

Hemp and flax shoe soles bring footwear a step closer to sustainability

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In a lab on the outskirts of the small city of Huesca in Spain, shoes are the main topic of conversation – the priority, however, isn't fashion. Over the last two years, scientists at the company Podoactiva have been trying to create customised shoe soles using hemp and flax without sacrificing anything in terms of the most important aspect of a shoe: functionality.

“The idea was to print prototypes through 3D printing with sustainable materials,” said Marina Azpíroz, research and innovation manager at Podoactiva. At Podoactiva, the focus is on developing customised insoles for patients with health issues centred around their feet. The sole was produced as part of the EU-funded [INN-PRESSME](#) project, which supports researchers and companies in nine countries developing bio-based products.

Globally, around 24 billion pairs of shoes [are produced](#) every year – roughly three pairs for every person on Earth. One environmental agency found that the footwear industry is responsible for around [1.4%](#) of annual global emissions, more than [many developed](#) nation states.

Aside from emissions, shoes are often made out of materials derived from fossil fuels. Data shows that one pair of shoes can [take up to 30 or 40 years](#) to biodegrade, demonstrating the need to move towards more sustainable materials.

Prototype

Research suggests that materials made from plants can be [completely degraded](#) in comparison to fossil fuel alternatives. That's one of the main reasons that the INN-PRESSME project has decided to focus on creating functional materials from hemp and flax, though it's not the only one.

“Natural fibres are from renewable resources, are relatively low-cost, and have specific strength and stiffness,” said Ulla Forsström, principal scientist at VTT Technical Research Centre of Finland Ltd, and co-ordinator of the project.

An important part of the work for Podoactiva is that their insoles, which have been designed to help patients with foot issues, could be used within and integrated in the sole. The insoles also add a therapeutic function.

Development of the sole took two years in total, and it wasn't always smooth sailing. The initial prototype didn't meet the functionality requirements, forcing the researchers to go back to the drawing board.

“The mesh that we produced was not the most optimal, so we moved to a different structure,” said Ignacio Colom Díaz, researcher and specialist in 3D design and printing at Podoactiva.

After a redesign, using lessons learned from the previous attempts, the final prototype produced promising results.

“The results have been very good in terms of functionality,” said Azpíroz when referring to the final prototype that was developed.

The prototype has undergone rigorous testing. One experiment involved flexing the sole 10,000 times, mimicking the normal flexion that occurs during human walking. Results showed that there was no damage to the sole, nor was it permanently deformed.

Aside from that, the sole has been shown to have antimicrobial properties, meaning that on top of its sustainable credentials, it could contribute to a world where smelly shoes are a thing of the past.

The production of the sole was a collaborative effort, with many researchers and organisations from across Spain, and Europe more broadly, involved. The company aitiip was responsible for the 3D printing, for example, whereas a coating used in the insole came from the Fraunhofer ISC in Germany.

The remainder of the shoe, a necessity for testing the sole properly, was designed using 100% recycled materials.

Same shoes, smaller footprint

The use of 3D printing not only allows the reduction of waste, it also offers other advantages too. “3D printing is a novel alternative that allows versatility, customisation, affordability, and rapid production of different parts,” said Forsström.

A total of four pairs of the final prototype were printed, and Podoactiva are continuing to work with real patients to validate the design.

Although the shoe was designed with a foot health focus in mind, there is no reason the materials developed during the project couldn’t be more broadly used in the fashion industry.

Research [has found](#) that only around 5% of shoes are recycled. There is, however, some movement in the industry towards the circular economy. One company in Japan, for example, [recycles old tyres into shoe soles](#), and many others are [turning used plastic bottles into footwear](#). Still, it’s early days, meaning there is still space in the market.

In the future, the hemp and flax materials designed during the INN-PRESSME project could be at the centre of the sustainable, smell-free shoes of the future.