Researcher develops fungi-based dye for leather

The substance is less damaging to the environment than the synthetic ones currently used in the industry

Report: Nathália Cassola

The research was conducted by the chemical engineer Wagner Fernando Fuck at the Laboratory of Studies in Leather and Environment of UFRGS (Laboratório de Estudos em Couro e Meio Ambiente - LACOURO) – Image: Rochele Zandavalli/UFRGS

Brazil is the biggest leather producer in South America, having the largest commercial cattle herd in the world. According to data, from 2018, from the Brazilian Association of Chemists and Technicians of the Leather Industry, the Brazilian annual production is of 352 tons, the equivalent of 13% of the global market. A research of the Foreign Trade Secretariat from the same year points out the state of Rio Grande do Sul as the leader in exports in the country. Approximately 90% of the leather produced in the world is dyed with azo dyes, which are synthetized in laboratories. As stated by the Asthma and Allergy Foundation of America, some of these dyes can even be dangerous to human health, because they transfer carcinogen compounds to the skin, and have their use restricted. The leather industry also pollutes effluents with residues of dyes which are not fixed to the leather, such substances have low degradability and high toxicity. The control requirements of these substances in leather have been growing with the implementation of regulations and promotion of sustainable environmental practices, which focus on optimizing the chemicals used during the production. In Brazil, this is a process which is starting; researchers and industries of the area are searching for new dyeing alternatives. In this context, dyes extracted from fungi are a promising option for the industry, as the research conducted by Wagner Fernando Fuck for his doctoral dissertation, developed in the Post Graduate Program in Chemical Engineering of UFRGS, has demonstrated. "The initial focus of the project was to research for a source of dye that was more sustainable," he explains.

It is the waste of the fungi, such as the black mould that can be seen in ceilings and walls, which concentrate the dyeing power of these organisms. Obtained from partnerships with other laboratories, they are cultivated in aqueous solutions inside bioreactors and take around 12 days to produce the color which will then be filtered and utilized. Nine different species of fungi were tested in order to verify their productivity and if they generated colorful extracts. Each species can originate a type of color. From this selection, the researcher chose the *Monascus purpureus,* which produces the color red, to continue with the research. The majority of the other fungi that were tested also have the potential of producing dyes, although this has not been sufficiently studied yet. During the process, the micro-organisms are fed with amino acids, which are essential to the generation of the dye. According to Wagner, studies confirm that the culture medium represents up to 75% of the costs. Thinking of reducing this number, the researcher used bovine fur , an agro industrial residue which would be designated to a landfill, as a nutritional source. "The most negative impact that the leather industry has is precisely in the step of hair removal and liming [process in which the fur or fleece are removed from the skin, along with the epidermis], which generates most part of the pollution," he affirms. This is one of the differentials of the research: to reuse a material that did not have a proper destination beforehand. The final dye developed can also be used in other fabrics and plastics. Besides that, the fungi also have ecological and nutritional benefits, with several application possibilities. "The fungi by-products, the metabolites, can be used in the food industry, in waste treatment, in the pharmaceutical industry, in agriculture. They produce enzymes which are biotransformed – our use was as biodyes," says Mariliz Gutterres, the advisor of

the project and professor responsible for the Laboratory of Studies in Leather and Environment of UFRGS (Lacouro). With this research, and many others, the laboratory studies alternatives for the improvement of sustainability in the production of leather with less chemical inputs.

To ensure its suitability to be used in the material, it was verified if the substance produced microtoxins, since not all types of fungi can be used as dyes. Moreover, the resistance of the color to light, heat, and friction to the body, was tested. These are important characteristics to garments such as purses, clothes and shoes, which should resist to the time of use without deteriorating too fast. Being a product of natural origin, the fungal dye deteriorates over time, but it proved to be adequate and durable enough for the use in the leather industry. The garments that were dyed during the research have gone through more than four years without much fading. The longer durability of the artificial version is undeniable, but it also means that this residue will remain eternally in nature when thrown away, while all products have their own lifespan, until they get replaced by another model or a newer version. “We are going to have an item which will last longer than our use of it, and will take years or decades to decompose; and this is a dilemma,” he explains. Additionally, the leather is coated by resin, in the finishing stage, which acts as a protective layer for the integrity of its color. The version that was tested by the team was not the final one, not having passed through this process, but it showed promising results to the degradation tests, even using one of the most unstable and difficult colors to work with: the red. In order to be used in the industry, the dye developed by the researcher would still need to have its process optimized and its economic viability calculated, other than be tested in bigger scales.

The natural dyes, extracted from sources such as fruits, leaves, seeds or roots, would also be non allergic, non toxic and sustainable alternatives which could dye leather. However, they also have their own problems, such as the large plantation area required to obtain the dye, and its dependency on the climate. The logistics to its production involves the use of materials which could be used as food to many people, while the bio dyes are created from the cultures of microorganisms in laboratory. Thus, making the manufacturing more efficient when compared to the ones which are produced from large plantations, taking up space, and wasting money. "There is a common appeal here: you are going to stop producing food in order to produce dye. This is one of the main obstacles of the natural dyes," Wagner points out. Other than that, the natural dye has a shorter lifespan and deteriorates faster, something which is not well seen to wearable articles, making it less economically viable. Mariliz adverts that, even if we can compare byo dyes to natural dyes, our reality is much worse – it is one in which the industry, in its majority, resorts to dyes which can be toxic and damaging to the ecosystem. For Wagner, the most important thing is to find a middle ground which is more adequate. Between the natural version and the synthetic one, the fungi represent a great option of dye with good durability and less impact on the environment.

Dissertation

Title: Selection of byo dyes of filamentous fungi for leather dyeing and submerged culture of M. purpureus with substrate of hydrolysate fur

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