Supplementary Materials

Marine-Derived Actinomycetes: Biodegradation of Plastics and Formation of PHA Bioplastics—A Circular Bioeconomy Approach

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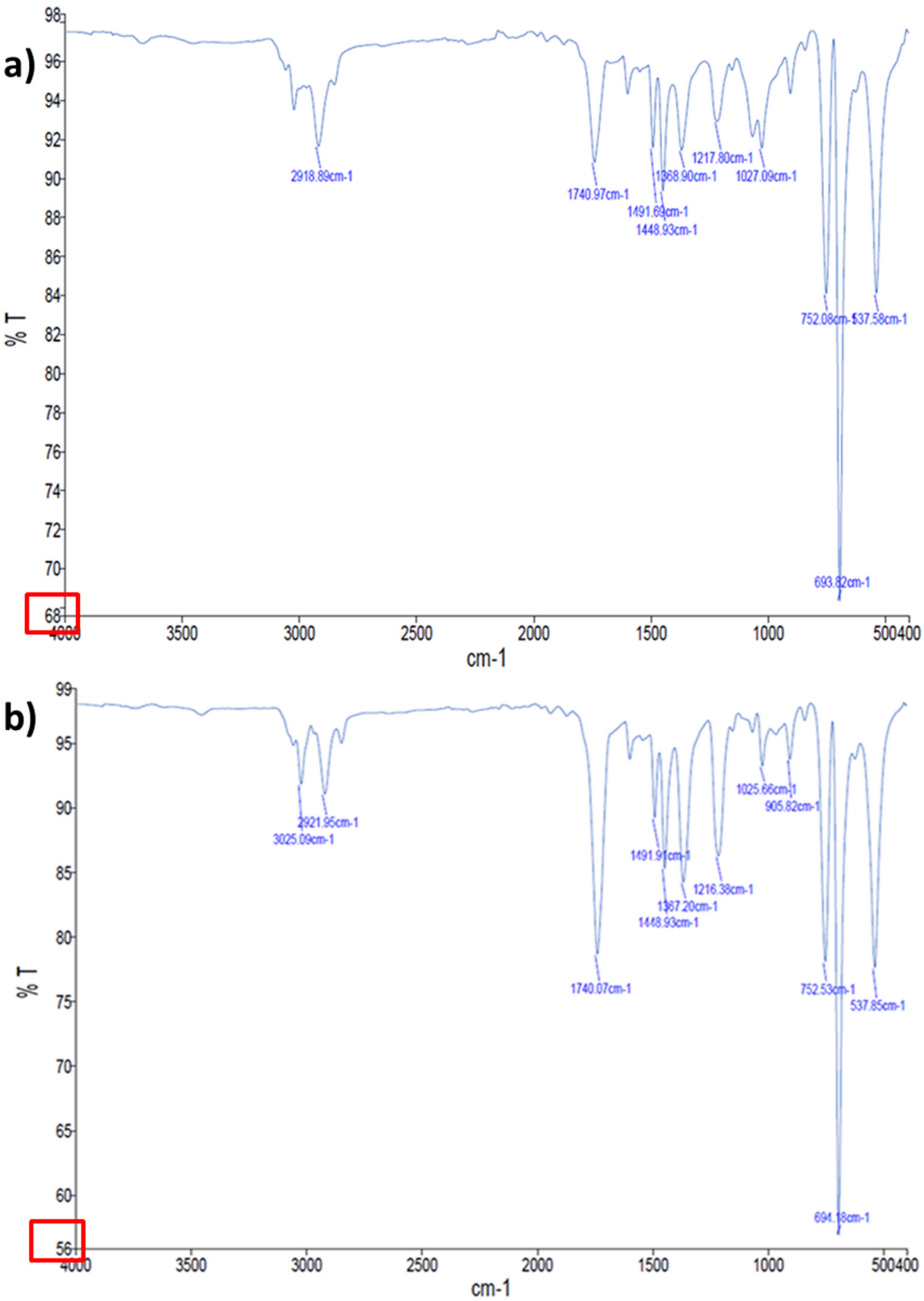


Figure S1. FTIR-ATR spectra of PS thin films incubated with *S. gougerotti*: a) in culture media without yeast extract; b) in culture media supplemented with yeast extract. Red rectangle highlights the increase in the intensity of the bands with the yeast extract conditions, which corresponds to polymer oxidation and a decrease in PS chain polymerization.

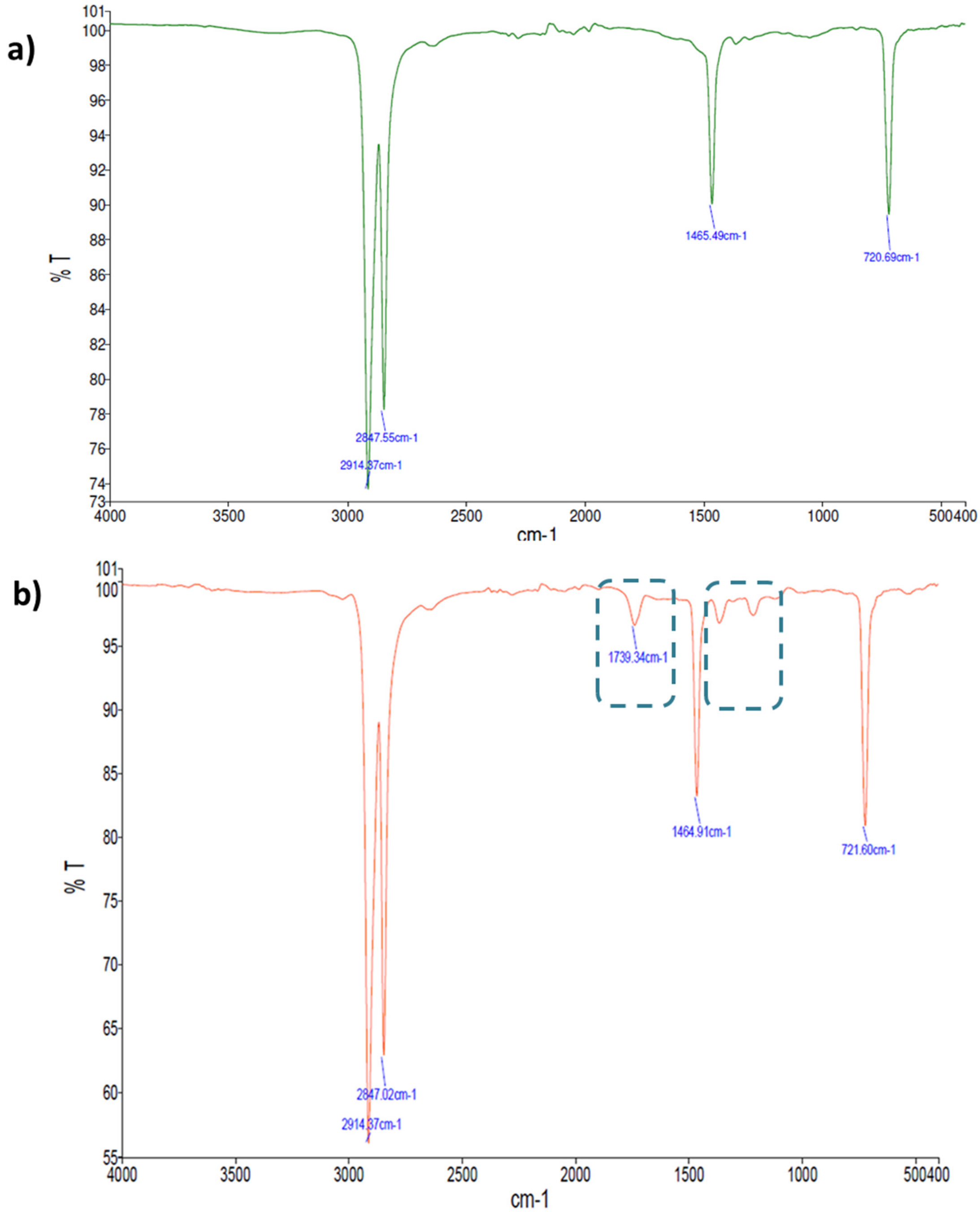


Figure S2. FTIR-ATR spectra of LDPE thin films incubated with *M. matsumotoense*. a) LPDE thin film control; b) LDPE thin film incubated with *M. matsumotoense*. The rectangles correspond to the new observed bands after incubation, at 1739 cm^{-1} and at 1367 and 1217 cm^{-1}, corresponding to carbonyl group formation and a decrease of LDPE chain polymerization, respectively.

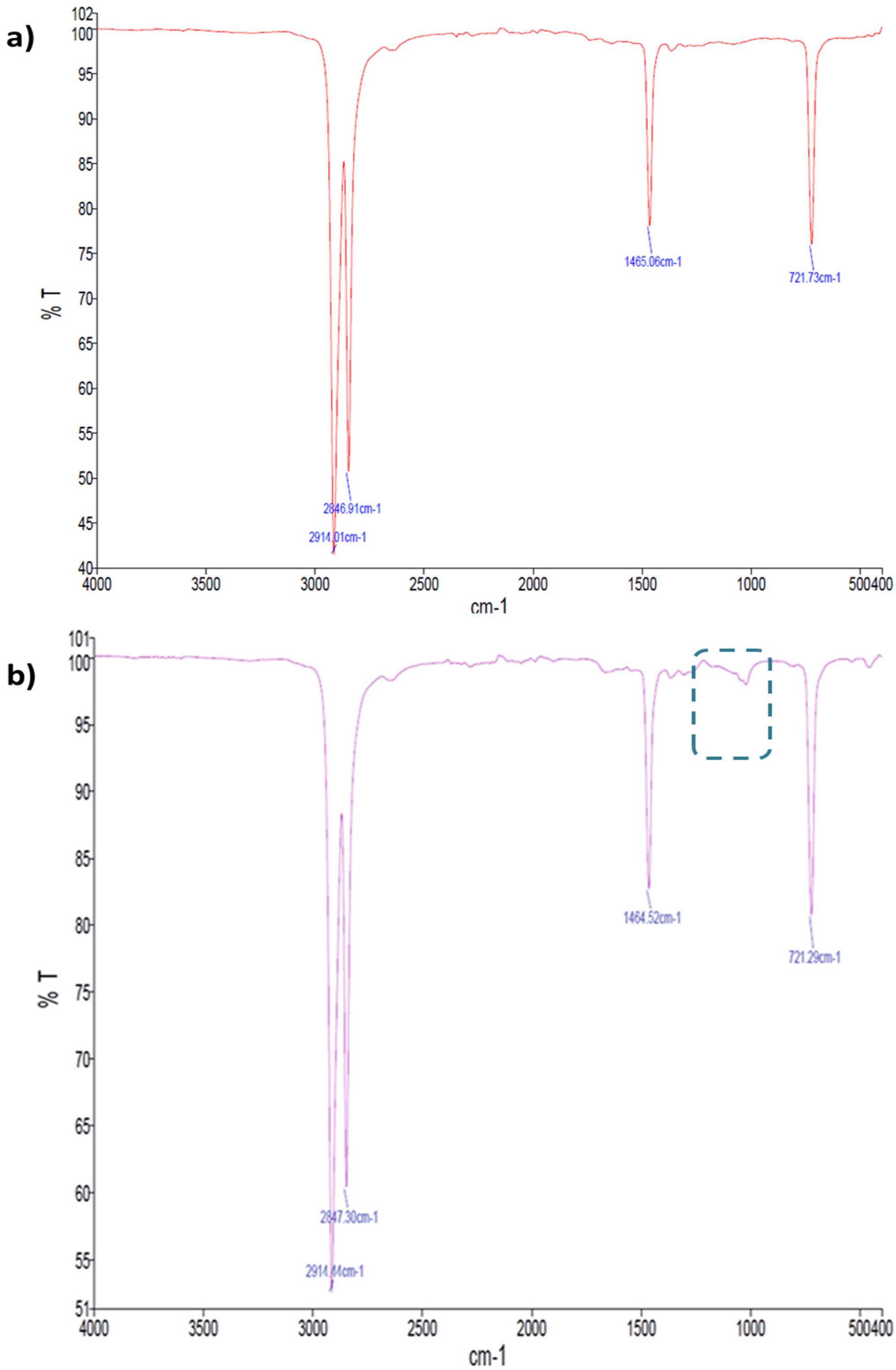


Figure S3. FTIR-ATR spectra of LDPE UV thin films incubated with *M. matsumotoense*. a) LPDE UV thin film control; b) LDPE UV thin film incubated with *M. matsumotoense*. The rectangle corresponds to the new observed bands after incubation, at 1096 cm^{-1}, indicating the presence of oxidized groups (groups containing -OH), which results from bacterial biodegradation.

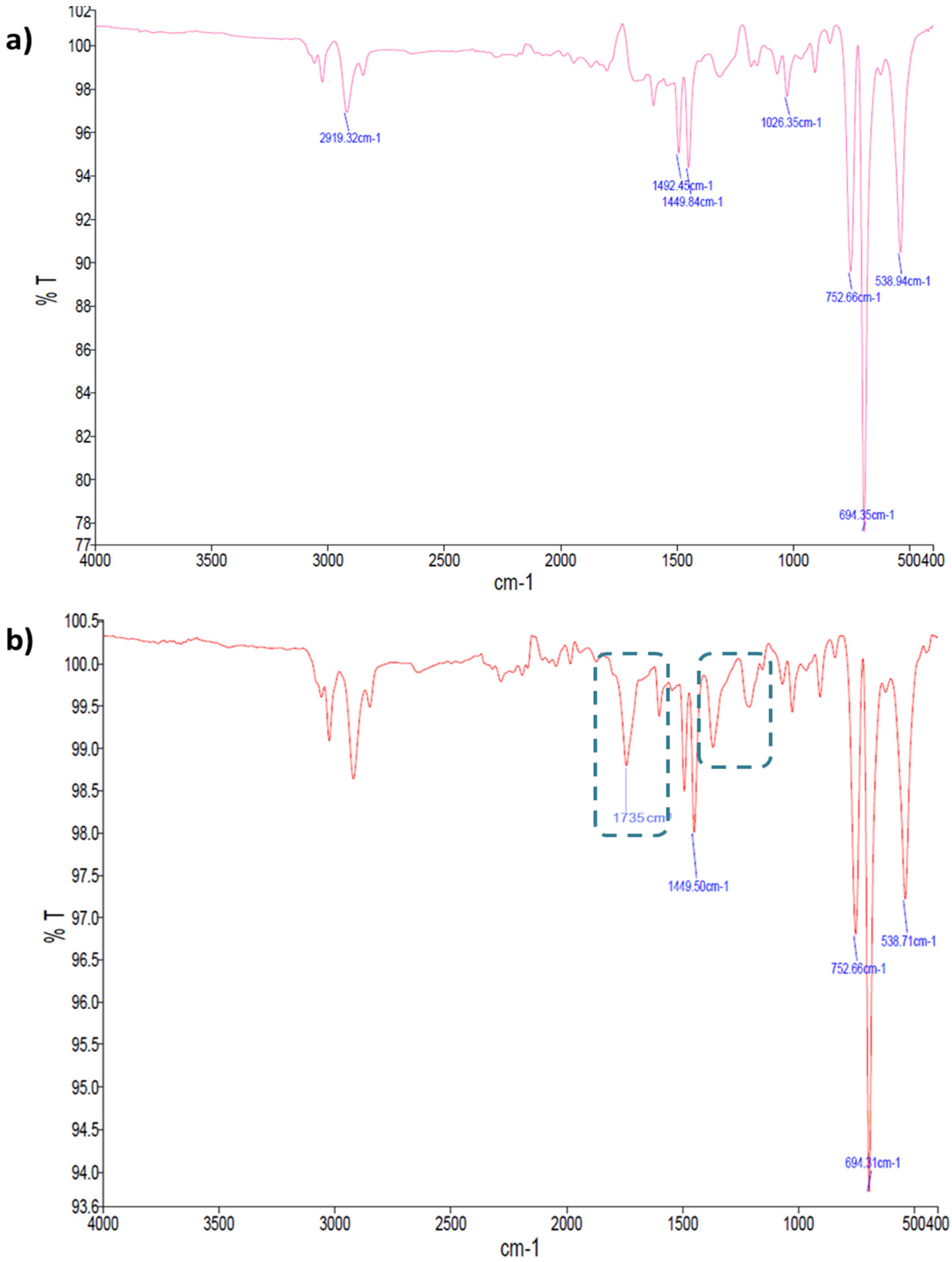


Figure S4. FTIR-ATR spectra of PS thin films incubated with *M. matsumotoense*. a) PS thin film control; b) PS thin film incubated with *M. matsumotoense*. The rectangle corresponds to the new observed bands after incubation, at 1735 cm^{-1} and at 1367 and 1217 cm^{-1}, corresponding to carbonyl group formation and a decrease in PS chain polymerization, respectively. This reveals biodegradation of the polymers by the secretion of enzymes from the microorganisms, which leads to polymeric disintegration.

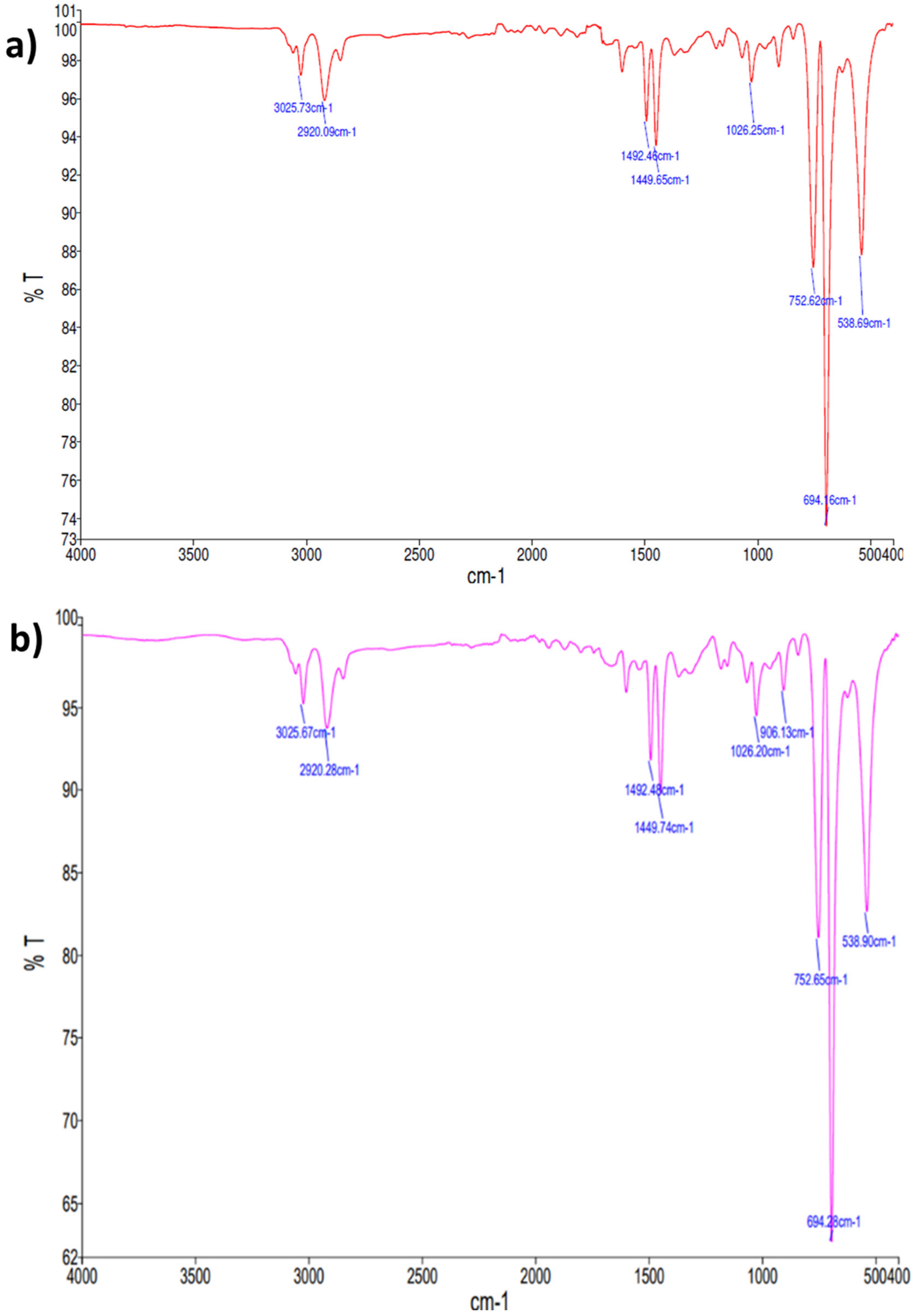


Figure S5. FTIR-ATR spectra of PS UV thin films incubated with *M. matsumotoense*. a) PS UV thin film control; b) PS UV thin film incubated with *M. matsumotoense*. An increase of the bands intensity after incubation with *M. matsumotoense* was observed, revealing chain oxidation and a decrease in PS UV chain polymerization.

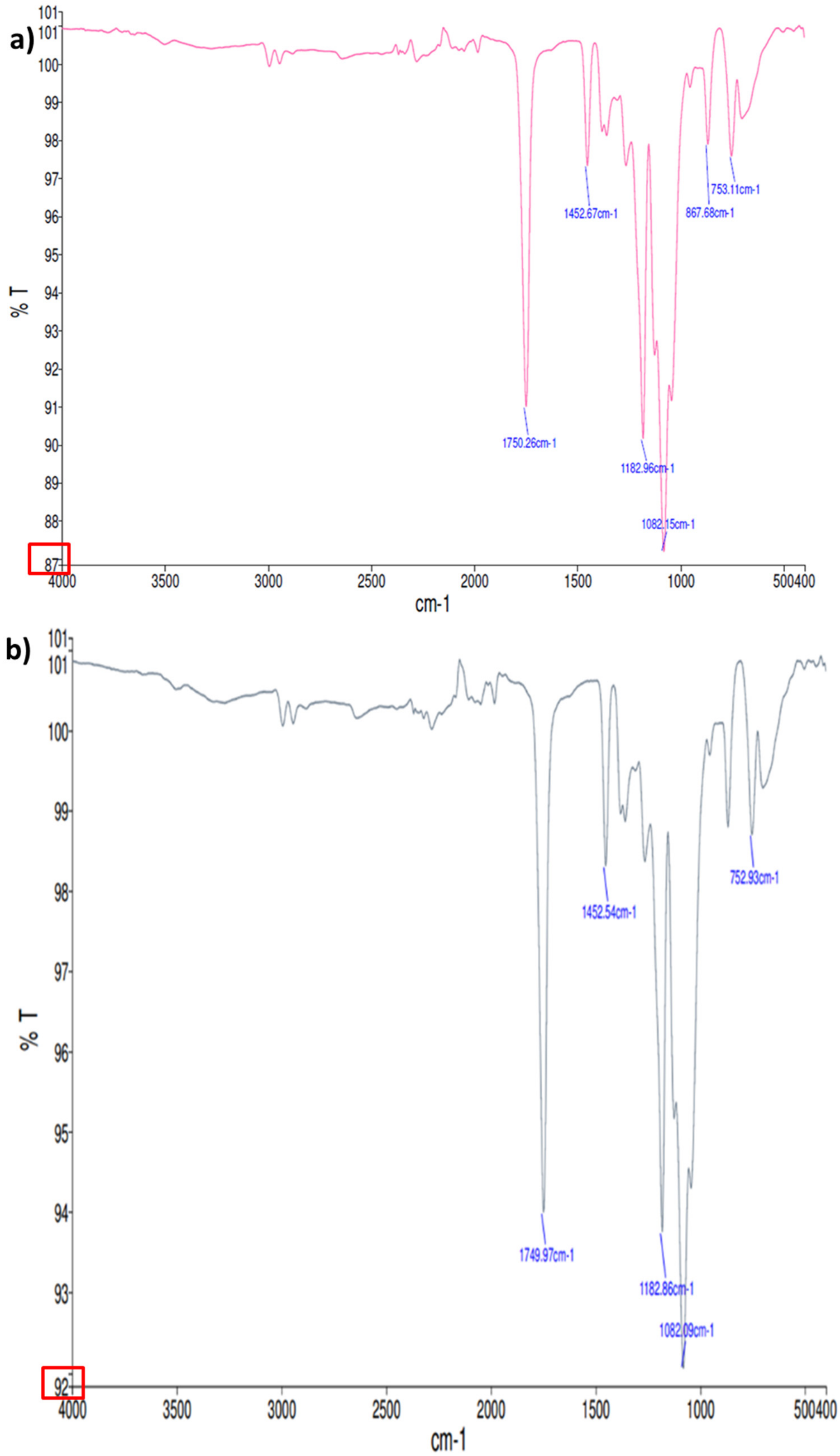
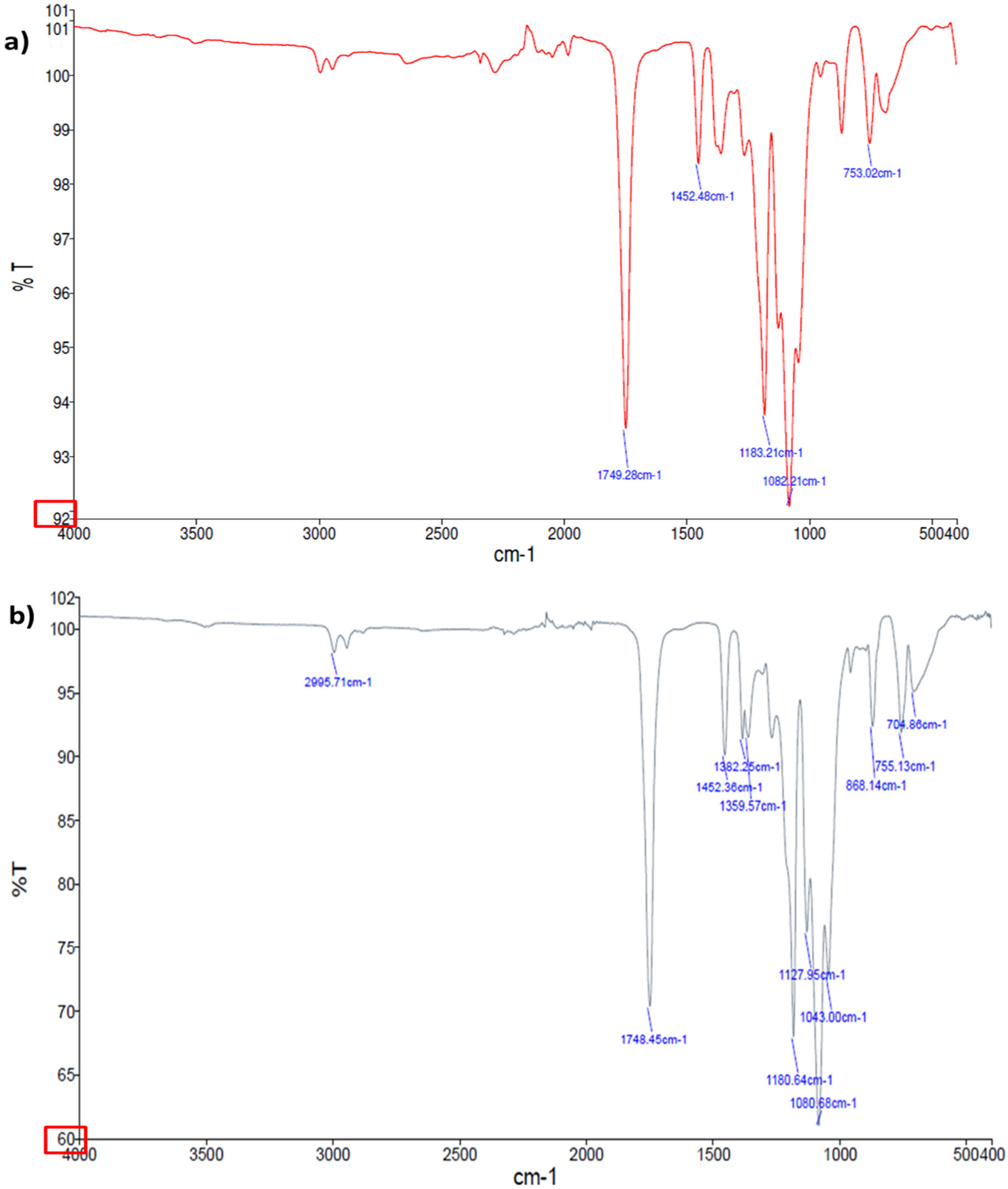


Figure S6. FTIR-ATR spectra of PLA thin films incubated with *N. prasina*. a) PLA thin film control; b) PLA thin film incubated with *N. prasina*. Red rectangle highlights the increase of the bands intensity after incubation with *N. prasina*, revealing chain oxidation and a decrease in PLA chain polymerization.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1043.00cm-1
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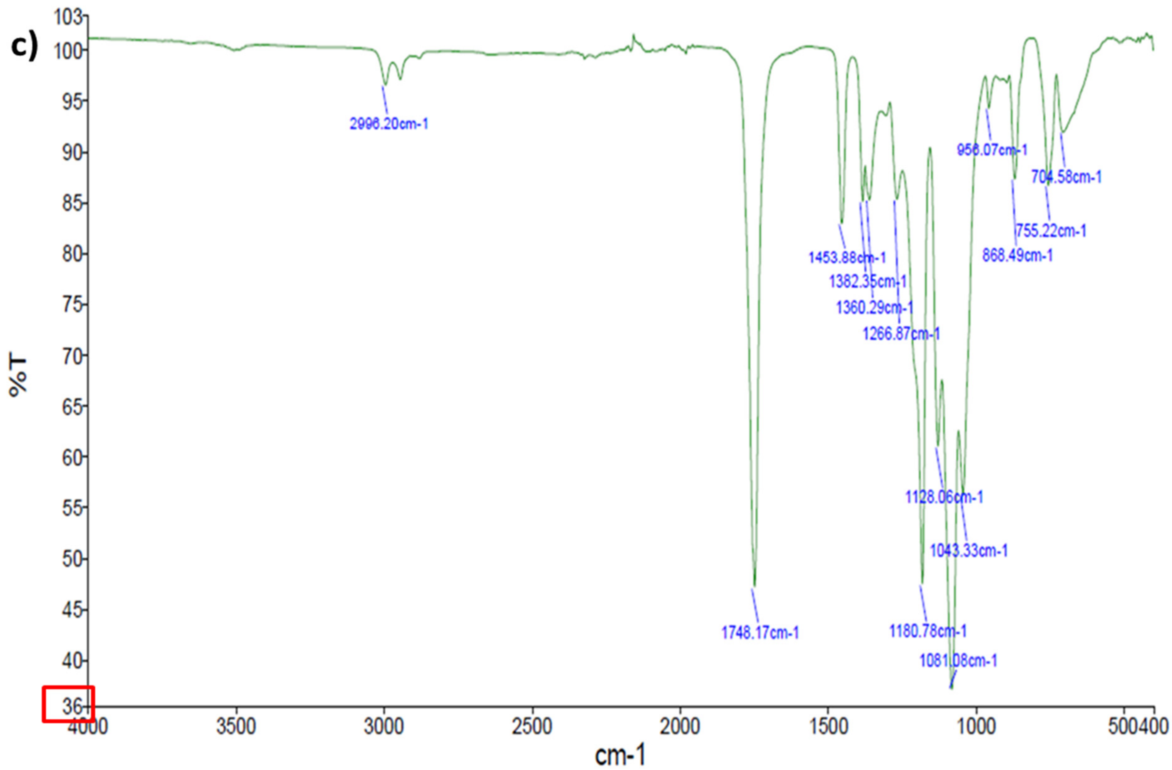

Figure S7. FTIR-ATR spectra of PLA UV thin films incubated with *N. prasina*. a) PLA UV thin film control; b) PLA UV thin film incubated with *N. prasina*; c) PLA UV thin film incubated with *N. prasina* in culture media supplemented with yeast extract. The red rectangles highlight the bands intensity differences with the different conditions, revealing higher oxidation. The bands at ~950 cm^{-1} and 700 cm^{-1} become more notorious and are characteristic of vinyl unsaturated groups and C-O double bounds, respectively. This is related to biodegradation.

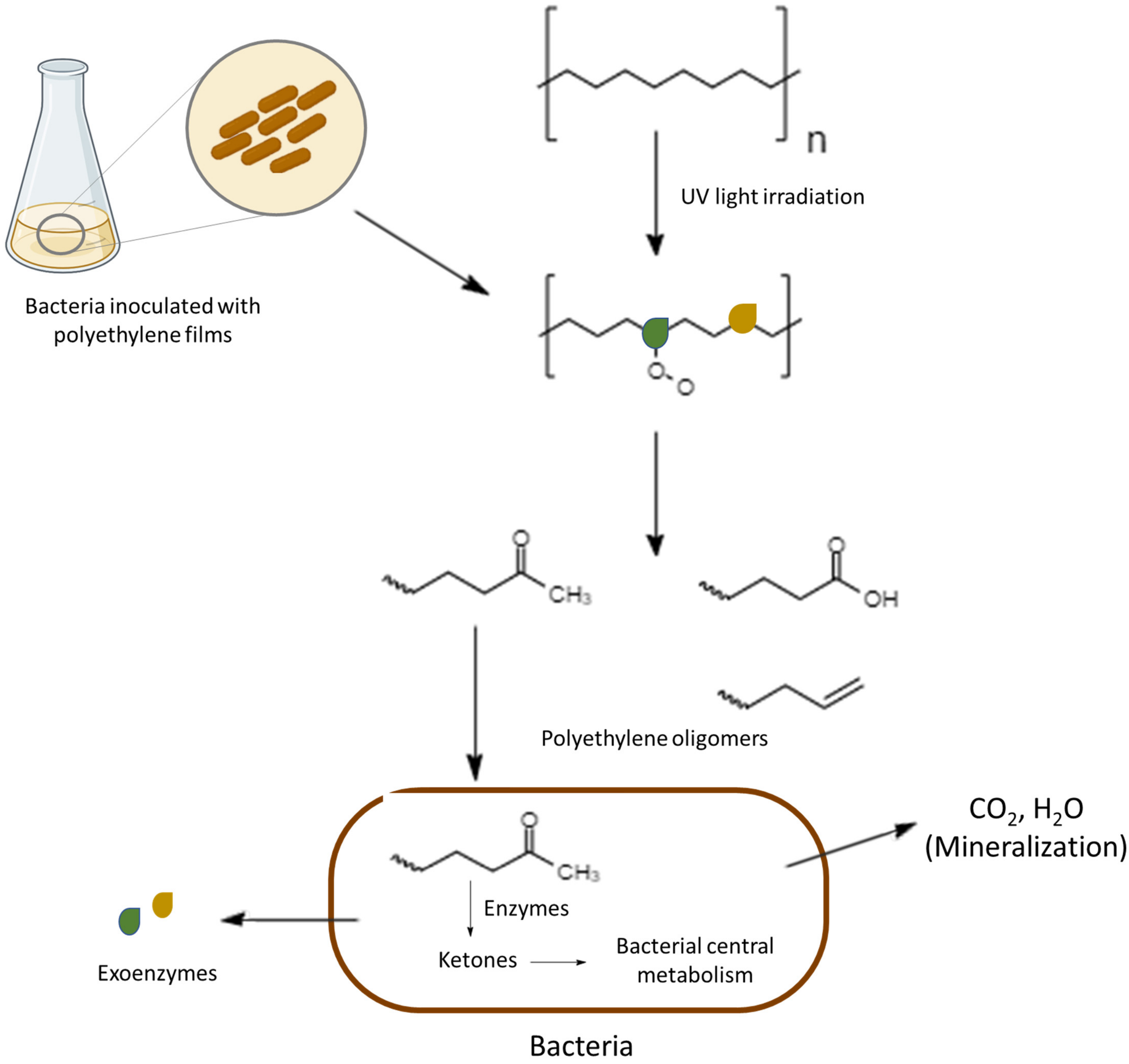

Figure S8. Mechanism of PE biodegradation by bacteria. During PE biodegradation carbonyl groups (-C=O) and oxidized groups such as moieties containing –OH groups are formed. These chemical changes were observed in the FTIR-ATR spectra. Adapted from Ghatge, S. et al. (2020). [1]

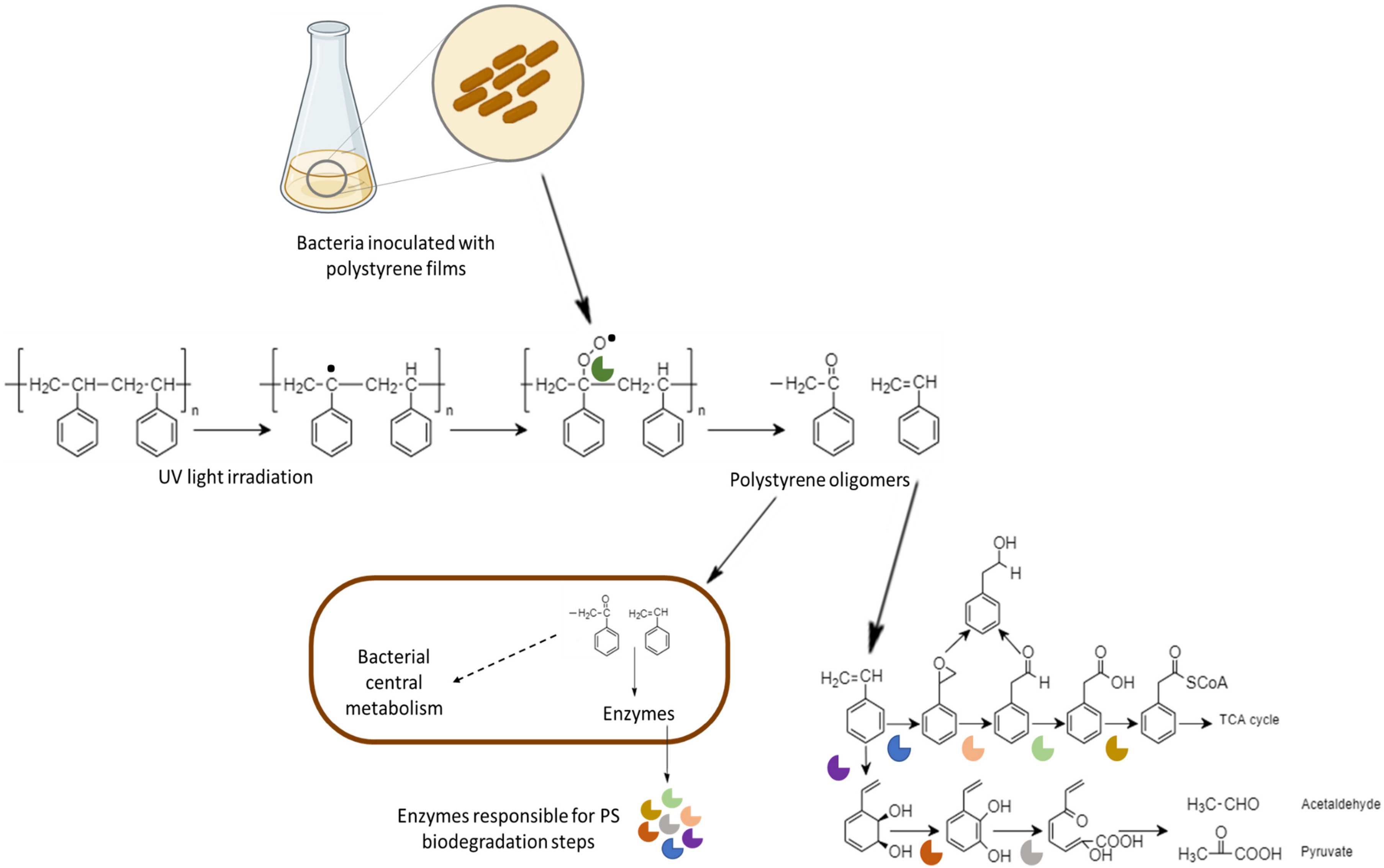

Figure S9. Mechanism for PS biodegradation by bacteria. During PS biodegradation several chemical groups are formed in the polymer surface, such as carbonyl groups (-C=O), alcohols (-C-OH), carboxylic acids (-COOH), esters (-COOR), and bound alterations in the benzene ring. These chemical changes were observed in the FTIR-ATR spectra. Adapted from Mooney, A. et al (2006). [2]

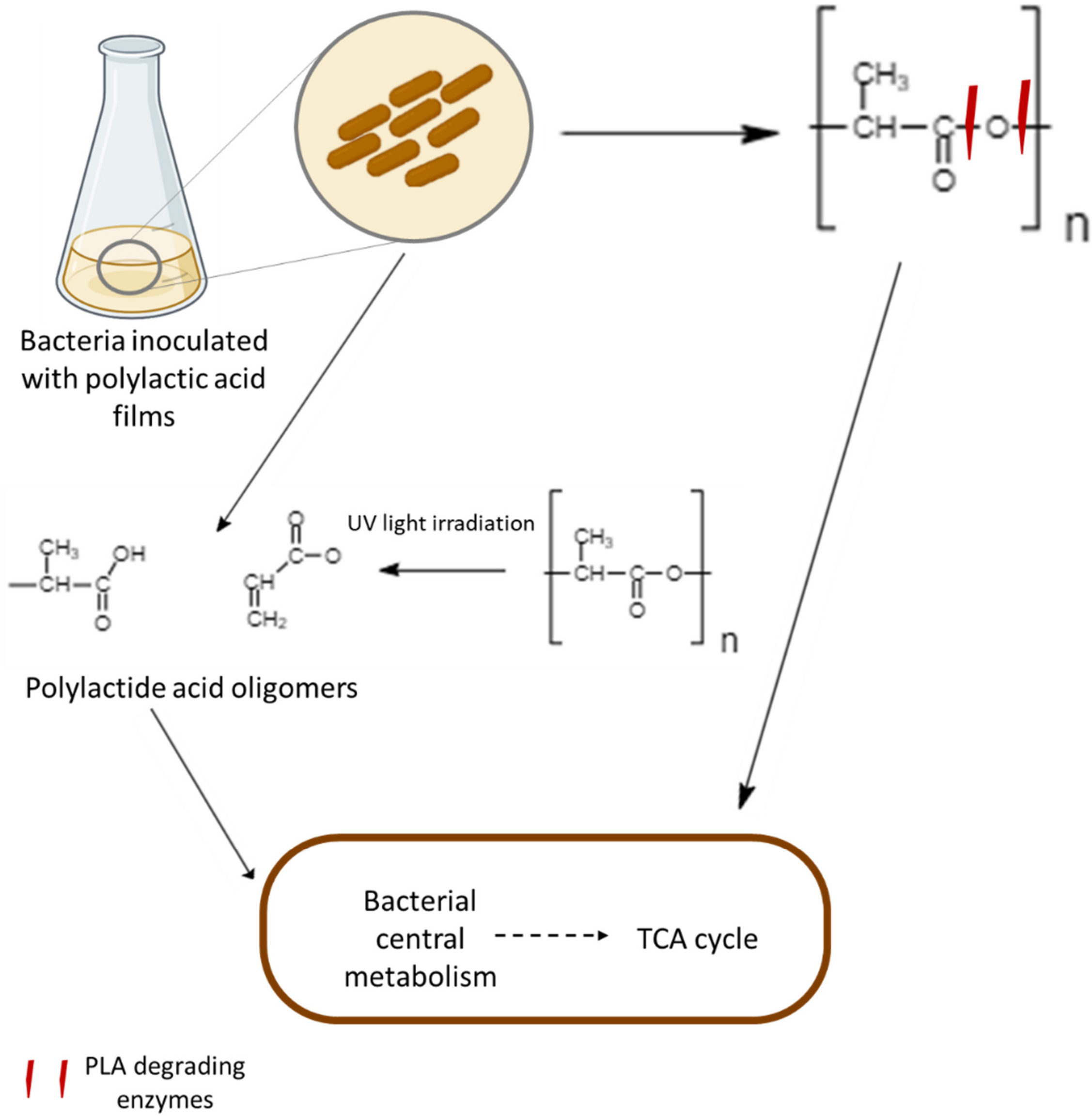

Figure S10. Mechanism for PLA acid biodegradation by bacteria. During PLA biodegradation chain oxidation and formation of vinyl unsaturated groups are observed. These chemical changes were observed in the FTIR-ATR spectra. Adapted from Pattanasuttichonlakul, W. et al. (2018). [3]

References:

[1] Ghatge, S.; Yang, Y.; Ahn, J.H.; Hur, H.-G. Biodegradation of polyethylene: a brief review. *Appl. Biol. Chem.* **2020**, *63*, doi:10.1186/s13765-020-00511-3.

[2] Mooney, A.; Ward, P.G.; O'Connor, K.E. Microbial degradation of styrene: biochemistry, molecular genetics, and perspectives for biotechnological applications. *Appl. Microbiol. Biotechnol.* **2006**, *72*, 1–10, doi:https://doi.org/10.1007/s00253-006-0443-1.

[3] Pattanasuttichonlakul, W.; Sombatsompop, N.; Prapagdee, B. Accelerating biodegradation of PLA using microbial consortium from dairy wastewater sludge combined with PLA-degrading bacterium. *Int. Biodeterior. Biodegradation* **2018**, *132*, 74–83, doi:https://doi.org/10.1016/j.ibiod.2018.05.014.