THE THERMAL STABILITY OF THERMOPLASTIC STARCH/POLYLACTIDE BLENDS

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Introduction

The increase in solid waste from non-biodegradable polymers and the depletion of petroleum resources have heightened environmental awareness and stimulated interest in alternative raw materials, particularly biodegradable plastics from renewable resources. These biodegradable plastics aim to match the properties and cost of conventional polymers. However, they face challenges such as slow degradation rates, higher costs and increased brittleness materials which is important to improve.

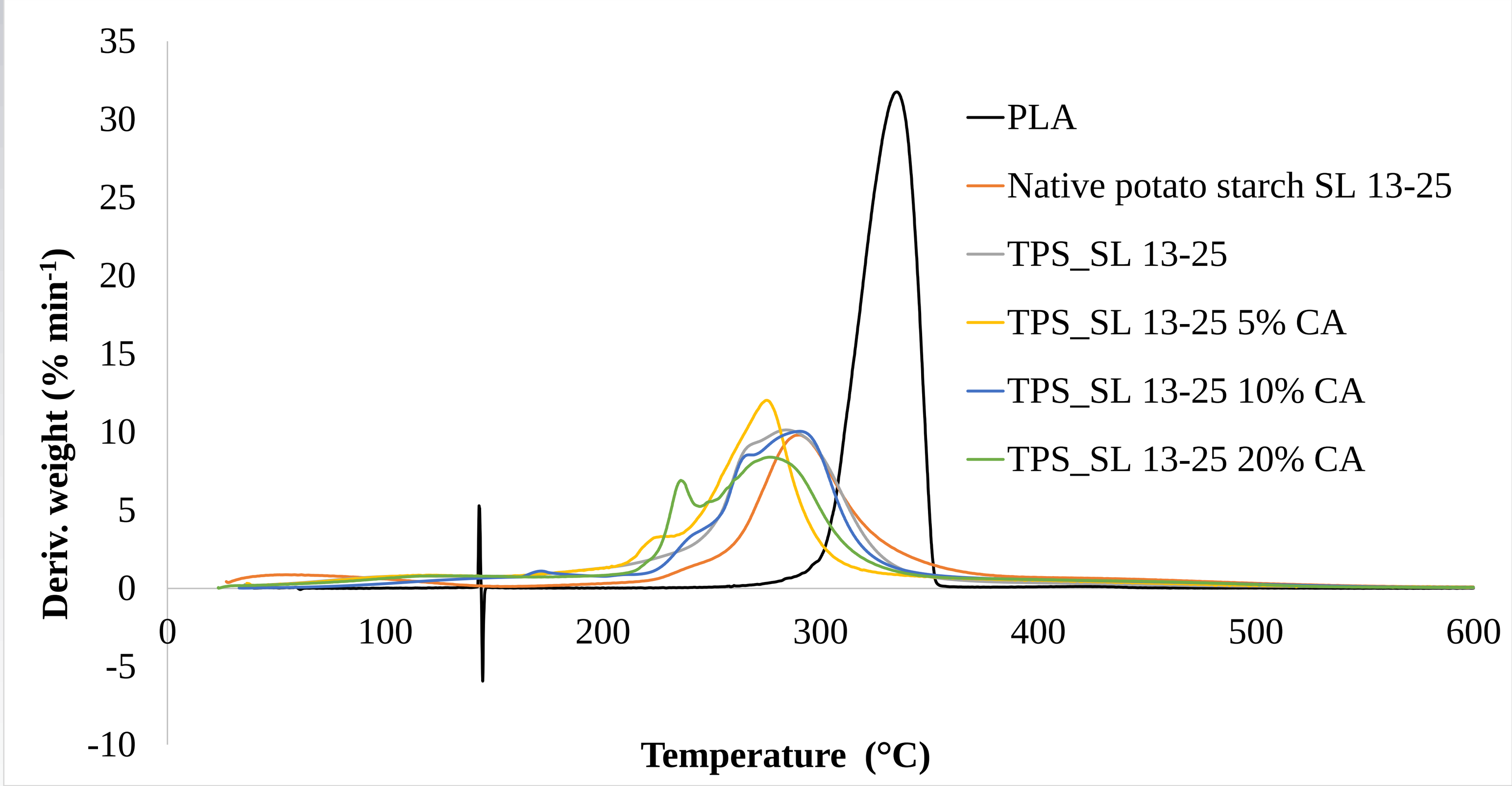

Figure 1 TGA curves of PLA, native potato starch and TPS with different content of CA

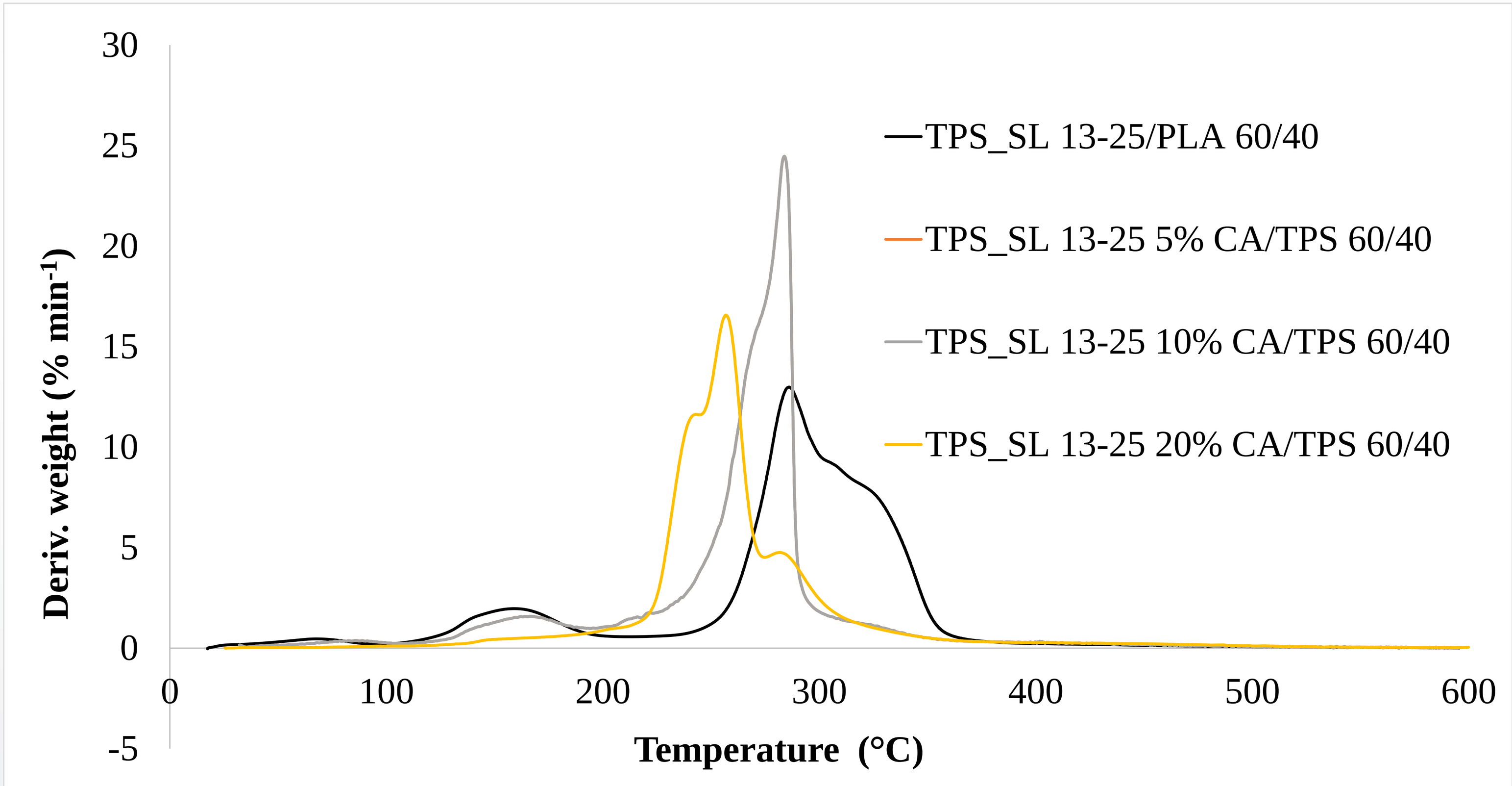

Figure 2 TGA curves of polymer blends TPS_SL 13-25/PLA 60/40 with different content of CA

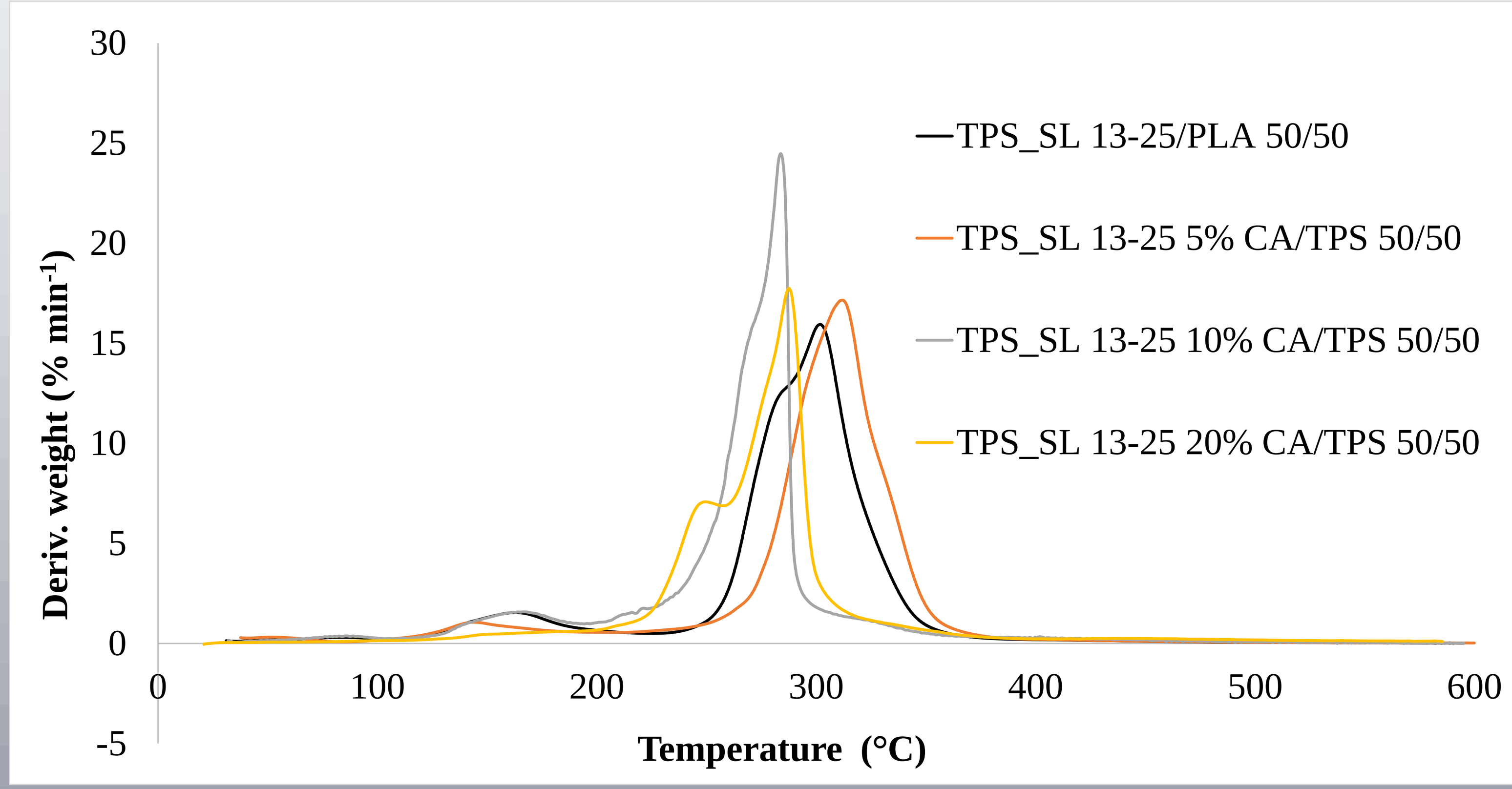

Figure 3 TGA curves of polymer blends TPS_SL 13-25/PLA 50/50 with different content of CA

Materials and Methods

Starch is a promising renewable resource as it is available, easy to produce, environmentally friendly, inexpensive and easy to handle. In this study, starch was isolated from two potato varieties (Scala and SL 13–25) grown at the experimental station of the Faculty of Agrobiotechnology in Osijek in 2021. The isolated starches were then processed into thermoplastic starches by extrusion with glycerol as a plasticizer, with and without citric acid (CA) as a compatibilizer/crosslinking agent. The thermal stability and structural properties of blends of thermoplastic starch (TPS) or thermoplastic starch citrate and polylactide (PLA) are investigated. The analysis was performed with a thermogravimetric analyzer. Due to the hydrophilicity of thermoplastic starch (TPS), PLA/TPS blends exhibit significant incompatibility. The addition of CA not only improves the overall thermal stability of TPS/PLA blends but also acts as a crosslinking and plasticizing agent, promoting the formation of the PLA–CA–TPS structure, which results in a new class of biodegradable and environmentally acceptable materials. The results obtained in this research are presented on this poster only for the SL 13-25 potato variety.

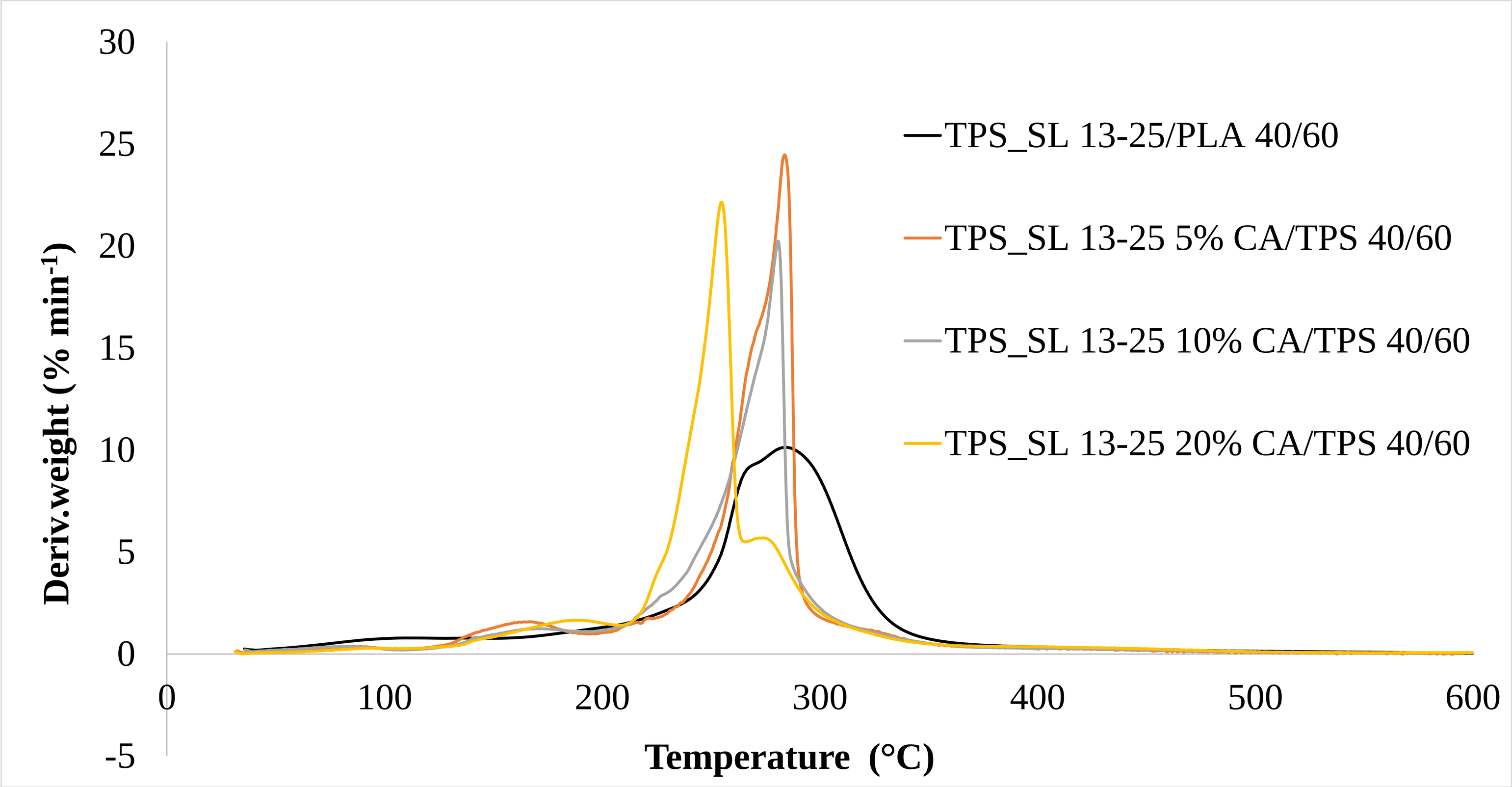

Figure 4 TGA curves of polymer blends TPS_SL 13-25/PLA 40/60 with different content of CA

Table 1 Results of thermogravimetric analysis

Sample	T_{start} [°C]	T_{max1} [°C]	Δm_1 [%]	T_{max2} [°C]	Δm_2 [%]	T_{end} [°C]	$R_{600\,°C}$ [%]
PLA	287.37	/	/	334.74	98.48	368.14	1.01
Native potato starch SL 13-25	113.02	289.38	64.84	/	/	464.20	24.21
TPS_SL 13-25	123.82	284.88	79.47	/	/	350.40	11.94
TPS_SL 13-25/PLA 60/40	138.21	158.90	12.25	286.03	77.72	440.61	6.63
TPS_SL 13-25 5% CA/PLA 60/40	141.16	165.52	8.97	282.84	75.50	355.28	10.42
TPS_SL 13-25 10% CA/PLA 60/40	134.60	171.65	7.23	279.17	70.21	354.04	17.09
TPS_SL 13-25 20% CA/PLA 60/40	114.89	188.55	10.09	254.14	71.64	340.97	12.31
TPS_SL 13-25/PLA 50/50	145.63	163.01	9.92	302.03	82.42	392.54	5.29
TPS_SL 13-25 5% CA/PLA 50/50	146.87	153.88	6.35	283.21	82.15	343.95	12.90
TPS_SL 13-25 10% CA/PLA 50/50	139.04	162.17	7.36	283.34	82.08	350.75	6.45
TPS_SL 13-25 20% CA/PLA 50/50	151.13	154.74	3.22	276.97	82.01	348.50	11.19
TPS_SL 13-25/PLA 40/60	141.08	150.49	6.94	312.30	85.69	400.51	4.49
TPS_SL 13-25 5% CA/PLA 40/60	135.64	146.67	5.62	297.53	84.98	368.21	6.61
TPS_SL 13-25 10% CA/PLA 40/60	138.76	156.03	3.29	300.07	85.42	353.54	8.03
TPS_SL 13-25 20% CA/PLA 40/60	128.74	166.98	5.17	281.99	83.16	356.98	7.91

Conclusion

CA played a key role as an effective compatibilizer, enabling the creation of polymer blends with a uniform microstructure and improved thermal stability. The addition of polylactide increases the thermal stability of TPS in biodegradable polymer blends. At certain proportions of citric acid, an increase in the temperature of the beginning of decomposition of the analyzed blends of biodegradable polymers with the addition of citric acid was observed, which indicates a positive influence of the addition of citric acid on the thermal stability of TPS/PLA blends. Tests have shown the great potential of TPS/PLA blends with the addition of citric acid as possible packaging materials, thus emphasizing the importance of the transition to a circular economy related to biodegradable polymer materials.

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