Two Birds with One Stone: Bioplastics and Food Waste Anaerobic Co-Digestion

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Table S1. Summary of studies on biodegradable bioplastics (BBPs) and food waste (FW) anaerobic co-digestion.

Cited Study	Basis	FW: BBP	BBP Tested	BBP Size	HRT (Days)	Reactor	°C	Findings
13	Weight	200:3*	Range of BBP films	25 x 4 mm^2	Up to 127	Batch	T	The majority of the tested BBPs and their blends degrade by thermophilic AD with high biogas output, but degradation times are 3–6 times longer than the retention times in commercial plants.
21	Weight	15:2	Range of BBP films	10 x 10 mm^2	50	Batch	M	Materials have different degradation rates under different end-of-life scenarios. Most BBPs biodegraded to only a limited extent under AD.
41	VS	1:1	PHA film	10 x 10 mm^2	60	Batch	M & T	PHA co-digestion with food waste significantly improved the consistency of degradation under thermophilic conditions and slightly increased PHA degradation, which reached 43% over 60 days. Mesophilic conditions enabled PHA degradation to reach 70%.
45	Volume/ Weight	200 ml: 1.1g	PLA bags	20 x 20 mm^2	70	Batch	M	Alkaline pre-treatment with NaOH has the greatest solid reduction of PLA and maximum methane production.
46	VS	1:1	PLA film	20 x 20 mm^2	60	CSTR	M	The results found that NaOH concentration and reaction time were two main parameters influencing PLA degradation. Optimum pre-treatment conditions were at 0.5 M of NaOH, temperature of 60°C over 24 hours.
47	VS	2:1	HDPE bags, PS boxes, & rigid PP trays†	10 x 10 & 5 x 5 mm^2	30-35	Batch	M	Plastics inhibited methane production. PS and PP were found to inhibit methane production from FW more than HDPE. Inhibition was more likely due substrate competition, which intensified with increased plastic surface area.
48	Weight	7:1	PBAT/PLA bag	Not specified	100	CSTR	M & T	The addition of the polymer to FW AD did not enhance overall biogas production, with no discernible degradation. Disintegrated fragments were observed under thermophilic conditions, which facilitated degradation in subsequent aerobic treatment.
49	Weight	From 10,000 to 65:1 (10 pieces)	PLA bottles & starch-based bags	20 x 20 mm^2	23	CSTR	T	Lack of degradation for PLA bottles, while starch-based bags achieved significant disintegration. Phytotoxicity test on compost (for aerobic conditions) revealed negative effects on seed germination for PLA.

50	COD	4:1	PLA bags	2 × 2 mm^2	25-41 (run over 592)	CSTR	T & hT	Introducing the hyper-thermophilic treatment improved the overall performance. The microbial communities in both conditions were dominated by similar genus.
51 (& 55)[§]	VS	4:1	PLA, Starch-based, cellulose-based films & PLA blend pellet	10 x 10 mm^2	147	Batch & SBR	M	Of the 9 BBPs tested, only 4 showed substantial biodegradability under AD conditions. Even the most degradable materials would not break down sufficiently to meet the physical contaminant criteria of the UK PAS 110 specification standard for anaerobically digested material, if fed to a digester at 2.0% of the input load on a VS basis.
52	Weight	10:1	Starch-based plastic bags & PLA tableware	50 x 50 mm^2	35	Not specified	M	Starch-based BBPs were shown to degrade faster than PLA, but both types showed limited degradability in co-digestion and subsequent composting of the digestate. The resulting compost yielded a relatively high BBP content, which did not meet current regulatory requirements. Intrinsic biodegradability in soil was demonstrated (though very slow).
53	Volume/ Weight	50 ml: 1g	Mater-Bi (corn starch) bags & PLA cups	10 x 10 mm^2	98	Batch	M & T	Synergistic effect of BBP co-digestion with pig slurry or cheese whey on methane and hydrogen yields. Thermophilic treatment further increased yields by roughly 50%.

BBP: Biodegradable Bioplastic; FW; Food Waste; AD: Anaerobic Digestion; PHA: Polyhydroxyalkanoate; PLA: Polylactic Acid; HDPE: High-Density Polyethylene; PP: Polypropylene; PS: Polystyrene; VS: Volatile Solid; COD: Chemical Oxygen Demand; CSTR: Continuous Stirred Tank Reactor; SBR: Semi-Batch Reactor; M: Mesophilic (35-37°C); T: Thermophilic (55°C), hT: Hyperthermophilic (80°C); [*]Not directly FW but sludge inoculum obtained from an AD plant running on the organic fraction of municipal solid waste; [†] Not BBPs but conventional plastics; [§]Associated data article supporting primary research article.