos of the surface and the cross-section, light microscope, "Apple skin")





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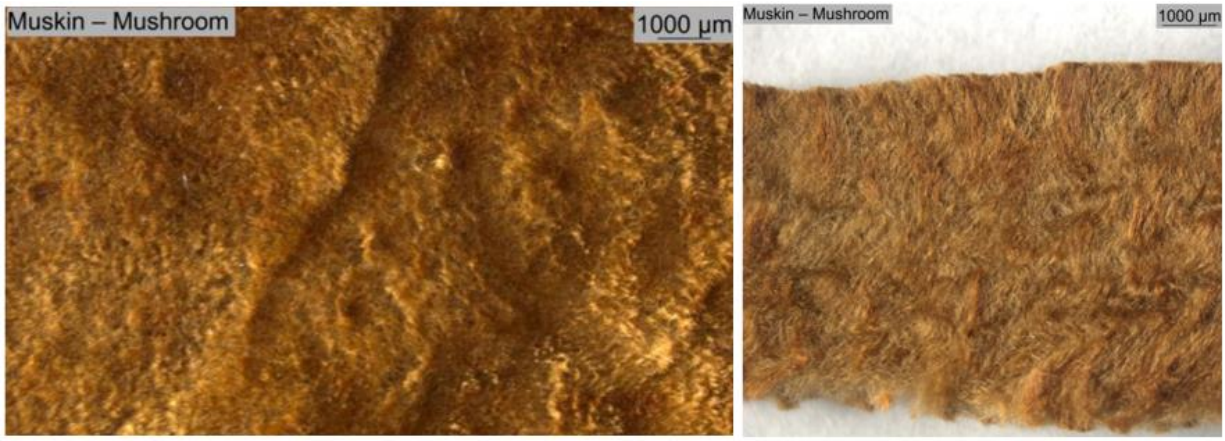
MuSkin

According to the manufacturer: a vegetable material made from a parasitic fungus.

We found: a finely porous material in a single layer; no coating or textile backing.

How it feels: soft surface; rough suede-like feel.

(Photos of the surface and the cross-section, light microscope, MuSkin)



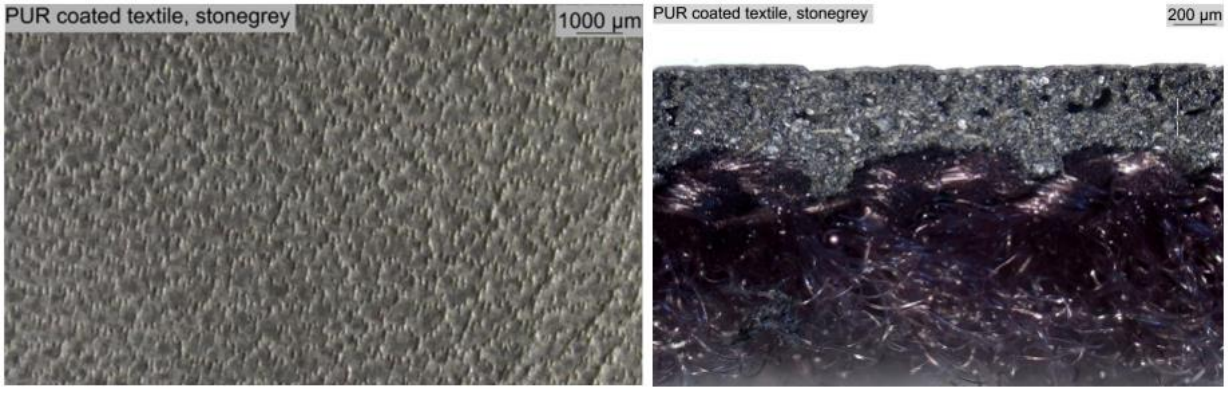
Synthetics (marketed under the term artificial leather)

According to the manufacturer: PUR-coated textile produced by a coagulation process; thin compact layer and foamed layer underneath; fillers inside; polyester-based woven textile.

We found: a coagulated PUR fabric with a thin compact top layer and an under layer of composite material with fillers based on microcrystalline cellulose.

How it feels: soft, malleable material; blocky surface; feels not authentic.

(Photos of the surface and the cross-section, light microscope, artificial leather)



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SnapPap

According to the manufacturer: paper-plastic mixture mimicking leather; made of cellulose (> 60 %), latex, with colour pigments; tear-resistant, abrasion-resistant, no linting, washable, sewable; vegan; for use in purses, clothing.

We found: a dense composite material made of cellulose fibres, impregnated with an acrylic-based polymer.

How it feels: stiff and rigid material; hard and rough to the touch, like cardboard.

(Photos of the surface and the cross-section, light microscope, SnapPap)

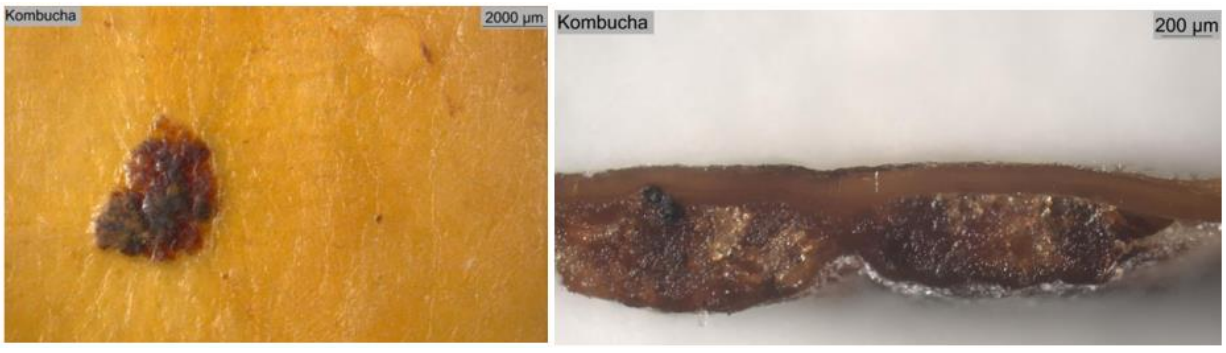
Kombucha

According to the manufacturer: a sustainable fabric made from green tea fermented with symbiotic yeast and bacteria; versatile, imitates leather, canvas and silk.

We found: a dense and compact polysaccharide-based material; yellowish translucent, with some heterogeneous inclusions.

How it feels: unevenly soft material, very sticky surface; unpleasant smell.

(Photos of the surface and cross-section, light microscope, Kombucha).



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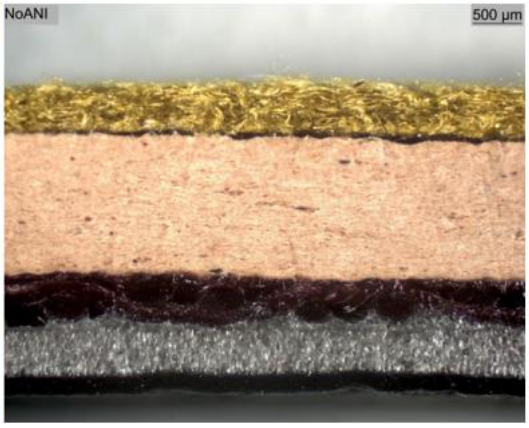
Noani

According to the manufacturer: various eco-friendly materials made from eucalyptus and pineapple fibres or recycled polyester or PUR-coated textile with apple remnants (apple skin); vegan, without toxic chrome or pesticides; according to the website, Made in Italy, according to the stamp on the product, Made in Germany; versatile, breathable, soft, light and flexible; PETA-approved; used in belts, bags, fashion.

We found: Composite material made of three different layers: 1. top layer - microfibre material (polyester), 2. middle layer - leather fibre board, 3. back: conventional PUR coated fabric.

How it feels: natural looking, soft material with a velvety and warm feel.

(Photos of the surface and cross-section, light microscope, Noani).



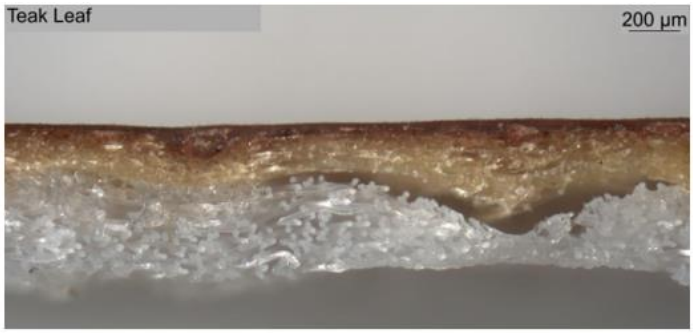
Teak-Leaf

According to the manufacturer: products made from a renewable material, from teak leaves that have fallen to the ground; strong and durable; vegan; used in fashion, accessories, bags, purses.

We found: Leaves laminated with a transparent film, on the back also laminated with two layers of fabric, the outside being fleece made of polypropylenes.

How it feels: slightly deformable material, hard and stiff coating, surface naturally structured, artificial feel.

(Photos of the surface and cross-section, light microscope, teak leaf)



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Vegea

According to the manufacturer: plant-based alternative material; use of renewable raw materials from biomass such as vegetable oils and fibres from agro-industry (e.g. wine residues); use of biopolymers for coating; vegan; application in fashion, furniture, packaging, automotive and transport.

We found: a PUR-coated textile with compact layer and partially foamed layer underneath, the compact layer is filled with some particles.

How it feels: soft and malleable material, artificial feel.

(Photos of the surface and the cross-section, light microscope, Vegea)

Leather (Reference)

According to the manufacturer: a chrome-tanned full-grain cowhide, lightly embossed, suitable for everyday use.

We found: full-grain cowhide; dyed brown; typical leather structure; provided with a very thin and open top layer.

How it feels: firm and voluminous material with a finely structured surface;

soft feel.

(Photos of the surface and cross-section, light microscope, leather).

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2. Properties of the materials (Reference: Shoe upper leather)

The properties required by leather or any other material are determined by the final application. For example, the leather of a shoe should stretch during use, but not lose its shape after use. Where the leather/material has been sewn, it must be able to withstand the stresses of use. The limits given in the relevant standards (ISO 20942, ISO 14930 and ISO 14931) are appropriate for the stresses in the shoe. As a general rule, any material must be able to withstand the stress scenarios caused by use in order to be suitable for the corresponding application.

a) Stress and elongation properties / tensile strength (Tensile Strength)

Why this test?

It measures how quickly a material will "wear out" or lose its shape. The material should not permanently deform during processing and stress.

The standard specifies that a value of at least 15 N/mm2 should be achieved.

Leather achieved a value of 39.5 N/mm2.

Values of more than 15 N/mm2 were achieved by : SnapPap (24.9 N/mm2); Desserto (20.8 N/mm2) and; Noani (15.8 N/mm2). All other materials were clearly below this, e.g. MuSkin with 0.2 N/mm2.

b) Tear Load

Why this test?

A shoe has to be sewn and glued. Therefore, it is important that the material does not tear/continue to tear at the seams or at the cut edges. In order for this not to happen, the material must reach certain values.

According to the standard, a value of over 20 N should be achieved.

Leather, as a reference, achieves 142 N.

Pinatex (53 N), Noani (40 N), Desserto (33 N) and Apple skin (32 N) are also above 20 N in this test. The other materials were below this, sometimes very clearly, such as Kombucha (2 N).

c) Water vapour absorption

Why this test?

This is about comfort in use. If the material can absorb moisture from the air in the shoe, feet will not feel damp or sweaty. The higher this value, the longer you can wear the shoe without getting damp feet.

The test measures how much water vapour can be absorbed. A limit or standard value is not specified here. In our test, leather achieved a value of 8.4 mg/cm2. Kombucha achieved a value of 9.2 mg/cm2, which is slightly higher than leather.

MuSkin achieved 6 mg/cm2 and all other materials were considerably below these values.

d) Water vapour permeability

Why this test?

This property also belongs in the category of comfort. Since feet always produce moisture, it must be wicked away, otherwise the feet will become sweaty. Either the leather/material can absorb the moisture, by absorbing water vapour (as described in c)), or it can allow the moisture to pass through. Of course, permeability can also be achieved by making holes in the material. However, holes also mean that moisture (water) penetrates from the outside to the inside. If it rains, your feet will still be wet.

For leather there is a minimum value of 2 mg/(cm2xh). The leather reached a value of 4.6 mg/(cm2xh). MuSkin (10.4 mg/(cm2xh)), SnapPap (10.3 mg/(cm2xh)) clearly exceeded this value. All other materials, especially those based on plastic, hardly achieved any values.

e) Water vapour number

Why this value?

The longer you wear a shoe, especially during active use, it will feel comfortable if your feet stay dry. Well-suited materials such as leather have good water vapour absorption and a water vapour permeability. The combination of the two, the water vapour number, makes it easier to evaluate, although it should be noted that very high values indicate high permeability, which means that moisture can also penetrate from the outside. The only thing that is clear is that very low values mean that the material can neither absorb nor transmit moisture, which can quickly mean a sweaty, wet feeling in the shoe.

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This value is a combination of water vapour absorption and water vapour permeability. A value of at least 15 mg/cm2 is prescribed for leather. The leather achieved a value of 45.2 mg/cm2. This value was exceeded by MuSkin (89.2 mg/cm2) and SnapPap (86.1 mg/cm2). Pinatex reached the value required for leather with 23.8 mg/cm2. All other materials fell short of this requirement.

f) Flex resistance

Why this test?

If materials consist of several layers, this test gives an indication of how likely the material is to crack due to folding. Moisture and dirt penetrate such cracks and damage or break the material. The durability of the material can be deduced from this.

The number of flexes the material can withstand without cracking are counted. For example, for shoe applications, the ISO 20942 specification defines a minimum of 80,000 flexes without cracking. The shoe upper leather achieved more than 200,000 folds. This value was also achieved by “artificial leather”, Pinatex and Noani (as a single layer material). All the other materials were below the specified value, in some cases considerably so, e.g. Teak-Leaf with only 100 folds.

3. Critical Substances

Why did we want to know this?

We live in a world that has improved significantly in terms of environmental protection. However, increasingly precise measurement methods show that we must continue to remain alert here. As consumers, we want to be as sure as possible that the production of materials is environmentally friendly, but we also want the materials we use not to have adverse effects on our immediate environment. So, we wanted to know whether the materials we examined release critical substances.

We measured critical components that are released, for example, when the material is exposed to heat. The method is used for textiles, carpets, leather, plastic parts, etc. to determine emissions.

No critical emissions were recorded for leather, MuSkin, SnapPap, Noani or Teak Leaf.

Critical substances were measured in the remaining materials. For example, pesticides were measured in Desserto. Plasticisers were measured in Desserto and Pinatex. Further substances such as butanonoxime, toluene, free isocyanate, etc., were found and are reported in the study.

Note: In this context, we found it at least critical that Noani is advertised as vegan, but was to contain leather fibre, i.e. that animal components were used.

4. Conclusion

Leather is unique. So far, it has not been possible to replace leather.

From our point of view, the materials that are claimed to be alternatives to leather can be divided into three broad clusters:

1. Materials with a natural base, with small proportions of non-natural materials.

We include materials that have a natural base, similar to leather. Such as MuSkin, Kombucha, SnapPap, real and genuine attempts to do without plastics as much as possible.

2. Material, predominantly plastic, but with proportions of natural materials.

With these materials, one is predominantly in the area of plastics. In some cases, so-called bioplastics are used and certain components such as fabrics or fillers are replaced by materials with a natural base: Apple leather, Desserto, Pinatex, Vegea, Teak-Leaf.

3. Materials made of synthetics, which include "artificial leather".

These materials differ greatly and cannot achieve the properties expected of a shoe upper leather. Thus, these materials cannot be called "leather", either according to the definition of leather or according to the properties of leather.

Consumer must be able to decide what they want. To do so, they must know what they are buying. Misleading terms do not help. This study provides clarity and makes it clear that leather is a special, natural material that humanity, even with a great deal of know-how, has not yet been able to reproduce with all its properties.