# OXO-BIODEGRADABLE PLASTICS ASSOCIATION

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**STATEMENT BY PROFESSOR TELMO OJEDA**

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On Loughborough University Report EV0422: "Assessing the Environmental Impacts of Oxo-degradable Plastics Across Their Life Cycle."

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1. There are no new facts in the report, as admitted by the authors at the beginning. What is found is a collection obtained from a mosaic of ideas, prepared by researchers who are not experts in oxo-biodegradation. For example, composting is seen as a complete and perfect test of biodegradation. But, a high level of biodegradation is not to be expected from materials designed for a useful life exceeding six months, as the antioxidant additives must first be consumed, in order to let biodegradation begin.

2. A key and central point in the Report is the absence, to the present time, of a method (standard) suitable for testing biodegradability of polymeric materials that require several years to complete degradation. Some people used to working with hydro-biodegradable materials (e.g. poly(lactic acid) and aliphatic-aromatic polyesters, such as PBAT or PBST) tend to choose the tests designed to evaluate such materials. Thus, for example, tests with 50% solids (which cause anaerobic or microaerophilic environments in the respirometric cells) and requiring 60 or 90% degradation in 6 months are unrealistic. They are really composting tests, not biodegradation tests.

It is a coarse error to choose composting tests to assess biodegradability of oxo-biodegradable materials. These materials must be tested by standard methods that accept their slower biodegradation after their service life. Such methods are still being developed. The report authors themselves acknowledge that the main disposal routes for plastic wastes are mechanical recycling, incineration and landfill, not

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composting. Please observe that leaves, twigs, straw and many natural materials do not pass the present composting tests.

3. Nevertheless there is evidence that PE and PP oxo-bio materials are completely biodegradable: the complete molecular modification by oxidative degradation, dramatically reducing all the molecules in size, and greatly increasing their content of groups containing oxygen. Also the presence of biofilm on the oxidised plastic residues is evidence.

The laboratory methodology, based on respirometry, presents problems after a few months of testing. The metabolic wastes tend to concentrate in the respirometric cells, impairing the metabolism of microbial consortia that are present. Populations tend to grow old and die in isolated respirometric cells, unlike what occurs in nature. This fact is usually observed in laboratory tests with different polymeric materials, including hydro-biodegradable ones.

To overcome these difficulties in evaluating slow biodegradable materials, Prof. Chiellini sought to accelerate the abiotic degradation with the use of temperatures higher than the ambient, and Prof. Jakubowicz sought to increase the degradation temperature, extrapolating the time for complete biodegradation by the Arrhenius equation. A reliable laboratory method to assess the biodegradation of slow biodegrading materials is still to be implemented. This fact does not mean that such materials do not degrade and biodegrade much faster than the traditional polyolefins (in fact, the degradation is accelerated by a factor of about $10^2$).

4. Evidence of degradation was observed in the dark and at 4ºC (by Ojeda's research group at Porto Alegre, Brazil). The modern oxo-bio additives are very efficient. There is no reason to think that a fraction of the molecules will not suffer oxidation, remaining so for decades or centuries in the form of invisible or barely visible fragments, with high specific surfaces. GPC (or SEC) analyses showed that all molecules are strongly reduced in size, being oxidized.[6]

5. There is clearly a bias on the part of certain people accustomed to hydro-biodegradable materials, who think that products of petrochemical origin are all dangerous and recalcitrant (bio-resistant) xenobiotics. However, the oxidative degradation of PE and PP, for example, was not observed to generate any type of hazardous or toxic compound. Rather, the products generated present several oxygenated atomic groups and insaturation, all these new groups being degradable by several types of enzymes present in the terrestrial and aquatic environments. These oxidation products are more hydrophilic than the original molecules and have molecular masses much lower. Poli(epsilon-caprolactone) (PCL) and poli(vinyl alcohol) (PVA) have petrochemical origin and they are easily biodegraded in the environment. Rubber is an example of a natural biodegradable product which may be synthesised artificially, presenting hydrocarbon structure.

6. It is a coarse error to think that oxo-bio materials would exacerbate the situation of plastic garbage floating on the oceans. In fact, a vast amount of waste that is mixed with the plankton is composed of conventional plastics, that have undergone a process of oxidative degradation (and hydrolysis in some cases), which is accelerated on sea surfaces, because of the high temperature, the movement of the waves, and the high concentration of oxygen. Under these conditions, oxo-biodegradable materials degrade and biodegrade quickly, which helps them not to be accumulated in the ocean vortices of plastic garbage.

7. The idea that degradation is only true if carbon dioxide is measured is somewhat coarse, since photomicrographs showing the biofilm, as well as tests of enzyme

[6] Ojeda et al. Abiotic and biotic degradation of oxo-biodegradable polyethylene. Polymer Degradation and Stability, 94 (6), June 2009, p.965-970.

activity and of ATP concentration, also prove that the degradation is actually occurring, among many other techniques.

8. The report states that the peer-reviewed evidence based on standard methods suggests that the biodegradation of oxo-degradable polyethylene is no more than 15% after 350 days. This conclusion is absurd and based on few evidences. Ojeda et al (Abiotic and biotic degradation of oxo-biodegradable polyethylene. Polymer Degradation and Stability, 94 (6), June 2009, p.965-970) found values of 12-13% in 3 months, and the curve showed positive slope, indicating that biodegradation would exceed 20% in one year. The "thermal activation" commented is probably nothing more than a period for consumption of the antioxidant additives, since degradation has been observed to occur at 4ºC in the dark.

9. The oxo-bio additives are mainly applied in thin PE and PP packaging and agricultural films, which are often contaminated with food or organic materials. These kinds of products are not suitable for recycling, both economically and ecologically, as they need to be collected, transported, cleaned and sorted. So it does not make much sense to argue that the oxo-bio plastics contaminate other plastic products during recycling. In any event they do not (see eg http://www.biodeg.org/position-papers/recycling/?domain=biodeg.org).

10. The report appears to refer to oxo-biodegradable materials as a single, homogeneous product, when in reality there are many formulations on the market. Therefore there is no meaning to consider equally all oxo-bio additives and products, as if they were all identical.

11. Some phrases show little familiarity by the authors with biology. For example, "It is possible that they [the oxo-bio fragments] may become ingested by earthworms, other insects, birds or animals". Another example is "concerns have been raised that these particles of plastic may be ingested by insects, birds, animals or fish". Or "research should be carried out to determine the effect of the particles on plants, invertebrates and animals". It is, after all, the biology that underlies the whole discussion on biodegradability.

12. Several people cited in the report are related to the competition from oxo-bio materials (e.g. Narayan, Steve Mojo and others), who have added little or nothing in terms of credibility of peer-reviewed literature.