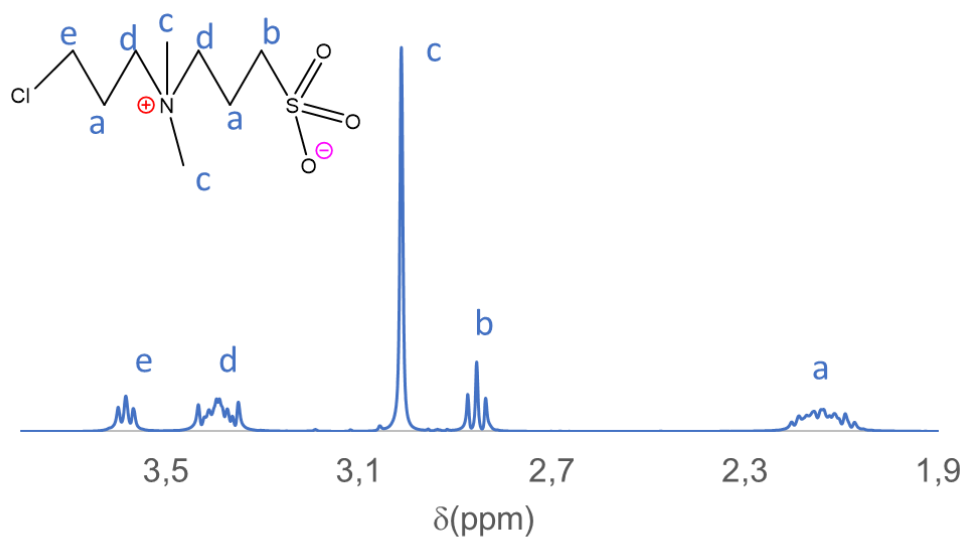


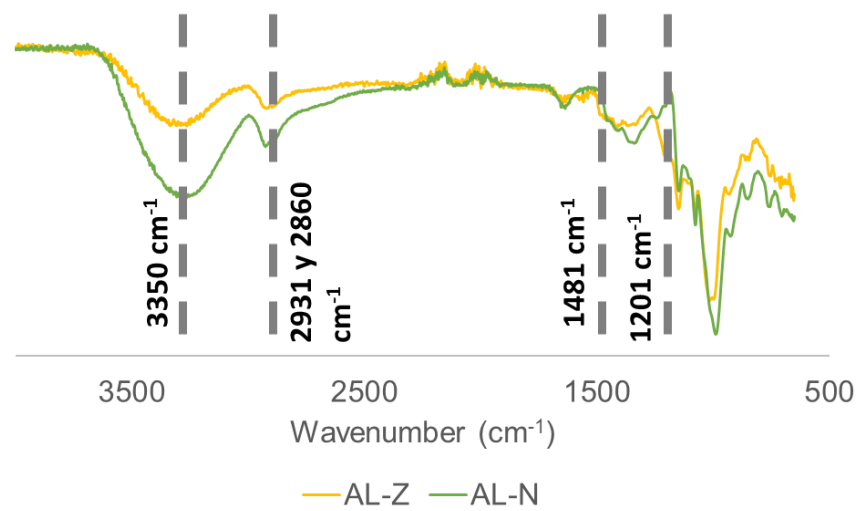
## Supplementary material



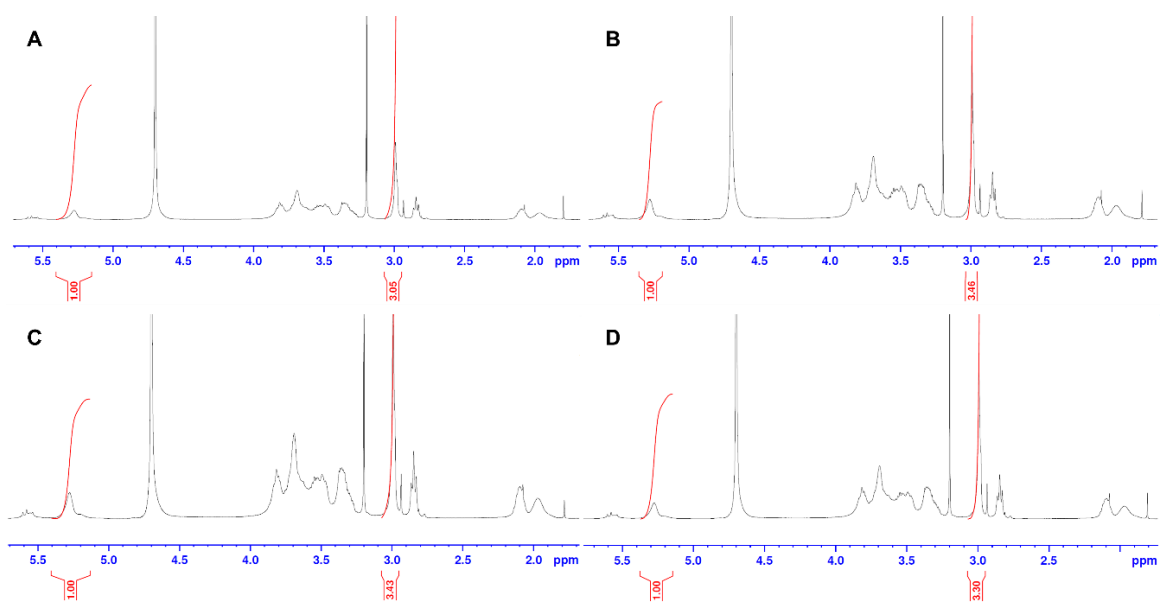
**Figure S1.** Synthesis of zwitterionic starch after (A) twelve-hour of reaction, (B) neutralization, precipitation, and three wash with methanol, (C) smash in methanol, and (D) filtration.



**Figure S2.**  $^1\text{H}$  RMN spectrum of DCAPS



**Figure S3.** FTIR spectra of AL-N and AL-Z



**Figure S4.** AL-Z synthesis replicate (A) 1, (B) 2, (C) 3, and (D) 4

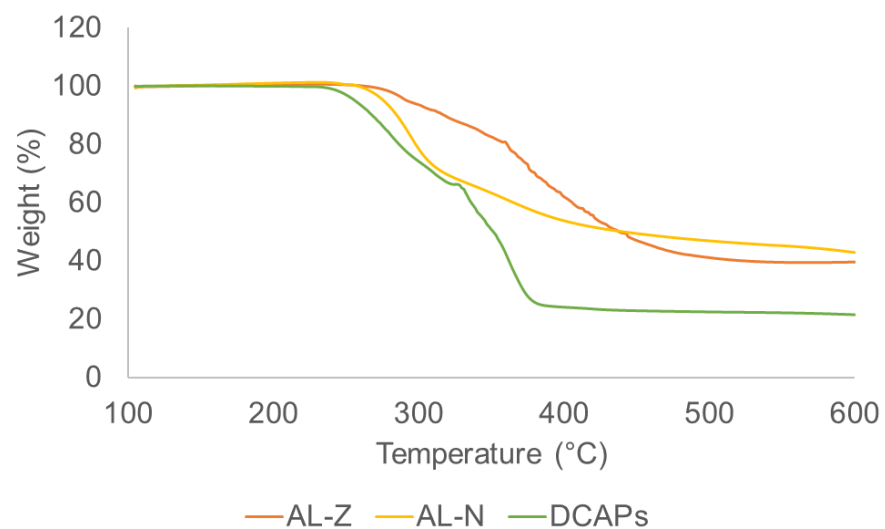


Figure S5. TGA of AL-N, AL-Z and DCPAS

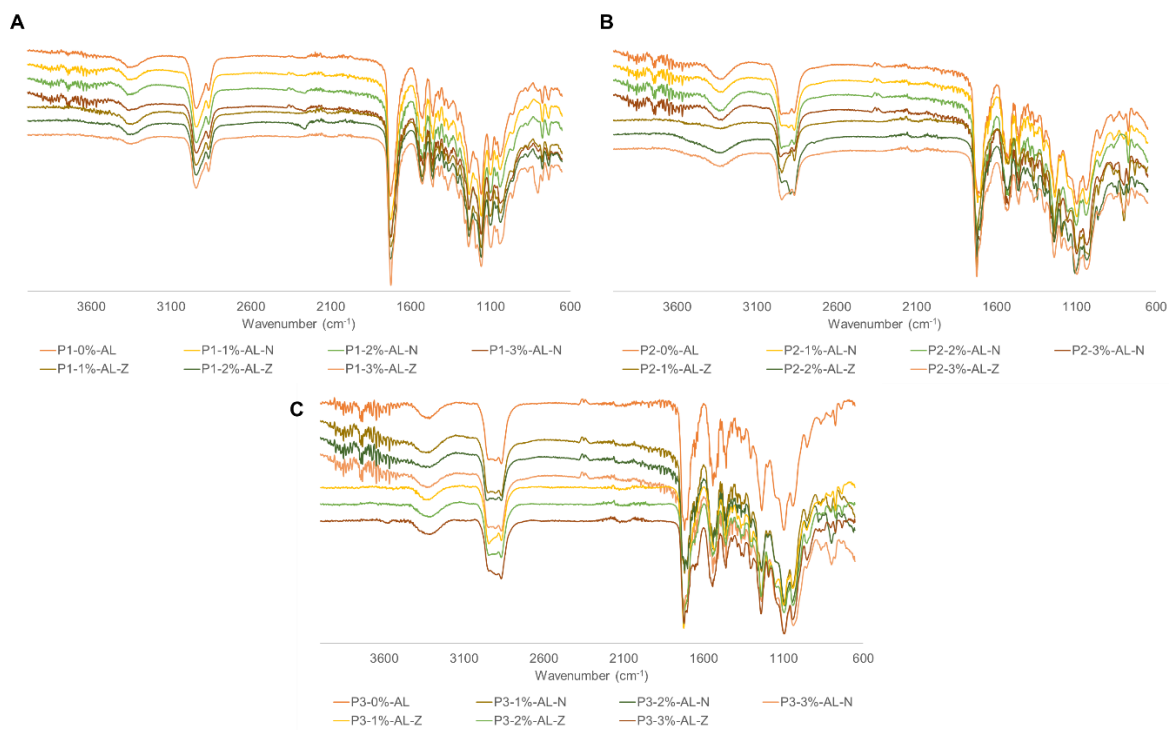
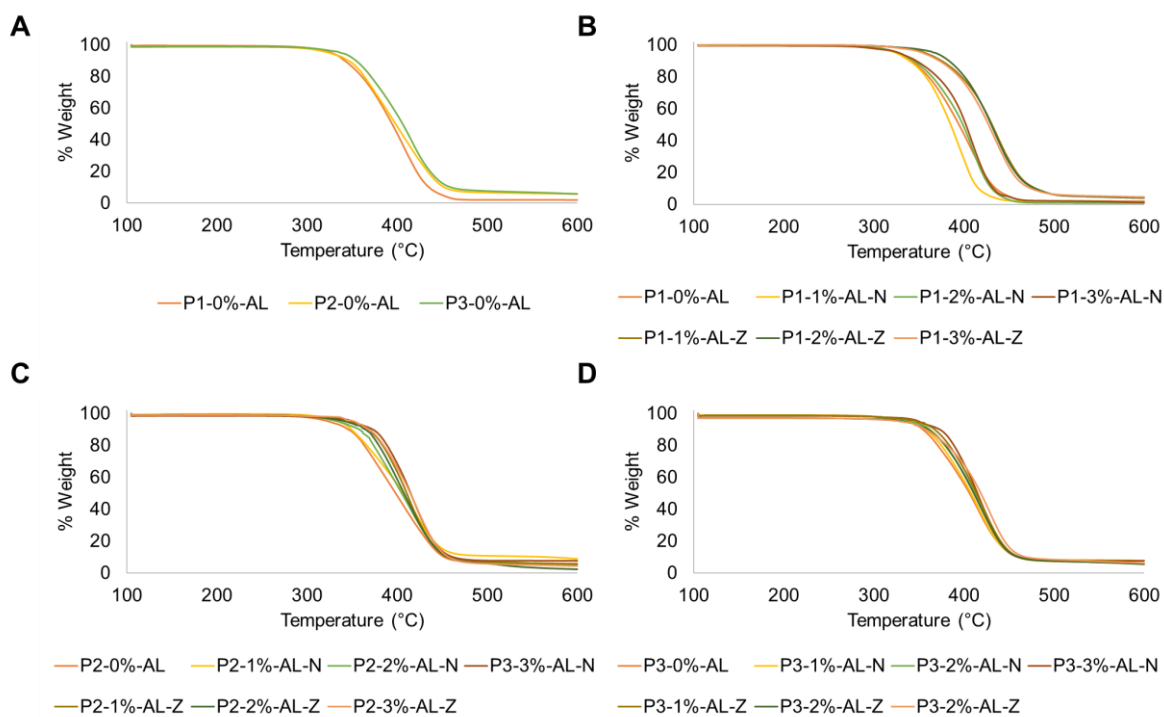


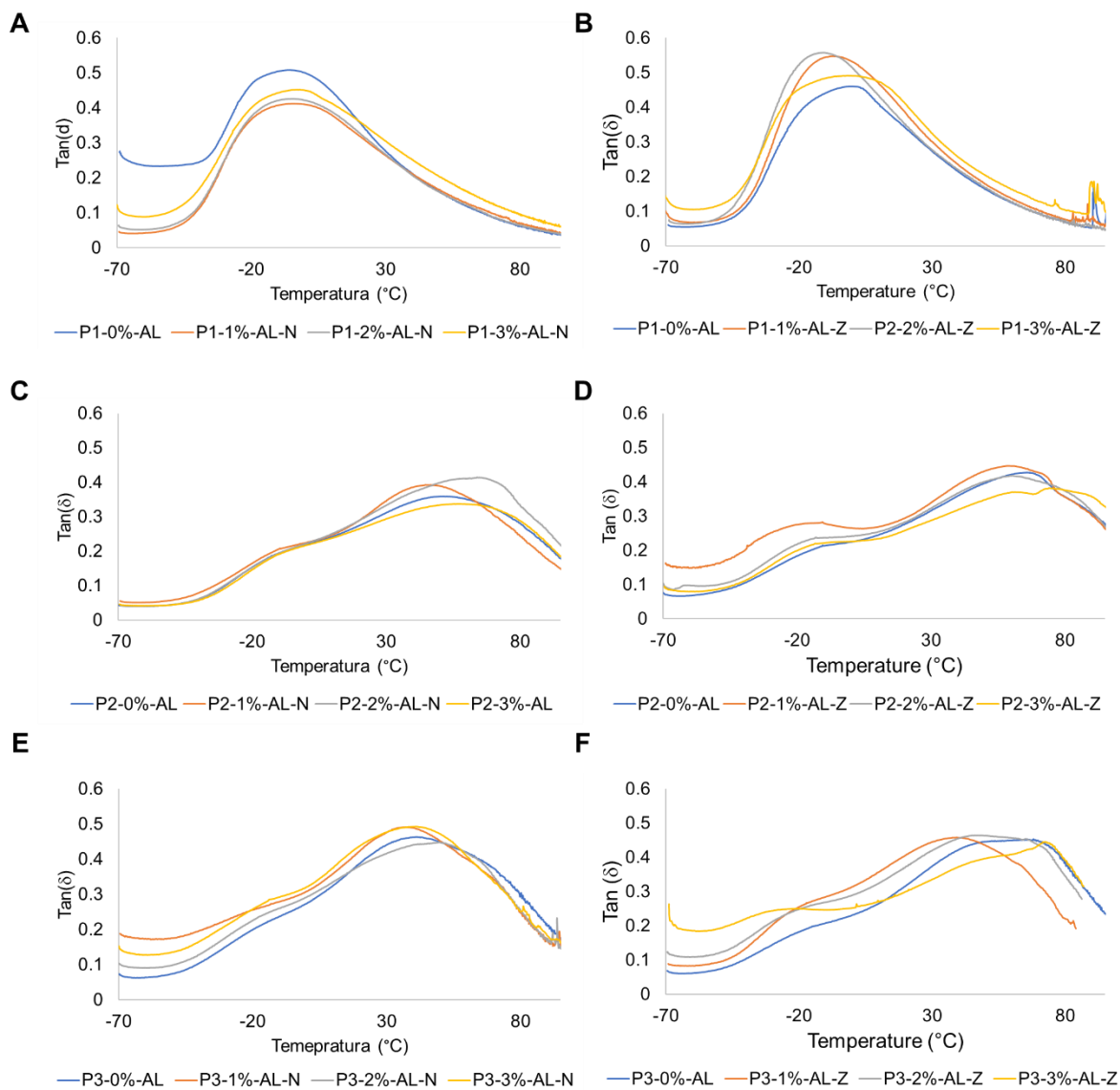
Figure S6. FTIR spectra of (A) P1, (B) P2, and (C) P3 of polyurethane composites

**Table S 1.** Element weight composition of polyurethane composites from energy dispersive X-ray spectroscopy analysis.

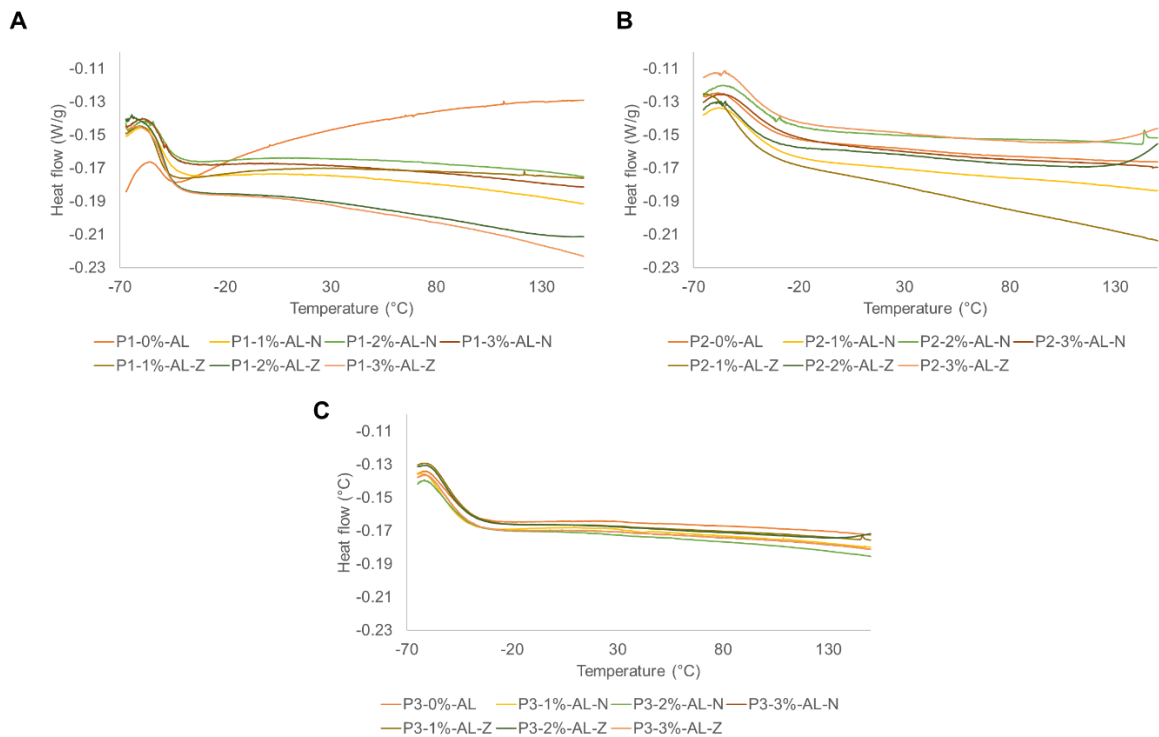
PU	Starch	Concentration	Zone	Element Wt%		
				C	O	S
P1	AL-N	3%	AL-N	71.05	28.95	0
			AL-Z	66.01	28.52	4.02
			AL-0%	87.95	12.05	0
			Matrix	85.61	14.39	0
			Filler	80.37	19.63	0
			Matrix	85.73	12.56	0
			Filler	79.11	19.22	1.20



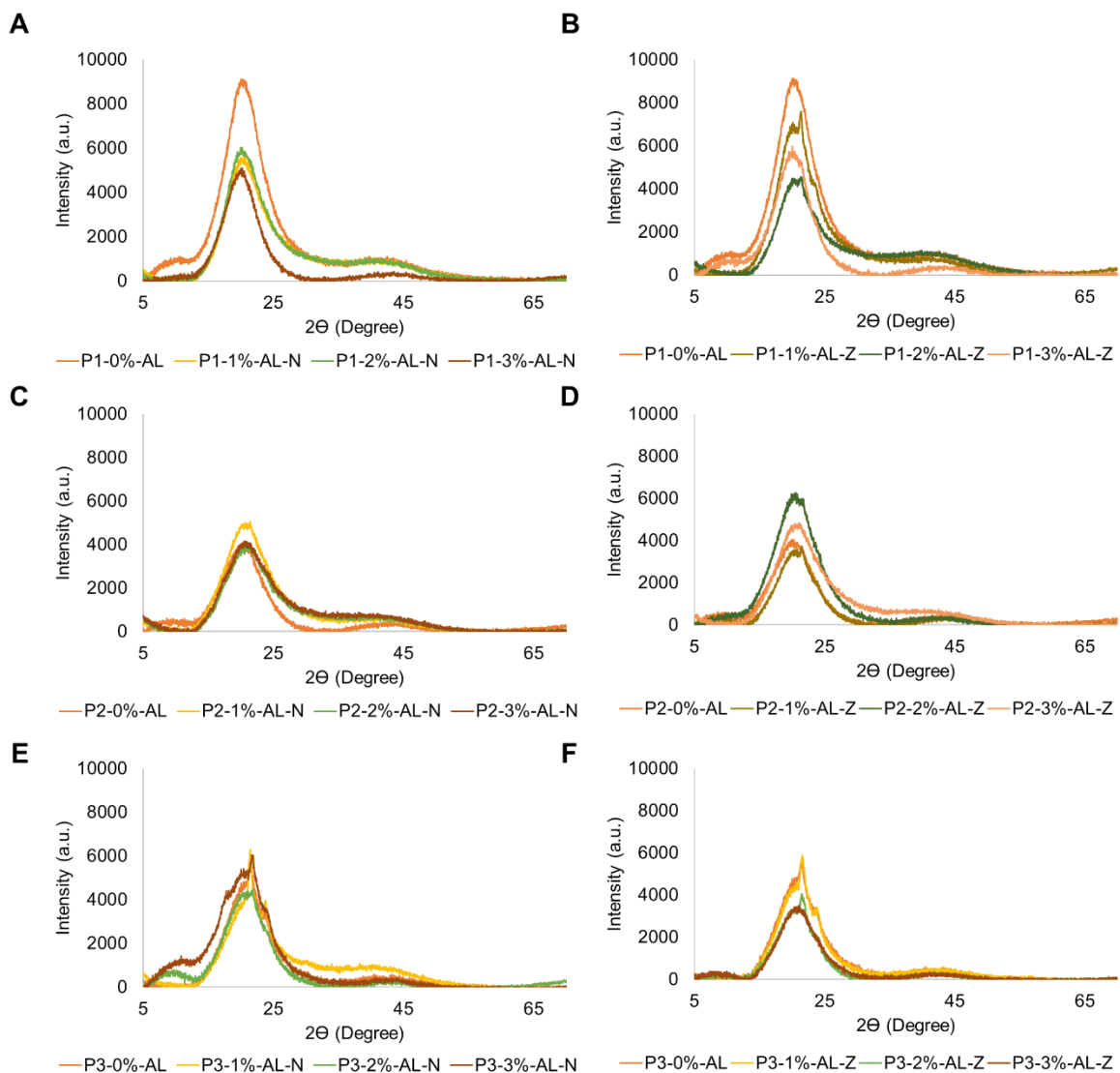
**Figure S7.** TGA of polyurethane (A) without fillers, (B) P1, (C) P2, and (D) P3 composites



**Figure S8.** Loss factor of polyurethane composites P1 (A-B), P2 (C-D), and P3 (E-F)



**Figure S9.** DSC of polyurethane (A) P1, (B) P2, and (C) P3 composites



**Figure S10.** XRD spectra of composite polyurethane P1 (A-B), P2 (C-D), and P3 (E-F)