Research by UFRGS and UEA concluded that Shell-precious fungi may be able t

Unprecedent results indicate that five fungi that live in an Amazonian tree known as precious bark manage to grow on PET plastic, which suggests that they may be able to degrade the polymer

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PET plastic Pellets on which the fungus Phomopsis sp. grew. - Photo: Rosiane Matias / Disclosure

The phone or computer you are using now, the clothes you are wearing, the packaging of the tele-delivery of food you ordered yesterday, the bottle in which you drink water every day, the dashboard of the car you use to get around... it is not difficult to find examples of common things of our daily lives with some kind of plastic in their composition.

Because of its practicality and low cost, this material is increasingly present in the life of the population.

However, this massive use also generates huge environmental and health problems.

One of the ways to reduce the impact of plastic on the environment is degradation, but this is still an expensive and difficult process.

Thinking about that, researchers from UFRGS and the Amazonas State University (UEA) are studying how fungi found in the precious bark (Aniba canelilla), a plant found in the Amazon, can facilitate this process.

The unprecedent results pointed out that five fungi that live inside the shell-precious managed to grow on pellets (small fragments) of PET plastic – and one of them even grew on other types of polymers – which leads the research group to believe that microorganisms might be able to degrade these materials.

"What makes this investigation innovative is the use of Whole fungi and not enzymes produced in laboratory, explains Rosiane Matias, the PhD student in Biotechnology and Biodiversity at UEA who is developing the study.

“We decided to put these microorganisms in contact with the polymers to observe which enzymes would be produced and how this degradation occurred, even because the action on the plastic can be caused by only one enzyme, or by several of them,” she explains.

Partnership Research

The research is carried out jointly between the two universities, uniting the expertise of each of them.

At UEA, the study is coordinated by Professor Patrícia Albuquerque, researcher of the Postgraduate Program in biodiversity and biotechnology that works with enzymes and fungi of Amazonian plants; at UFRGS, the study is coordinated by Professor Rosane Soares, researcher of the graduate programs in Materials Science (PGCIMAT) and chemistry (PPGQ), with expertise in the area of polymers and biomaterials.

The collaboration also includes the Biotechnology Laboratory of the Institute of Food Science and Technology (ICTA) of UFRGS, under the Coordination of Professor Marco Ayub.

The first phase of the research was carried out in the Adolpho Ducke Forest Reserve, in Manaus (AM), where the collection of thin branches and leaves of the precious bark was made, a medium-sized, aromatic tree, present in the North, Midwest and southeast of the country and known for its medicinal properties.

From several washings of plant tissue and incubation in greenhouses, carried out at UEA, the researchers initially isolated 492 endophytic fungi – fungi that live inside the plant.

Of these, 200 were lost due to contamination and due to issues of metabolism of some fungi, which survive only within plant tissue.

There were 292 left, which underwent an enzymatic screening to verify which microorganisms produced certain enzymes.

Finally, there were 36 fungi left, which were subjected to a technique called submerged fermentation for production of lipase, an enzyme known to facilitate the degradation of plastics.

The work followed at the Institute of Chemistry and the ICTA of UFRGS, where the scientists put the fungi in contact with PET pellets to observe if and how the degradation occurred.

Five of such microorganisms (Colletotrichum siamense, Clonostachys rosea F. catenulata, Endomelanconiopsis endophytica, Pestalotiopsis sp. and Phomopsis sp.) produced lipase and other enzymes and used plastic as a source of carbon, that is, energy.

The first results indicate that Pestalotiopsis sp. can also be effective in the degradation of other types of polymers (polyethylene, polypropylene, polyurethane and polyamide 6).

The other four microorganisms had never been described in the scientific literature as potential degraders of plastic, the researchers explain.

The contributions of research and the challenges for the future

UFRGS' scientist Rosane Soares makes an analogy to explain how the degradation process works: “the polymer chain is like a long pearl necklace.

'When we degrade the polymer, it is as if we break the necklace into several parts – some with ten pearls, some with five, some with three. 'The degradation consists of 'breaking the pearl necklace', that is, breaking the bonds”.

Since carbon is extremely necessary for the survival of the fungus, when the microorganism “realizes” that the polymer is the only source of this element, it begins to synthesize enzymes that degrade plastic and provoke the release of carbon.

The fungus bioassimilates carbon, that is, it uses it as an energy source, increasingly synthesizing more enzymes and promoting the degradation of the polymer.

Following the analogy used by her supervisor, Rosiane summarizes: "when this ‘little piece’ of the necklace is left with only one pearl, the fungus is able to absorb that and use it as a source of energy”.

Most of the research on plastic degradation uses enzymes synthesized in laboratory with genetic engineering techniques, a process which requires a differentiated infrastructure and only achieved at a high cost. One of the advantages of using the whole fungus is precisely its cost-effectiveness.

Rosane adds that the challenge in investigating the degradation process is to know the mechanism by which it occurs – as well as the fragments generated from this contact with the fungus.

However, this analysis is temporarily in stand-by due to the pandemic.

Although we have strong evidence and hypotheses as to where this break initially occurs, we do not yet know the time it takes to occur, nor what size these fragments will be, " explains Rosane.

Studying these "pieces of the pearl necklace" that result from contact with the fungus is the last stage of Rosane's doctoral research, which is to be carried out at the UFRGS Institute of Chemistry.

Another objective is to carry out biodegradation tests with the use of bottles, films and PET pellets to carry out a comparison between these three formats.

The PhD student points out that most studies in this area use an “amorphous” species of PET, which is more susceptible to degradation than the polymer used in the manufacturing of bottles.

"The bottles have a kind of’ additive barrier' so that the drink inside is not contaminated by plastic, but this barrier also makes degradation difficult,” she points out.

Since pellets and films have fewer additives, the idea is to assess whether the biodegradation effectiveness of these materials is comparable to that of bottles.

In addition to presenting more accessible degradation alternatives, the research identified two new species of fungi for the genera Phomopsis and asordaria sp., observed for the first time in the shell-precious, which are to be further investigated by the group.

The study also contributed to the UEA microbiological Collections Center: 292 endophytic fungi and 140 epiphytic fungi (isolated from the surface of the analyzed plant tissues) of aniba canelilla were deposited in this bank, addition which may benefit future studies of the Chemical Research Group applied to Technology from UEA.

Plastic: a useful material, but also a problem

Wherever you are when reading this text, if you look around you, you will see a lot of objects that contain various types of plastic in their composition (probably, almost everything that is near you). The use of plastic today is massive in our lives: from the equipment we use to the clothes we wear, through packaging and toys. This ubiquity of polymers comes from the second half of the twentieth century, when the polyvinyl chloride (PVC) started being manufactured by reusing the waste from the petrochemical industry. And between then and now, other types of plastic have been created by the industry to meet the most diverse demands.

Because it is durable, the material has become very useful in various situations, but the Atlas of plastic 2020 of the Heinrich Böll Foundation points out that almost half of all plastic products end up as waste in less than a month and that only 9% is recycled.

Huge production and rapid disposal generate numerous problems: the presence of plastic in the oceans leads fish and other marine animals to confuse the material with food, which can cause suffocation, for example.

“Since plastics are important vectors of heavy metals, exposure of animals to toxic substances can also lead to deformities and sterility in species,” says Rosiane.

Researchers from UFRGS and UEA add that human health is also impacted, as we feed on fish species contaminated by microplastics.

A study by the *High Level Panel for a Sustainable Sea Economy* concluded that specifying the impact of plastics on human health is a difficult task due to the great diversity of polymers and additives. However, the scientists signing this study claim that ingestion and inhalation of plastic waste can cause chronic inflammation and irritation, as well as endocrine changes. Social and economic impacts are also linked to excessive use and improper disposal of plastic, according to a report by the *World Wide Fund for Nature* (WWF).

With the covid-19 pandemic, this problem may still have increased. To protect themselves from SARS-CoV-2, health professionals use more disposable personal protective equipment (PPE), and several countries have begun to require the massive use of masks (fabric or disposable) by the general population as a prevention measure.

A study published in June 2020 by researchers from the University of Aveiro (Portugal) and Dalhousie University (Canada) estimates that with the pandemic global consumption reaches 129 billion face masks and 65 billion gloves per month.

Based on data from the Brazilian Association of Public cleaning companies and special waste (Abrelpe), the Böll Foundation plastic Atlas estimates that the average generation of hospital waste per patient hospitalized for covid-19 treatment reaches 7.5 kilograms per day.

There are different sources and authors who point out the same problems: massive use and inappropriate disposal.

“Companies need to reduce plastic production, and consumption is exacerbated because there is a lot of polymers available," says Rosane.

With the possibility of using a fungus of an Amazonian plant, the precious bark, to degrade polymers, the research of UFRGS and UEA brings a huge technological impact.

The scientist highlights that this discovery can reach the industry and make a difference in this scenario: “it is up to us researchers to show these companies that there are ways to minimize the environmental impact.”

“The value of the study outside the University is enormous: if companies used this technology, in addition to the environmental gain they would also have a product of great added value,” she concludes.

Translated into English by Rosana Vieira Chaves in October 2021, under the supervision and translation revision of Elizamari R. Becker (PhD) – IL/UFRGS.