Breaking down cleansing wipes using *Galleria mellonella*: an ecological solution to the problem in treatment plants

Authors: Miguel Aragón Fernández, Miguel Sequeiros Doval
Tutor: Lydia Castro Núñez
School: Maristas Santa María, Ourense

Abstract:

It is commonly known that human plastic waste is a worldwide problem. Recent years have seen a dramatic increase in ocean and river pollution with this kind of materials, giving rise to the accumulation of plastic fragments, both those visible to the naked eye and microplastics affecting the oceans' plankton and, subsequently, the entire food chain. Cleansing wipes used for personal hygiene and baby care are one of the main sources of these compounds. As well as being a direct source of pollution, one side effect of these products is the clogging and blocking of sewage systems in major cities across the world such as Madrid, New York and London. This is why there is such an urgent need to solve the problem, not only from the standpoint of reducing consumption or finding more eco-friendly alternatives, but also from that of breaking them down. A recently published work by Bertocchini *et al.* shows how the waxworm, *Galleria mellonella*, is able to break plastic down quickly. So, our goal in this work is to ascertain whether these worms can also metabolise the non-biodegradable compounds found in cleansing wipes, paving the way to what could, in the future, become a natural mechanism for eliminating this kind of waste.

Introduction:

We live in a society in which the use of plastics such as polyethylene—ranging from that in store and supermarket plastic bags to that used in everyday products such as cleansing wipes—has become commonplace.

This kind of polyethylene-based product would not be a great problem if there was an ecological way to break it down. Currently, the best available option is to recycle them in specialist plants, which allow the plastics to be reused or transformed into derivative products. Some of the most recycled plastics are polyethylene (PE), polypropylene (PP), polystyrene (PS) and polyvinyl chloride (PVC). The chief problem we are currently facing is that only a small percentage of the plastics used by humans is recycled, whilst a very high percentage ends up polluting our oceans and rivers. What's more, it should not be forgotten that the recycling process has the collateral effect of energy consumption, meaning that it is not an entirely ecological solution. We are currently even finding microplastics in the biopsies of large whales, showing the danger of the bioaccumulation of these compounds in the planet's oceans.

One product containing polyethylene is cleansing wipes, which are widely used in the West. These are made of an amalgam of chemical products, including polyethylene, polyethylene oxide or ethylene glycol. Use of these wipes has increased dramatically in recent decades, causing a wide range of problems in major cities around the world due to bad user habits. This kind of wipes should not be disposed of down the toilet, but using the organic waste bin. The fact that it is difficult for them to break down in water is causing millions of euros to be wasted in many cities due to the clogging of pipes, which can even cause the temporary shutdown of some water treatment plants and give rise to serious health risks.

In the specific case of our home city, Ourense, the municipal wastewater treatment plant has had to create a 4 metre-deep pit to hold the great amounts of this type of waste. The pit means they can be removed mechanically with a metal gripper, preventing them from reaching the treatment system, where they could cause serious problems. Once the waste mass made up of wipes is removed, it is transferred to an organic waste plant (Figure 1).

Figure 1. A metal arm removing the mass made up of accumulated cleansing wipes from Ourense's municipal treatment plant

In addition to this problem, these wipes are also a source of pollution from microplastics, which become detached from the wipes' fabric and end up in the planet's rivers and oceans. Recent studies published by the OCU, Spain's Consumers' and Users' Organisation, show that these wipes contain numerous non-biodegradable compounds intermixed with their cellulose fibres, making them a product that does not break down easily. Only 35% of the wipes breaks down after two days, whereas toilet paper, which is mostly cellulose, breaks down to the tune of around 95%. The microplastics in the wipes can pass through the treatment plants' filters to go on to pollute rivers and seas.

Recently, researchers from the Universities of Cantabria and Cambridge have shown that the waxworm, *Galleria mellonella*, is able to break polyethylene down naturally, paving the way for what could become a completely ecological breaking-down process, without any side effects and created naturally by this creature.

<u>Objective:</u>

For this research work, our goal is to ascertain whether the mechanism present in this worm is also able to break down the polyethylene derivative compounds found in cleansing wipes. Set out below is an explanation of the materials and methods used to perform the work, the results obtained and the conclusions we have finally drawn.

Material and methods:

- 50 individual *Galleria mellonella*: the worm (moth larva) used in this project, due to its ability to break down plastic—polyethylene—in its metabolism. The worms were obtained from the website of specialist fish tank company DNATecosistemas (http://www.dnatecosistemas.es/). Around 50 of these worms were received, of which 25 were finally used to carry out of the experiment.

- A 50 x 30 x 33 cm fish tank with a capacity of 60 litres.

- Nylon mesh, for covering the tank and keeping the worms there. With small holes, large enough for the passage of air but not the worms or moths.

- Glycerine, honey and oats: a mix used in the first part of the experiment to feed the *Galleria mellonella* for 48 hours. The worms' food was created by mixing equal amounts of honey and glycerine, and then adding enough oats to make a uniform paste. Rich in carbohydrates, proteins and lipids.

- Nitrile gloves: required for handling both the worms and the laboratory equipment. The gloves' composition contains no talc.

- Cleansing wipes: Freelife brand wipes were used, made of water, sodium chloride, PEG-40, fragrances, camomile, feverfew flower extract, potassium sorbate, sodium benzoate, levulinic acid, sodium levulinate, glycerine, tetrasodium glutamate diacetate and lactic acid.

- Sawdust: used to line the base of the fish tank, and upon which the worms were placed for the first 48 hours.

- Transparent plastic film wrap: to cover the recipient upon which the worms were placed with the cleansing wipe.

Results:

The *Galleria mellonella* were placed in the fish tank on a bed of sawdust, to which the previously prepared feed mix (equal parts of glycerine and honey, and oats) was added so that the worms would be in optimal condition prior to carrying out the experiment. They were kept in these conditions for 48 hours, after which 25 of them were selected for their good appearance and high activity levels (Figure 2).

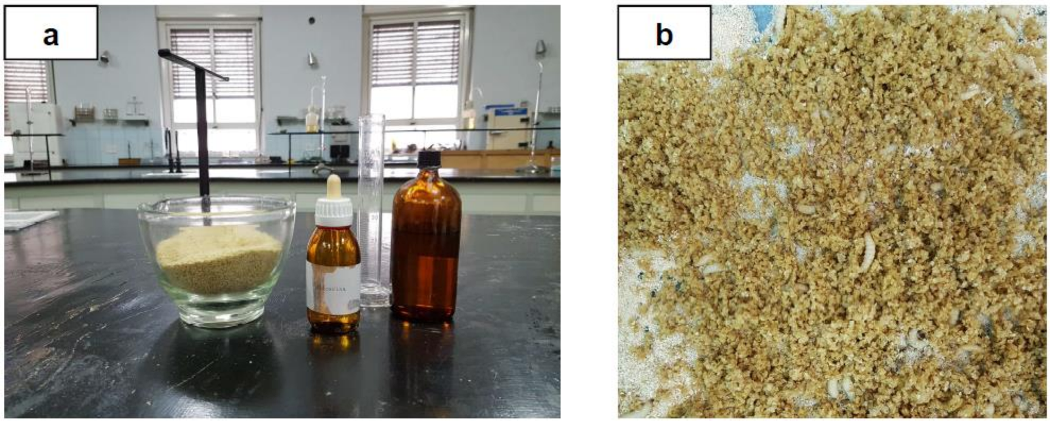

Figure 2. a) Ingredients required for making the feed paste, based on glycerine, honey and oats.
b) *Galleria mellonella* feeding on the paste, on a sawdust base.

25 *Galleria mellonella* were placed in a laboratory recipient, completely covered with plastic film wrap (punched with holes to permit the passage of oxygen) for around 48 hours, with a wipe as their only source of food. After the first 12 hours, the first holes in the wipe were noted, caused by the action of the worms, but it took a further 36 hours to really see a significant effect on the wipe (Figure 3).

Figure 3. *Galleria mellonella* ready for the experiment

Set out below (Figure 4) are photos showing the worms' ability to break down the polyethylene derivatives found in cleansing wipes.

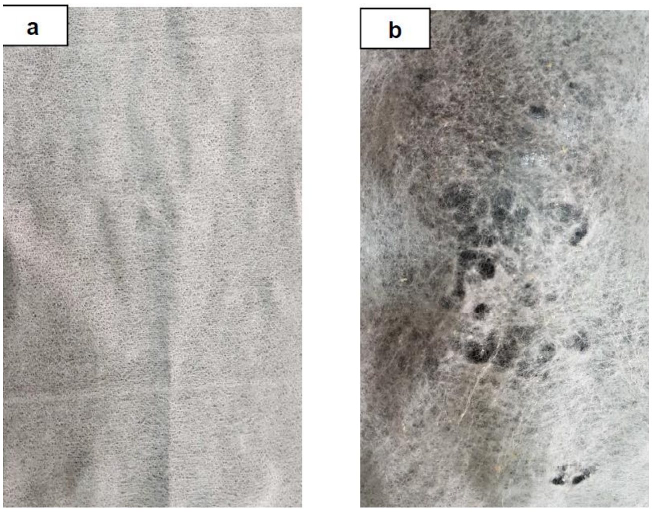

Figure 4. a) Wipe before performing experiment. b) Wipe after 48 hours in the presence of *Galleria mellonella*.

As can be seen by the naked eye, *Galleria mellonella* possesses a mechanism enabling it to break down the components present in wipes. To quantify the breakdown, we weighed the wipe before and after the experiment using precision scales, noting a weight loss of 100 mg in 48 hours. These figures are similar to those found in the article published by Bertocchini *et al.*, breaking down 100 mg in 48 hours with 25 worms, representing a rate of approximately 0.083 mg polyethylene per worm per hour.

We were also able to observe how the materials present in the wipe were not toxic for the worms, as they continued to be highly active and survived after completion of the experiment. The photo below shows the worms passing through the holes made in the wipe (Figure 5).

Figure 5. *Galleria mellonella* passing through one of the holes it had made.

<u>Conclusions:</u>

Today, it is vitally important to reduce the pollution of water by plastics. The use and abuse of these products, their low levels of recycling, and poor public practices in disposing of them, as is the case with cleansing wipes, has led to problems with a great economic impact that are difficult to solve. Finding ecological alternatives, cutting use and increasing recycling are some of the solutions that could have a positive impact. In the case of *Galleria mellonella*, the worm features a mechanism that can break polyethylene derivatives down without producing contaminants or affecting the creature's lifecycle. The study by Bertocchini *et al.* shows that both the worm itself and the juices obtained from their trituration are able to break polyethylene down, suggesting that the creature contains some kind of bacteria or symbiotic organism that can perform this, or a characteristic enzyme of its own, showing that this breaking down process is not due solely to mechanical digestion.

With a view to the future, we believe that it would be highly worthwhile for biotechnology companies and governments to invest time and resources in attempting to identify what the actual mechanism employed by these animals to enable them to break polyethylene down is. If this enzyme or microorganism could be characterised and put into large-scale production, it could be used to break down plastic compounds without the collateral effects of traditional recycling plants, providing an environmentally friendly, ecological alternative that could contribute to alleviating one of the greatest problems currently faced by our rivers and oceans: microplastics.

Bibliography

1. http://blogs.repsol.com/innovacion/polietileno-un-plastico-muy-resistente-con-gran-variedad-de-aplicaciones/

2. http://repositori.uji.es/xmlui/bitstream/handle/10234/30030/29497.pdf?sequence=1

3. https://news.nationalgeographic.com/2017/04/wax-worms-eat-plastic-polyethylene-trash-pollution-cleanup/

4. https://www.telegraph.co.uk/science/2017/04/24/plastic-eating-wax-worm-extremely-exciting-global-pollution/

5. https://www.theguardian.com/commentisfree/2017/apr/25/plastic-eating-bugs-wax-moth-caterpillars-bee

6. http://diario16.com/toallitas-humedas-ni-desechables-ni-bio-degradables-segun-ocu/

7. https://www.emasa.es/wp-content/uploads/2016/12/OCU-estudio-sobre-toallitas-tecnoaqua-es.pdf

8. https://www.ncbi.nlm.nih.gov/pubmed/?term=Bertocchini+plastic

9. http://www.elmundo.es/ciencia-y-salud/ciencia/2017/04/24/58fe33df22601d26338b4622.html

10. https://www.emasa.es/wp-content/uploads/2016/12/OCU-estudio-sobre-toallitas-tecnoaqua-es.pdf

11. http://kaloula-drpez.blogspot.com.es/2010/09/cultivo-de-galleria-melonella-gusano-de.html

12. www.faunaexotica.net › Foros › ALIMENTACIÓN › Alimentación

13. https://mieladictos.com › Diversidad ecológica

14. elherpetario.forumotion.net › ... › AlimentoVivo : Cuidados y alimentacion