



*INESCOP biodegradation equipment
based on ISO 20136: 2017.
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Assessing the biodegradability of leather

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A growing consumer interest in more sustainable products, as well as government demands to create more environmentally-friendly consumer goods, has led the leather industry to embrace the use of alternative tanning agents and processes that promote faster and more eco-friendly degradation of leather at the end of its useful life. In furtherance of this, INESCOP has recently developed a technology for the quantification and assessment of leather biodegradation processes in a fast and efficient manner. This technology, which is based on the International Standard ISO 20136, allows the accelerated assessment of such processes so that it becomes possible to determine in a relatively short period of time (just 30 days), the biodegradation profile of materials that

could take years to degrade in a natural environment.

Sustainability is a key factor for the viability of the entire leather industry. Indeed, its environmental impact is clearly a major concern for the most dynamic, prestigious and progressive brands. A major challenge for the leather industry today, therefore, is the introduction of innovative and resource-efficient processes to reduce or avoid the use of water, energy, hazardous chemicals and waste.

This need is due to the fact that the market is changing. On the one hand, consumers and brands are becoming increasingly aware of the need for ethical sourcing. On the other hand, it is also due to the introduction and enforcement of European legislation on certain chemicals. Furthermore, the

leather industry needs to reduce its environmental footprint as a way to improve competitiveness, so this change can be regarded as a business opportunity. As a result, the industry is working on the development of more sustainable leather products based on greener tanning processes and improving degradability at the end of their life cycles, among other sustainable approaches.

New methodologies

For this reason, new test methodologies are now required in order to evaluate the biodegradability of leather within relatively short timescales and at affordable costs. This is seen as a necessary alternative to current methods that entail long test times and high costs or even the performance of



Table 1: Percentage of Carbon (12C) present in the evaluated leather samples.

Tanning	Elemental Analysis (%)				
	Leather	Carbon	Nitrogen	Sulfur	Hydrogen
Oxazolidine 3% + Synthetic 15%	1	44.76	14.02	1.25	7.50
Titanium 1% + Synthetic 15% (green)	2	46.35	15.37	0.00	6.97
Chromium 3% + Synthetic 15%	3	41.72	13.68	0.51	6.85

field tests, the length of which can extend to several years. To this end, the International Standard ISO 20136:2017 - Leather - Determination of degradability by microorganisms, was published in 2017.

On the basis of the procedure described in this standard, INESCOP has developed a fully automated system based on an in-house technology that enables the biodegradation processes of leather to be quantified and evaluated quickly and efficiently. The system follows methodology B of ISO 20136, which uses infrared detectors to quantify CO₂ production during the degradation of leather by aerobic microorganisms. Pressure, temperature and airflow rate are also managed by software specifically developed for the purpose.

Up to four different samples can be simultaneously evaluated in duplicate, including both the positive and negative controls that are necessary to test validation according to the standard. The positive control, pure collagen,

must degrade by at least 70% in 30 days for the test to be considered valid. The negative control corresponds to the culture medium and inoculum¹. In this way, the system can determine the CO₂ produced purely as a consequence of the biodegradation of the sample in order to calculate the biodegradation percentage.

In order to corroborate the results of the laboratory tests conducted according to the standard, field tests have been carried out with the same leathers. These were conducted in a biological tank at the Spanish tannery Segorbe S.L., from where the inoculum for laboratory tests was also obtained. Three different types of tanned leathers based on oxazolidine, titanium and chromium respectively, were evaluated. Table 1 includes relevant information regarding each tanning process.

Two types of test samples were prepared:

1. 20 x 20 cm² leather pieces
2. Shoes made using these leathers

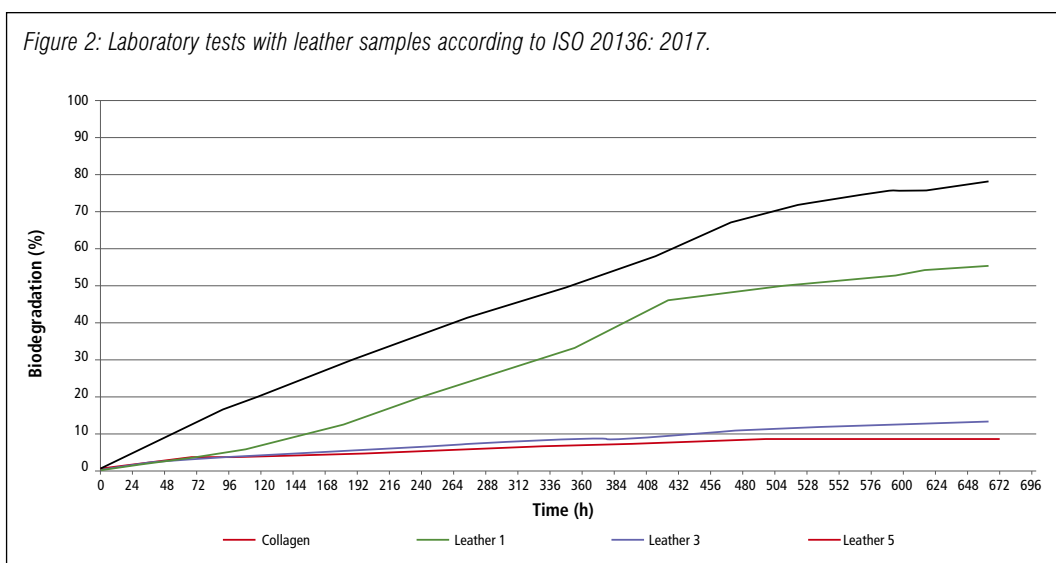
Both were immersed in the tank for a period of five months. After the biodegradation process was complete, the physical properties of the leather samples were evaluated as a function of the elapsed time (Figures 1 and 2).

Figure 1 shows that after 45 days, the pure collagen sample was already quite deteriorated, while the tanned leather samples still showed no visible deterioration. However, after 90 days of testing, the pure collagen samples were already completely degraded, making it impossible to recover them from the tank. Leather sample 1 already showed a high degree of degradation, both in terms of mass loss as well as the integrity of the leather itself. In contrast, samples 2 and 3 did not show any mass loss and, once dry, presented a rigid appearance although without significant changes in the material. After 120 days of field testing, sample 1 had completely degraded. Samples 2 and 3 maintained both their physical integrity and their mass until the end of the test at 150 days.

Figure 1: Field tests with biological tannery tank wastewater.

	Pure Collagen	Leather 1	Leather 2	Leather 3
Time 0 days				
Time 45 days				
Time 90 days	Degraded			
Time 120 days	Degraded	Degraded		
Time 150 days	Degraded	Degraded		

	Leather 1	Leather 2	Leather 3
Time 0 days			
Time 45 days			
Time 90 days			
Time 120 days			
Time 150 days			



The results obtained in the field test were compared with the results of the laboratory test conducted with the INESCOP biodegradation system (Figures 2 and 3). Figure 2 shows clear differences between the leather samples evaluated depending on their type of tanning in accordance with earlier field tests.

According to previous results, it can be concluded that there is a direct correlation between both biodegradation lab tests and field tests. It means that the greater the degradation percentage that a certain material obtains through the ISO 20136 standard, the more biodegradable that material will be. Nevertheless, the degradation time required in the field test for materials will depend on a series

of both biotic (microorganisms present, the degradation capacity of these microorganisms) and abiotic (temperature, humidity, etc.) factors that directly influence microbial effectiveness during degradation.

The system developed by INESCOP for biodegradation assessments has been verified and validated in the framework of different research projects where numerous tests have been conducted using laboratory-produced and commercial leathers. Furthermore, the equipment and system have been patented (ES-1233561_U) and been awarded with the Best Innovation in Biotechnology in Spain during 2019 by the Spanish Inventors Association.

Finally, evaluation of a leather's biodegradation allows companies,

concerned with their products' environmental footprint reduction, to evaluate the effectiveness of improvements made in relation to a product's biodegradation at the end of its life cycle. This contributes to current European regulations regarding the circular economy and the sustainable development of the industry, as well as achieving Sustainable Development Goals (SDG) 2030, particularly SDG 12 relating to responsible consumption and production. 🌱

1) *Inoculum in the microbiological sense refers to a small amount of substance containing bacteria from a pure culture which is used to start a new culture.*

