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SUPPLEMENTARY MATERIAL TO

**Optimizing fabrication of pharmaceutical capsule shell:
A factorial design of corncob-MCC/carrageenan/starch biofilm**

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Table S-I. ANOVA parameter for tensile strength response

Source	Sum of squares	df	Mean square	F-value	p-value	
Model	38.27	7	5.47	9.33	0.0005	significant
A-Carrageenan	0.0582	1	0.0582	0.0993	0.7581	
B-MCC	5.53	1	5.53	9.44	0.0097	
C-Glycerol	31.09	1	31.09	53.06	< 0.0001	
AB	0.4621	1	0.4621	0.7885	0.3920	
AC	0.0136	1	0.0136	0.0233	0.8813	
BC	0.3514	1	0.3514	0.5996	0.4537	
ABC	0.7634	1	0.7634	1.30	0.2760	
Residual	7.03	12	0.5860			
Lack of Fit	3.06	1	3.06	8.46	0.0142	significant
Pure Error	3.97	11	0.3613			
Cor Total	45.31	19				

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Table S-II. ANOVA parameter for elongation response

<i>Source</i>	<i>Sum of squares</i>	<i>df</i>	<i>Mean square</i>	<i>F-value</i>	<i>p-value</i>	
<i>Model</i>	247.89	7	35.41	58.86	< 0.0001	significant
<i>A-Carrageenan</i>	84.33	1	84.33	140.17	< 0.0001	
<i>B-MCC</i>	7.37	1	7.37	12.26	0.0044	
<i>C-Glycerol</i>	18.39	1	18.39	30.57	0.0001	
<i>AB</i>	12.59	1	12.59	20.93	0.0006	
<i>AC</i>	79.06	1	79.06	131.41	< 0.0001	
<i>BC</i>	32.00	1	32.00	53.19	< 0.0001	
<i>ABC</i>	14.15	1	14.15	23.51	0.0004	not significant
<i>Residual</i>	7.22	12	0.6016			
<i>Lack of Fit</i>	1.34	1	1.34	2.50	0.1419	
<i>Pure Error</i>	5.88	11	0.5346			
<i>Cor Total</i>	255.11	19				

Table S-III. ANOVA parameter for Young modulus response

<i>Source</i>	<i>Sum of squares</i>	<i>df</i>	<i>Mean square</i>	<i>F-value</i>	<i>p-value</i>	
<i>Model</i>	9755.36	7	1393.62	30.50	< 0.0001	significant
<i>A-Carrageenan</i>	2300.62	1	2300.62	50.35	< 0.0001	
<i>B-MCC</i>	1142.15	1	1142.15	25.00	0.0003	
<i>C-Glycerol</i>	4075.90	1	4075.90	89.20	< 0.0001	
<i>AB</i>	93.98	1	93.98	2.06	0.1771	
<i>AC</i>	1990.57	1	1990.57	43.56	< 0.0001	
<i>BC</i>	100.82	1	100.82	2.21	0.1632	
<i>ABC</i>	51.33	1	51.33	1.12	0.3101	not significant
<i>Residual</i>	548.34	12	45.69			
<i>Lack of Fit</i>	19.88	1	19.88	0.4138	0.5332	
<i>Pure Error</i>	528.46	11	48.04			
<i>Cor Total</i>	10303.70	19				

Table S-IV. Fit statistics of each response

<i>Parameter</i>	<i>TS</i>	<i>EL</i>	<i>YM</i>
Standard deviation	0.7655	0.7756	6.79
Mean	4.05	10.10	43.75
C.V. %	18.91	7.68	15.52
R ²	0.8448	0.9717	0.9418
Adjusted R ²	0.7543	0.9552	0.9149
Predicted R ²	0.6776	0.9112	0.8748
Adequate precision	9.3391	26.9560	18.1185

Based on Table S-IV, The C.V. values for tensile strength (18.91 %) and Young's modulus (15.52 %) indicate moderate experimental variability, which is commonly observed in mechanically tested polymer-based and biopolymer films due to inherent material heterogeneity, minor thickness variations, non-uniform

plasticizer distribution, and sensitivity to testing conditions. Despite this variability, the mechanical trends and statistically significant factor effects remain consistent, indicating acceptable methodological reproducibility for a factorial design. Model adequacy was assessed using ANOVA significance, lack-of-fit tests, and residual diagnostics; although one of the three responses exhibited a significant lack of fit, this suggests limitations of the linear model for that specific response rather than invalidating the overall trends, and higher-order models or additional experiments would be required only if greater predictive accuracy were sought.

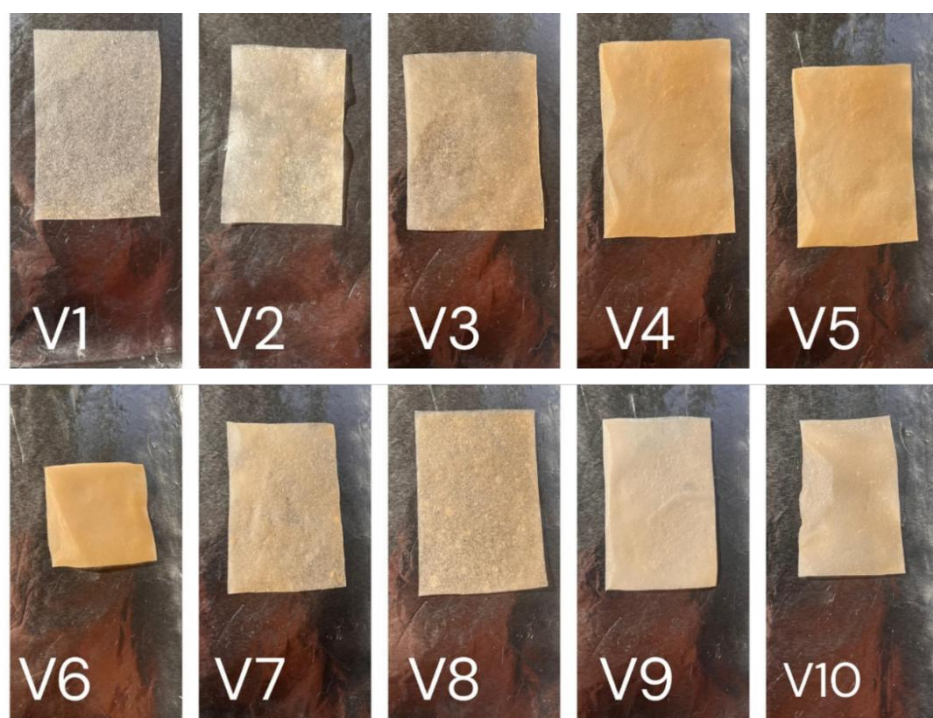


Fig. S-1. Appearance of the sample produced

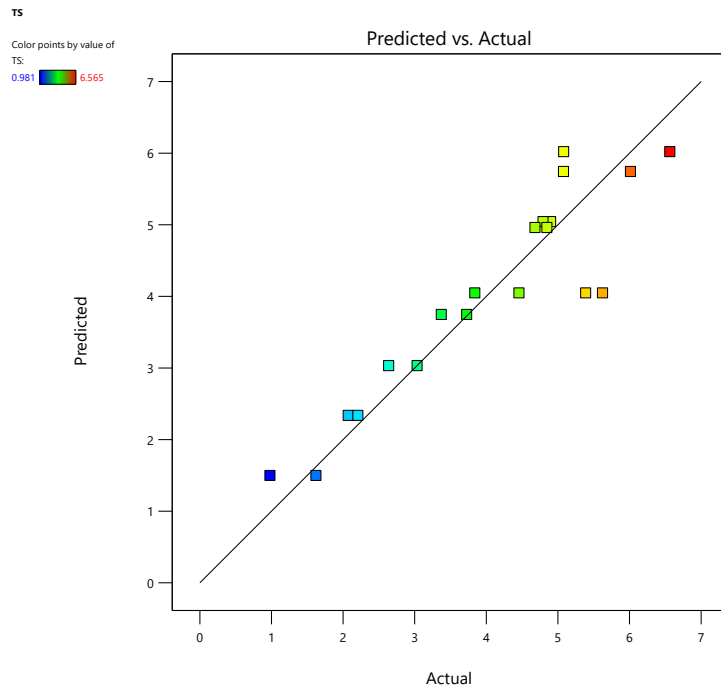


Fig. S-2. Predicted vs. actual scatter plot of TS response

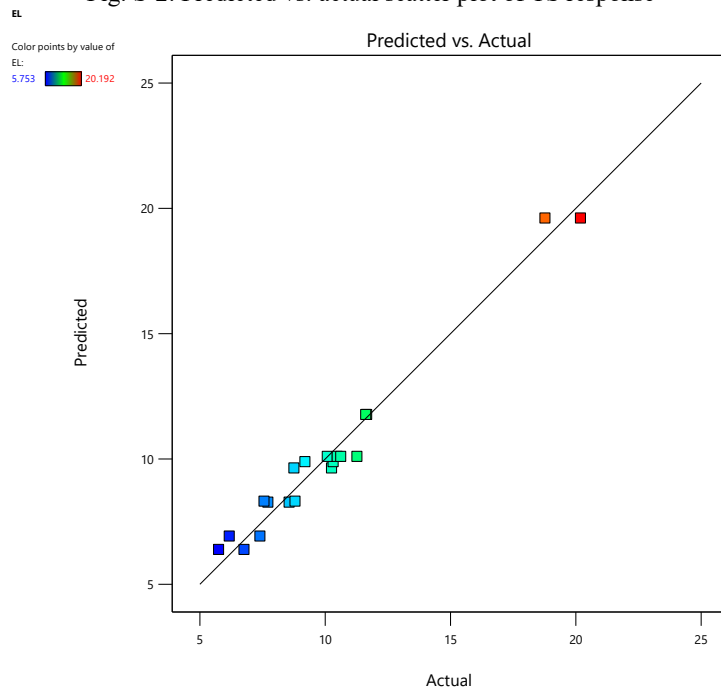


Fig. S-3. Predicted vs. actual scatter plot of EL response

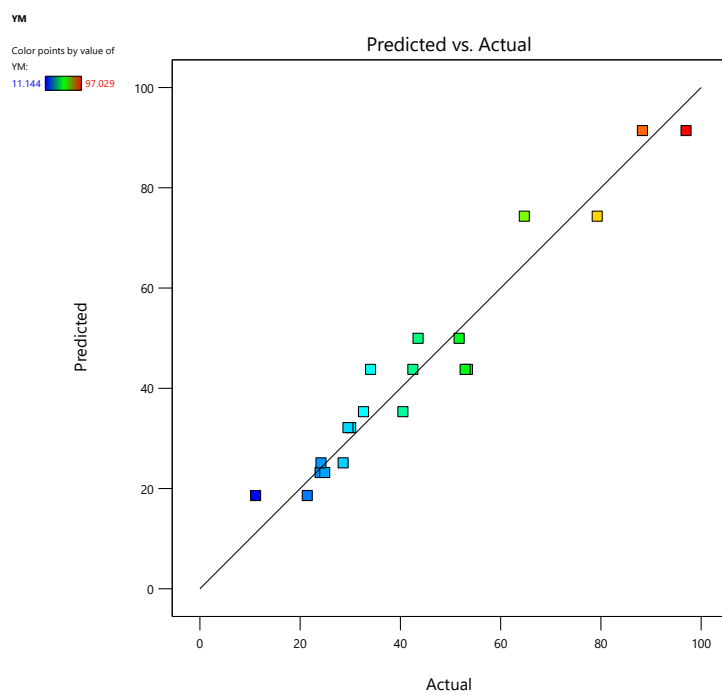


Fig. S-4. Predicted vs. actual scatter plot of TS response

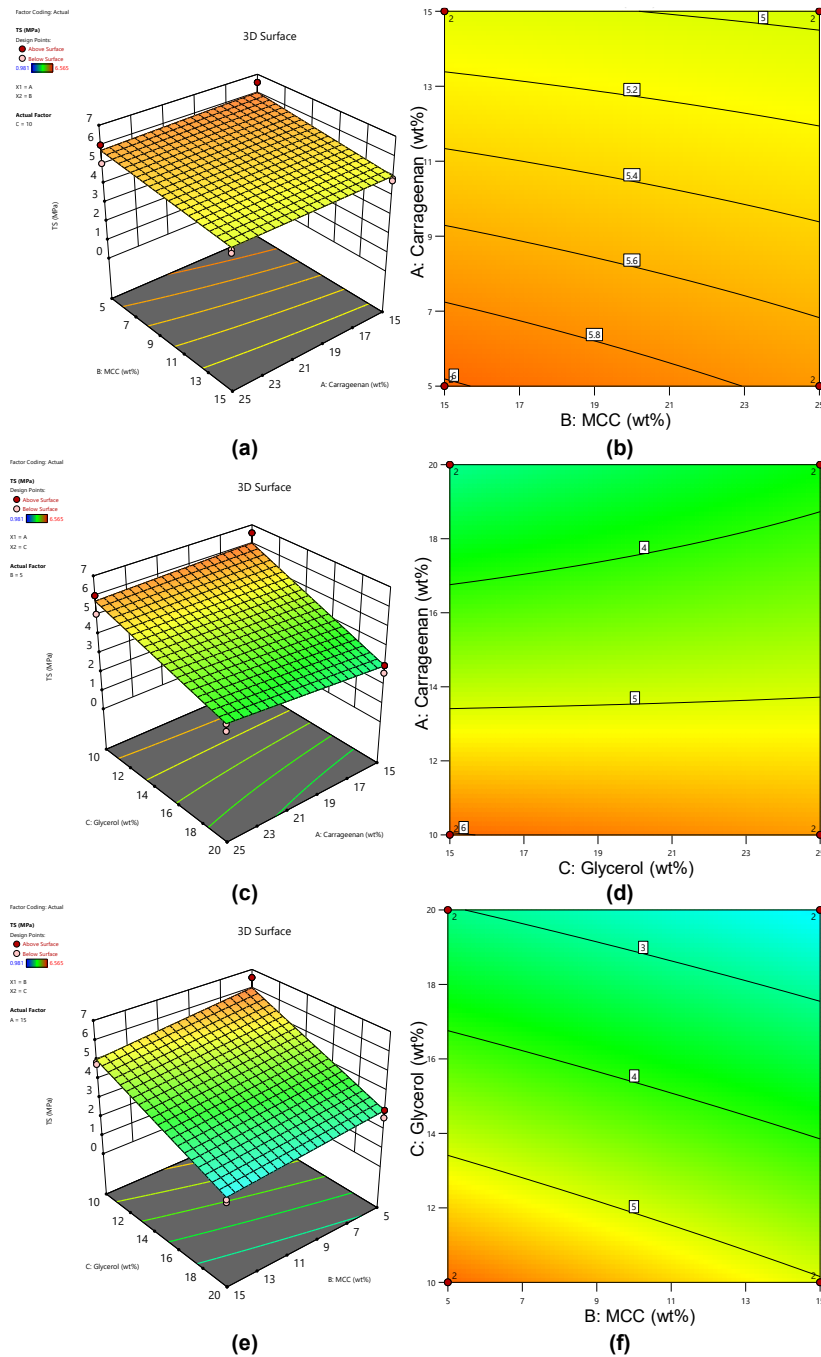


Fig. S-5. Surface and contour plots showing the effects of factors on TS: (a,b) carrageenan and MCC, (c,d) carrageenan and glycerol, and (e,f) MCC and glycerol..

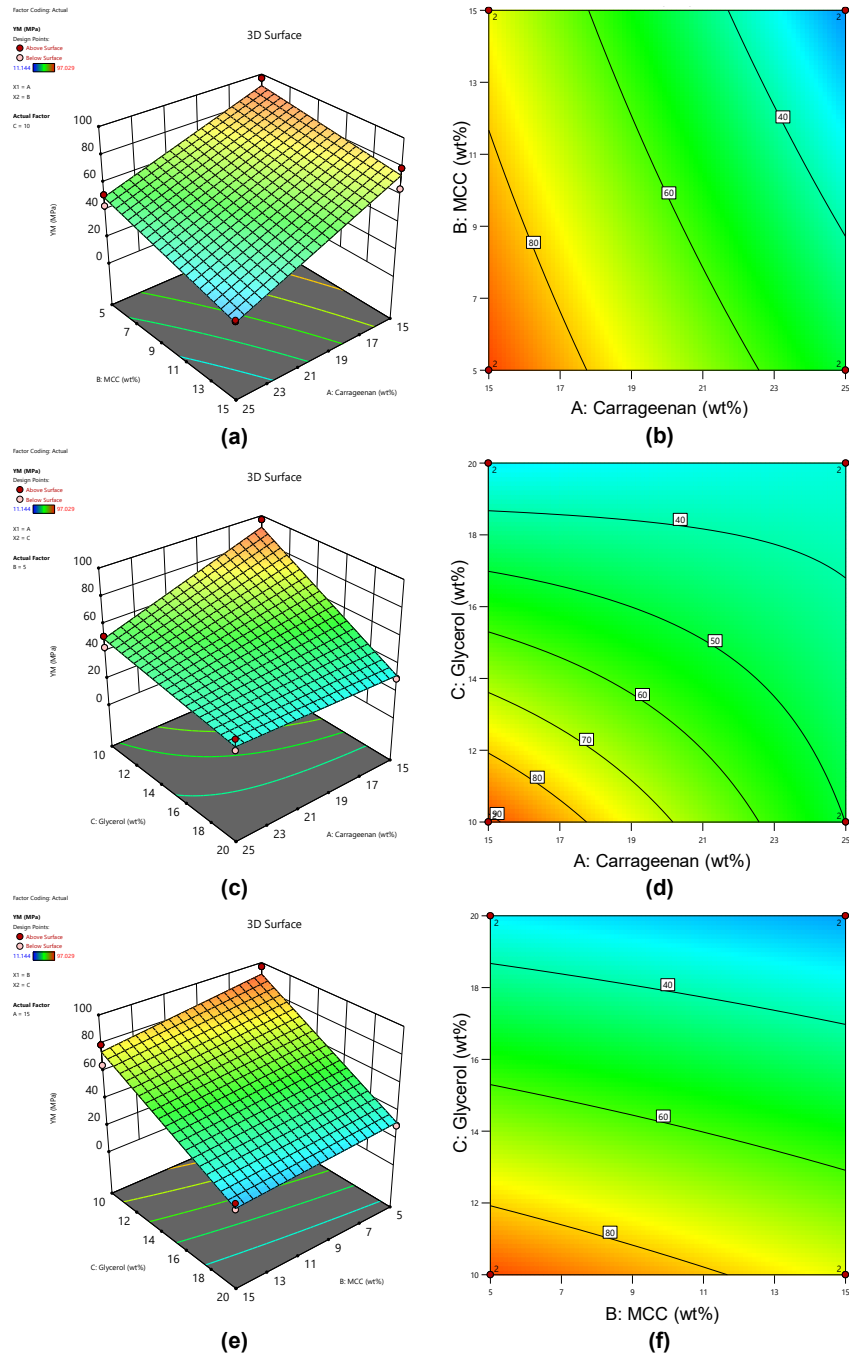


Fig. S-6. Surface and contour plots showing the effects of factors on YM: (a,b) carrageenan and MCC, (c,d) carrageenan and glycerol, and (e,f) MCC and glycerol.