

Table 1. The lower boundary(LB) and the upper boundary(UB)for each model.

Parameters \ Models	Cole		Double Cole		Double-shell		Proposed Stem model		Proposed Simplified Stem model	
	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB
α	0	1	0	1	0	1	0	1	0	1
β	-	-	0	1	0	1	0	1	0	1
γ	-	-	-	-	-	-	0	1	0	1
ζ	-	-	-	-	-	-	0	1	-	-
λ	-	-	-	-	-	-	0	1	-	-
R_∞	0	100K Ω	0	1M Ω	-	-	-	-	-	-
R_o	0	80M Ω	-	-	-	-	0	1G Ω	0	100M Ω
R_1	-	-	0	1M Ω	0	10M Ω	0	1G Ω	0	100M Ω
R_2	-	-	0	1M Ω	0	10M Ω	0	1G Ω	0	100M Ω
R_3	-	-	-	-	0	10M Ω	0	1G Ω	-	-
R_4	-	-	-	-	-	-	0	1G Ω	-	-
C_α	0	3 μ F	0	4 μ F	0	3 μ F	0	100 μ F	0	10 μ F
C_β	-	-	0	4 μ F	0	3 μ F	0	100 μ F	0	10 μ F
C_γ	-	-	-	-	-	-	0	100 μ F	0	10 μ F
C_ζ	-	-	-	-	-	-	0	100 μ F	-	10 μ F
C_λ	-	-	-	-	-	-	0	100 μ F	-	10 μ F

Table 2. The extracted parameters from the measured plant stem samples using different optimization techniques.

Parameters		α	β	γ	ζ	λ	R_∞	R_o	R_1	R_2	R_3	R_4	C_α	C_β	C_γ	C_ζ	C_λ
Models																	
Cole	Marjoram "5 cm"	0.6647	-	-	-	-	5.6834 (K Ω)	202.28 (K Ω)	-	-	-	-	4.2952 (nF)	-	-	-	-
	Marjoram "10 cm"	0.73	-	-	-	-	4.9567 (K Ω)	558.89 (K Ω)	-	-	-	-	1.1493 (nF)	-	-	-	-
	Salvia "5 cm"	0.7035	-	-	-	-	23.987 (K Ω)	441.99 (K Ω)	-	-	-	-	2.7149 (nF)	-	-	-	-
	Salvia "10 cm"	0.7159	-	-	-	-	25.565 (K Ω)	991.37 (K Ω)	-	-	-	-	1.4455 (nF)	-	-	-	-
	Lavandula "5 cm"	0.5016	-	-	-	-	9.4741 (K Ω)	384.92 (K Ω)	-	-	-	-	65.825 (nF)	-	-	-	-
Double Cole	Lavandula "10 cm"	0.5562	-	-	-	-	2.1391 (K Ω)	604.51 (K Ω)	-	-	-	-	12.135 (nF)	-	-	-	-
	Marjoram "5 cm"	1	0.6828	-	-	-	8.6531 (K Ω)	-	31.628 (K Ω)	194.2 (K Ω)	-	-	67.17 (nF)	3.6101 (nF)	-	-	-
	Marjoram "10 cm"	1	0.7156	-	-	-	0	-	38.239 (K Ω)	523 (K Ω)	-	-	1.6952 (nF)	1.3449 (nF)	-	-	-
	Salvia "5 cm"	0.5117	0.7908	-	-	-	0	-	143.71 (K Ω)	316.41 (K Ω)	-	-	27.943 (nF)	1.819 (nF)	-	-	-
	Salvia "10 cm"	0.8128	0.5932	-	-	-	0	-	757.92 (K Ω)	213.18 (K Ω)	-	-	0.8319 (nF)	8.0292 (nF)	-	-	-
Double-shell	Lavandula "5 cm"	1	0.3935	-	-	-	0	-	23.009 (K Ω)	551.16 (K Ω)	-	-	5.9543 (nF)	199.55 (nF)	-	-	-
	Lavandula "10 cm"	0.5271	1	-	-	-	0	-	585.57 (K Ω)	9.7282 (K Ω)	-	-	24.989 (nF)	0.4826 (nF)	-	-	-
	Marjoram "5 cm"	0.5649	0.9855	-	-	-	-	-	284.85 (K Ω)	239.4 (K Ω)	0	-	15.354 (nF)	0.9762 (nF)	-	-	-
	Marjoram "10 cm"	0.7813	0.7044	-	-	-	-	-	1.6228 (M Ω)	1.8514 (M Ω)	94.061 (K Ω)	-	7.9913 (nF)	1.5936 (nF)	-	-	-
	Salvia "5 cm"	0.7524	0.6209	-	-	-	-	-	456.63 (K Ω)	50.052 (K Ω)	369.52 (Ω)	-	1.5692 (nF)	7.9199 (nF)	-	-	-
Proposed Stem model	Salvia "10 cm"	0.8041	0.6305	-	-	-	-	-	966.94 (K Ω)	120.13 (K Ω)	7.4007 (K Ω)	-	0.6215 (nF)	6.2827 (nF)	-	-	-
	Lavandula "5 cm"	0.3885	1	-	-	-	-	-	666.78 (K Ω)	35.951 (K Ω)	0	-	214.87 (nF)	5.2109 (nF)	-	-	-
	Lavandula "10 cm"	0.5316	1	-	-	-	-	-	590.17 (K Ω)	10.33 (K Ω)	0	-	23.165 (nF)	0.5557 (nF)	-	-	-
	Marjoram "5 cm"	1	0.6132	1	0.5402	0.4903	-	33.796 (M Ω)	1.379 (M Ω)	0	9.2607 (M Ω)	43.527 (M Ω)	0.7156 (nF)	7.7111 (nF)	0	41.614 (μ F)	57.801 (nF)
	Marjoram "10 cm"	0.7154	0.2225	1	0.0475	0.9561	-	2.0143 (M Ω)	0	543.7 (M Ω)	10.95 (M Ω)	0	1.2829 (nF)	8.6658 (μ F)	0.146 (nF)	31.372 (μ F)	1.2404 (fF)
Simplified Stem model	Salvia "5 cm"	0.6902	0.5903	0.8177	0.2834	1	-	460.62 (K Ω)	1.0669 (K Ω)	9.7919 (M Ω)	284.34 (K Ω)	10.663 (M Ω)	1.9.99 (nF)	1.1963 (fF)	0.2533 (nF)	68.262 (μ F)	5.9601 (fF)
	Salvia "10 cm"	0.6129	0.8867	1	0.9857	0.7149	-	8.0791 (M Ω)	2.3004 (M Ω)	2.1541 (M Ω)	3.4699 (M Ω)	59.315 (M Ω)	4.4953 (nF)	182.8 (nF)	0.3679 (nF)	82.203 (μ F)	4.6292 (μ F)
	Lavandula "5 cm"	0.4788	0.1343	1	0.9360	1	-	48.259 (M Ω)	0	84.606 (M Ω)	536.39 (K Ω)	39.186 (M Ω)	59.305 (nF)	7.3663 (μ F)	60.852 (fF)	8.863 (μ F)	831.49 (nF)
	Lavandula "10 cm"	1	0.4085	1	1	0.7986	-	66.724 (M Ω)	2.0446 (M Ω)	0	740.7 (K Ω)	41.536 (M Ω)	17.092 (fF)	63.123 (nF)	5.4559 (nF)	0	0.2967 (nF)
	Marjoram "5 cm"	1	1	0.6737	-	-	-	7.0902 (K Ω)	252.81 (K Ω)	930.25 (K Ω)	-	-	6.1565 (μ F)	2.5936 (nF)	3.9351 (nF)	-	-
Simplified Stem model	Marjoram "10 cm"	0.7396	1	0.7146	-	-	-	97.745 (Ω)	938.9 (K Ω)	24.342 (M Ω)	-	-	39.234 (nF)	2.5913 (fF)	1.303 (nF)	-	-
	Salvia "5 cm"	0.0883	1	0.6405	-	-	-	4.1162 (K Ω)	134.14 (K Ω)	2.8018 (M Ω)	-	-	1.9577 (μ F)	0.3668 (nF)	4.0499 (nF)	-	-
	Salvia "10 cm"	0.714	1	1	-	-	-	35.391 (K Ω)	162.47 (K Ω)	953.3 (K Ω)	-	-	1.1235 (nF)	35.002 (nF)	34.057 (fF)	-	-
	Lavandula "5 cm"	1	1	0.4486	-	-	-	8.2413 (K Ω)	434.87 (K Ω)	641.19 (K Ω)	-	-	8.3765 (nF)	54.624 (fF)	92.939 (nF)	-	-
	Lavandula "10 cm"	1	0.1297	0.5844	-	-	-	596.96 (Ω)	1.9615 (M Ω)	532.04 (K Ω)	-	-	22.461 (fF)	7.4162 (μ F)	7.9638 (nF)	-	-

Table 3. Marjoram Nyquist and Error plots of the experimental and the fitted models using different optimization algorithms.

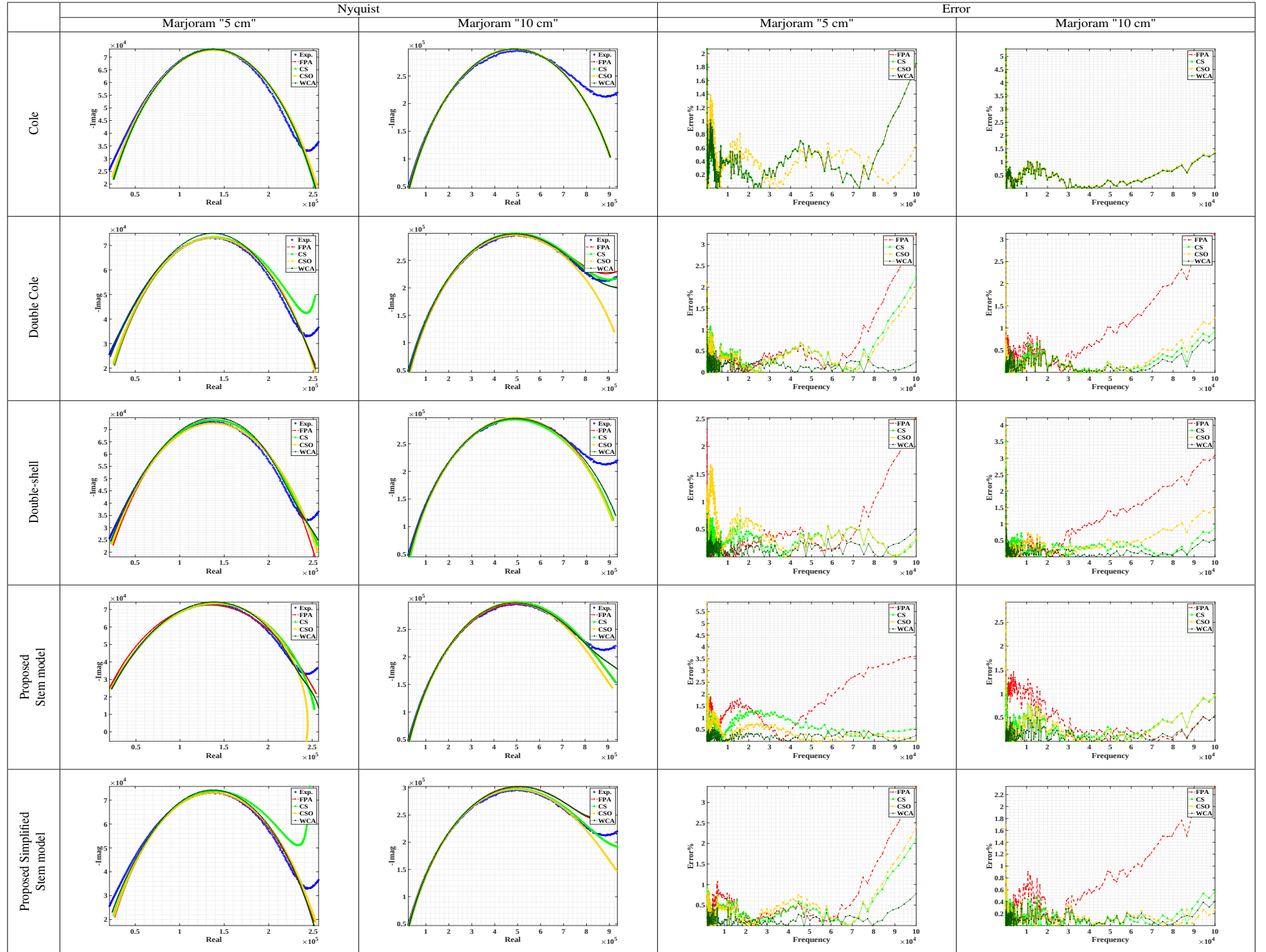


Table 4. Salvia Nyquist and Error plots of the experimental and the fitted models using different optimization algorithms.

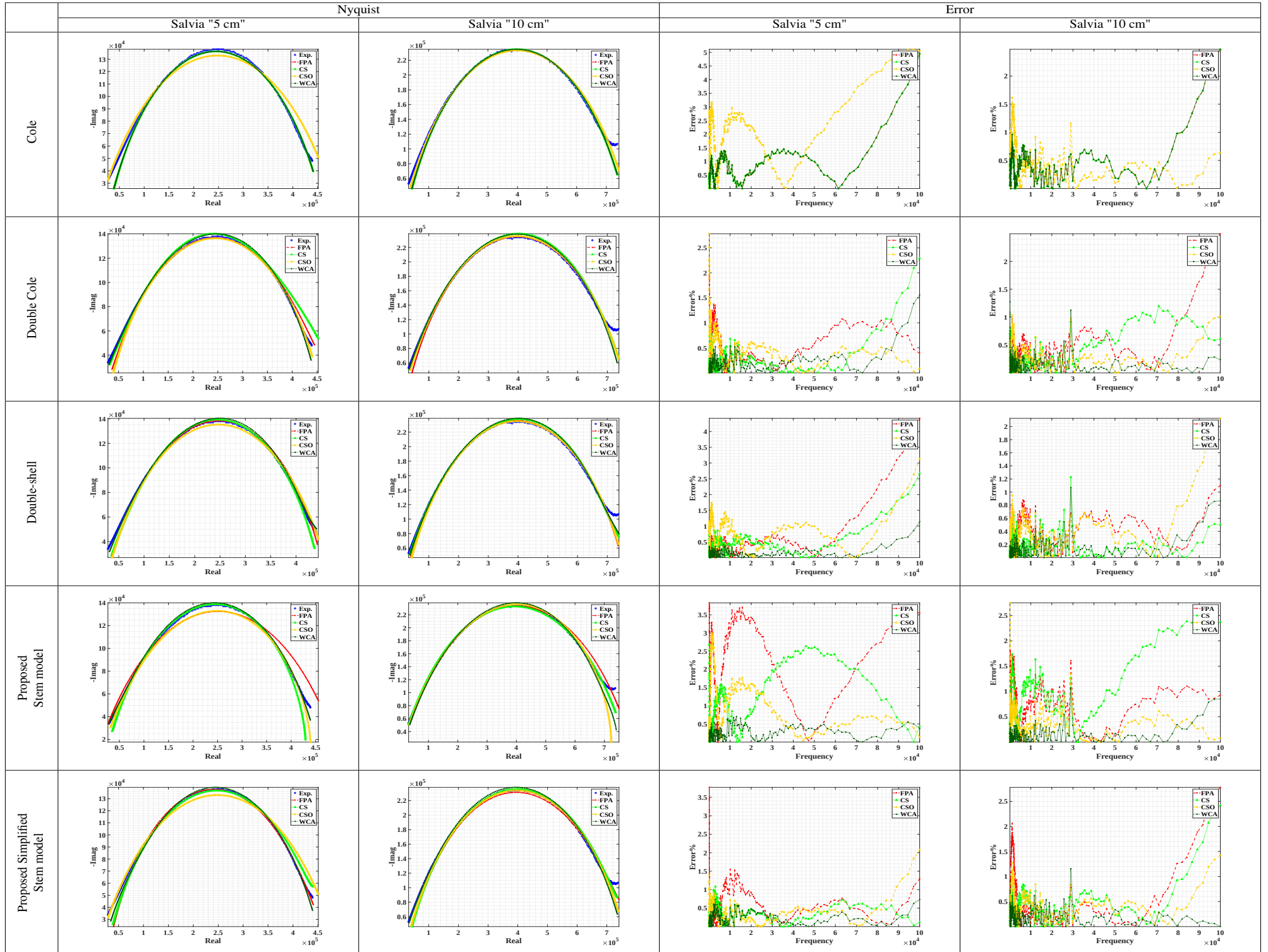


Table 5. Lavandula Nyquist and Error plots of the experimental and the fitted models using different optimization algorithms.

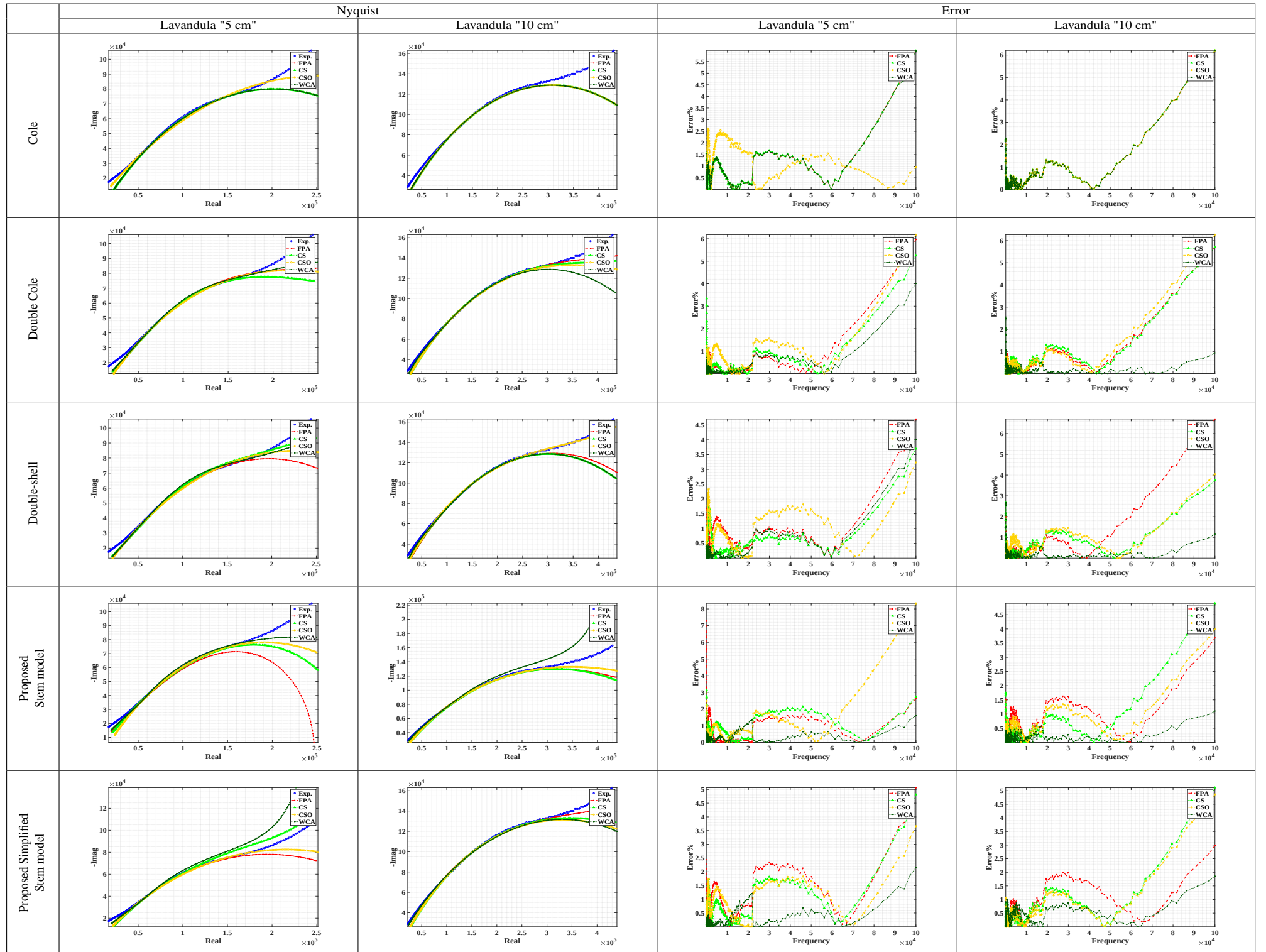


Table 6. Convergence curve for all used optimizations for Marjoram sample.

