Microstructural Aspects of the Plastic Waste Biodegradation in the Digestive Tract of the Mealworm, *Tenebrio molitor*

Bon-Jin KU[P], Yan SUN and Myung-Jin MOON[C]

Department of Biological Sciences, Dankook University, Cheonan 31116, Korea

ABSTRACT

- Globally, plastics are produced and used in a variety of fields.
- Plastic has the advantage of being easy to deform and simple to manufacture, but its recycling rate is low, so it is thrown away in land and marine ecosystems, causing environmental pollution.
- Biodegradation is receiving great attention as an effective way to dispose of plastics.
- In particular, it has been reported that the biodegradation of plastics by intestinal microbes of mealworm is an environmentally friendly and good solution.
- In this study, polystyrene, polyethylene, and polyurethane were ingested into mealworm larvae, and the biodegradation process in the digestive tract of mealworms was visualized through optical and scanning electron microscopy of the digestive tract and plasma.
- We observed plastic weakening and loss of shape within the digestive tract of mealworms, suggesting that plastics may be biodegradable.
- Further research is needed to apply the biodegradation of plastics through the digestive tract of mealworms in a sustainable way.

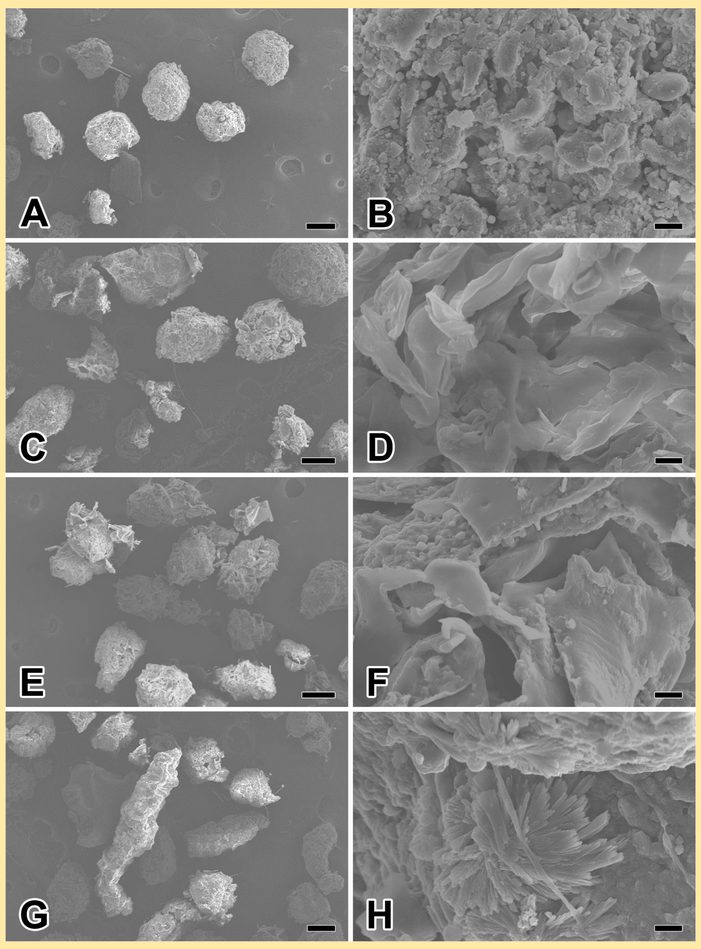

Fig. 1. Scanning electron micrographs of the frass. A,B: The frass of bran-fed larvae. C,D: The frass of PS-fed larvae. E,F: The frass of PE-fed larvae. G,H : The frass of PU-fed larvae.

RESULTS

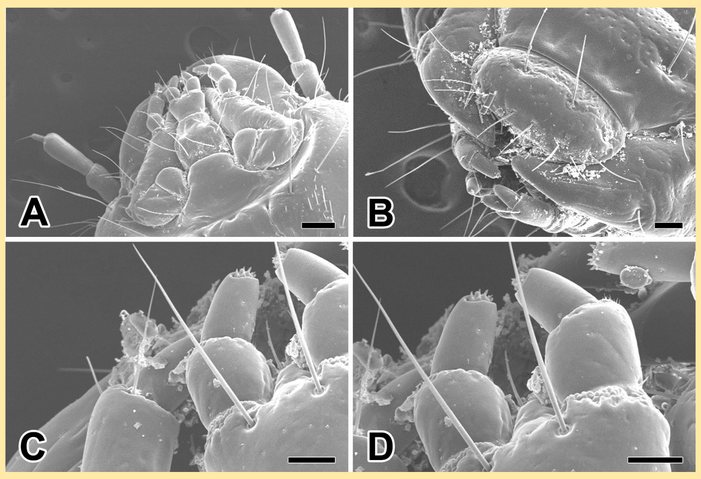

Fig. 2. Scanning electron micrographs of the mouth part in the *T. molitor* larva. Scale bars indicate 200 ㎛ (A), 100 ㎛ (B), 50 ㎛ (C,D).

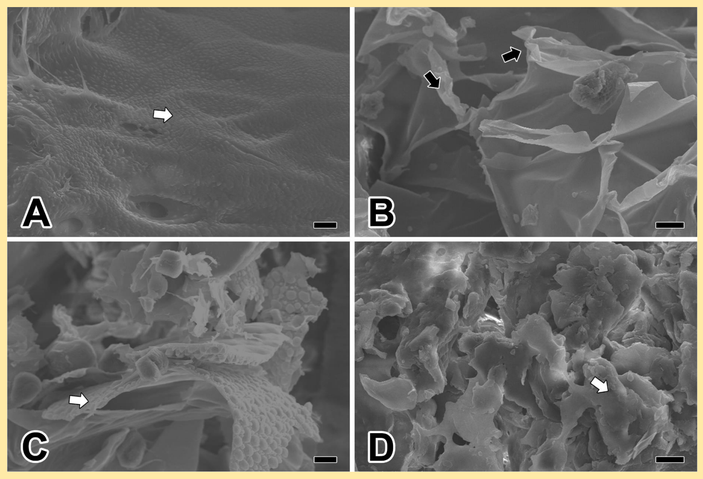

Fig. 3. Scanning electron micrographs of the whole PS biodegradation process. A: A spherical rough surface (white arrow) was observed in the pristine PS. B: The PS after mealworm ingestion. C: Substances in the digestive tract of mealworm. D : The frass of PS-fed larvae. All Scale bar indicates 10 ㎛.

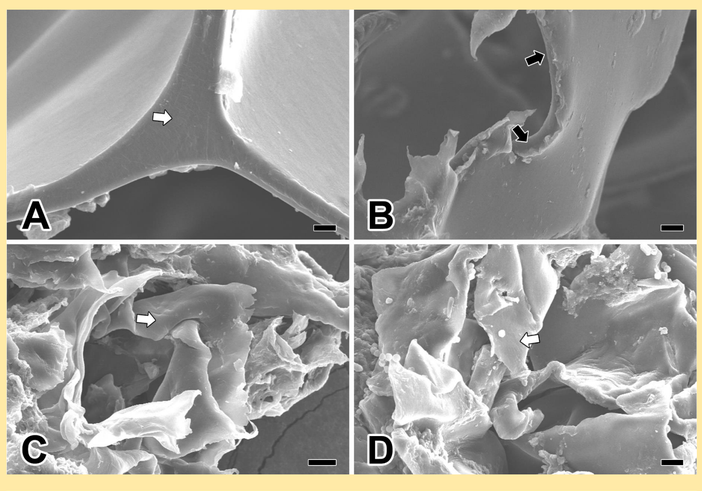

Fig. 4. Scanning electron micrographs of the whole PE biodegradation process. A: The PE was smooth on both the surface and the cut surface (white arrow) in the pristine PE. B: The PE after mealworm ingestion. C: Substances in the digestive tract of mealworm. D : The frass of PE-fed larvae. All Scale bar indicates 10 ㎛.

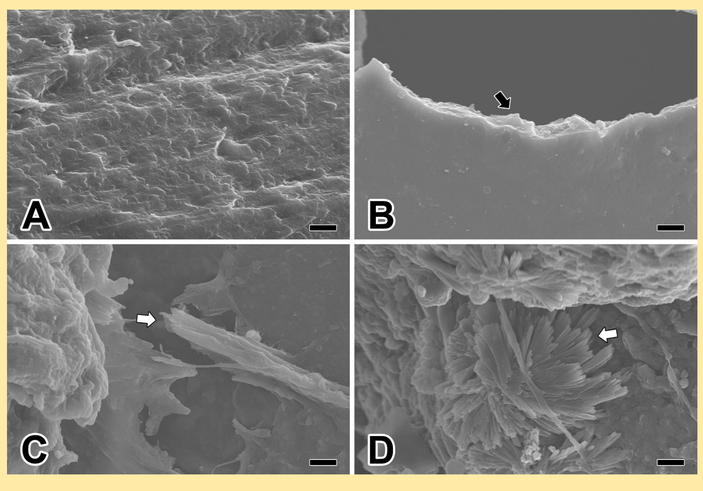

Fig. 5. Scanning electron micrographs of the whole PE biodegradation process. A: The cut surface of PU had a rough and sharp structure. B: The PU after mealworm ingestion. C: Substances in the digestive tract of mealworm. D : The frass of PU-fed larvae. All Scale bar indicates 5 ㎛.

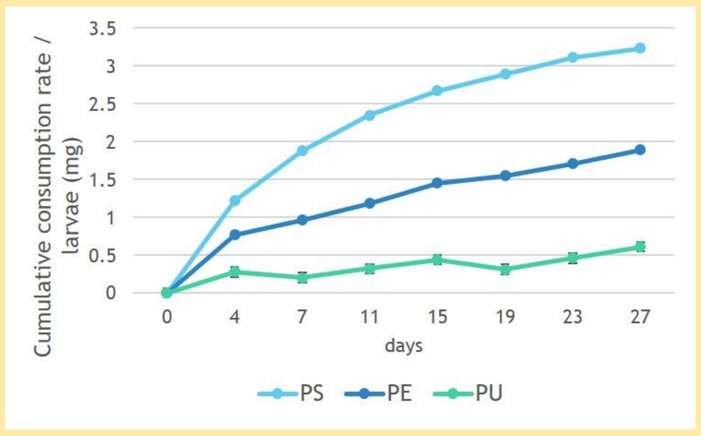

Fig. 6. Cumulative intake of plastic by mealworms. PS: Polysyrene, PE: polyethylene, PU: polyurethane.

Fig. 7. Survival rates of plastic-fed mealworms. PS: Polysyrene, PE: polyethylene, PU: polyurethane.

CONCLUSIONS

- The plastic consumption rate of mealworms was in the order of PS > PE > PU.
- Polystyrene and polyethylene lose their surface properties and biodegrade as they pass through the mealworm's digestive tract.
- Biodegradation of polyethylene is thought to have occurred actively in the midgut of mealworms.
- Biodegradation of polystyrene is thought to have occurred actively in the hindgut of mealworms.
- The polyurethane passed through the digestive tract of the mealworms, but was not completely biodegraded and sharp particles were observed.

Dr. & Prof. Moon, Myung-Jin

Tel: +82-41-550-3445 Fax: +82-41-550-3409 E-mail: moonmj@dankook.ac.kr