

Supplementary Information

Utilization of waste banana peels as heterogeneous catalyst in room temperature biodiesel production using a homogenizer

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Table 1. Fatty acid profile of palm oil biodiesel

	Fatty Acid	Percentage
C _{12:0}	Lauric	0.32
C _{14:0}	Myristic	0.99
C _{16:0}	Palmitic	36.86
C _{16:1}	Palmitoleic	0.18
C _{18:0}	Stearic	3.57
C _{18:1}	Oleic	46.03
C _{18:2}	Linoleic	11.36
C _{18:3}	Linolenic	0.21
C _{20:0}	Arachidic	0.33
C _{20:1}	Eicosenoate	0.15
SFA		42.07
MUFA		46.36
PUFA		11.57

Table 2. ANOVA and Tukey Post Hoc Test for biodiesel conversion of the calcined waste banana peels catalyze transesterification palm olein to biodiesel using homogenizer. Significance values below $\alpha < 0.05$ are colour coded in red.

Effect of ratio molar

Effect	Univariate Tests of Significance for Biodiesel Conversion (%) (Spreadsheet1 in Ratio molar) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	107806.2	1	107806.2	14281.91	0.000000
Ratio Molar	296.5	4	74.1	9.82	0.001715
Error	75.5	10	7.5		

Tukey HSD test; variable Biodiesel Conversion (%) (Spreadsheet1 in Ratio molar) Approximate Probabilities for Post Hoc Tests Error: Between MS = 7.5484, df = 10.000						
Cell No.	Ratio Molar	{1}	{2}	{3}	{4}	{5}
		92.097	79.107	84.450	86.577	81.653
1	1:9		0.001401	0.041758	0.176323	0.006365
2	1:12	0.001401		0.197438	0.047171	0.785415
3	1:15	0.041758	0.197438		0.871749	0.726675
4	1:18	0.176323	0.047171	0.871749		0.256400
5	1:21	0.006365	0.785415	0.726675	0.256400	

Effect of catalyst weight

Univariate Tests of Significance for Biodiesel Conversion (%) (CW) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	111818.9	1	111818.9	19526.21	0.000000
Catalyst Weight (wt.%)	977.3	4	244.3	42.67	0.000003
Error	57.3	10	5.7		

Tukey HSD test; variable Biodiesel Conversion (%) (CW) Approximate Probabilities for Post Hoc Tests Error: Between MS = 5.7266, df = 10.000						
Cell No.	Catalyst Weight (wt.%)	{1}	{2}	{3}	{4}	{5}
		75.663	84.450	80.443	94.347	96.797
1	5		0.008003	0.180004	0.000182	0.000177
2	7	0.008003		0.310790	0.003568	0.000762
3	9	0.180004	0.310790		0.000371	0.000211
4	12	0.000182	0.003568	0.000371		0.722746
5	15	0.000177	0.000762	0.000211	0.722746	

Effect of reaction time

Univariate Tests of Significance for Biodiesel Conversion (%) (Spreadsheet14) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	120969.6	1	120969.6	21198.44	0.000000
Reaction Time (min)	220.1	4	55.0	9.64	0.001838
Error	57.1	10	5.7		

Tukey HSD test; variable Biodiesel Conversion (%) (Spreadsheet14) Approximate Probabilities for Post Hoc Tests Error: Between MS = 5.7065, df = 10.000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
		87.513	91.603	89.630	84.450	95.820
1	5		0.292454	0.810245	0.545237	0.011382
2	10	0.292454		0.844503	0.027989	0.268077
3	20	0.810245	0.844503		0.132330	0.060083
4	30	0.545237	0.027989	0.132330		0.001339
5	40	0.011382	0.268077	0.060083	0.001339	

Effect of rotational speed

Univariate Tests of Significance for Biodiesel Conversion (%) (Spreadsheet19)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	133778.0	1	133778.0	36612.06	0.000000
Rotational Speed (rpm)	378.7	4	94.7	25.91	0.000029
Error	36.5	10	3.7		

Tukey HSD test; variable Biodiesel Conversion (%) (Spreadsheet19)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 3.6539, df = 10.000						
Cell No.	Rotational Speed (rpm)	{1}	{2}	{3}	{4}	{5}
		96.030	84.450	96.860	97.753	97.097
1	3000		0.000305	0.981876	0.800970	0.955719
2	4000	0.000305		0.000238	0.000204	0.000226
3	5000	0.981876	0.000238		0.976322	0.999865
4	6000	0.800970	0.000204	0.976322		0.992453
5	7000	0.955719	0.000226	0.999865	0.992453	

Table 3. ANOVA and Tukey Post Hoc Test for biodiesel yield of the calcined waste banana peels catalyze transesterification palm olein to biodiesel using homogenizer. Significance values below $\alpha < 0.05$ are colour coded in red.

Effect of ratio molar

Univariate Tests of Significance for Biodiesel Yield (%) (Spreadsheet1 in Ratio molar)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	94276.60	1	94276.60	9854.505	0.000000
Ratio Molar	476.37	4	119.09	12.449	0.000676
Error	95.67	10	9.57		

Tukey HSD test; variable Biodiesel Yield (%) (Spreadsheet1 in Ratio molar)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 9.5669, df = 10.000						
Cell No.	Ratio Molar	{1}	{2}	{3}	{4}	{5}
		85.847	74.993	82.553	82.463	70.537
1	1:9		0.010740	0.695109	0.675195	0.001016
2	1:12	0.010740		0.079295	0.083758	0.441666
3	1:15	0.695109	0.079295		1.000000	0.005491
4	1:18	0.675195	0.083758	1.000000		0.005776
5	1:21	0.001016	0.441666	0.005491	0.005776	

Effect of catalyst weight

Univariate Tests of Significance for Biodiesel Yield (%) (CW) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	91060.43	1	91060.43	11378.29	0.000000
Catalyst Weight (wt.%)	502.88	4	125.72	15.71	0.000259
Error	80.03	10	8.00		

Tukey HSD test; variable Biodiesel Yield (%) (CW) Approximate Probabilities for Post Hoc Tests Error: Between MS = 8.0030, df = 10.000						
Cell No.	Catalyst Weight (wt.%)	{1}	{2}	{3}	{4}	{5}
		71.250	82.553	70.660	84.287	80.823
1	5		0.004522	0.998933	0.001676	0.013502
2	7	0.004522		0.003184	0.939137	0.939527
3	9	0.998933	0.003184		0.001227	0.009228
4	12	0.001676	0.939137	0.001227		0.585012
5	15	0.013502	0.939527	0.009228	0.585012	

Effect of reaction time

Univariate Tests of Significance for Biodiesel Yield (%) (Spreadsheet14) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	112975.4	1	112975.4	13426.53	0.000000
Reaction Time (min)	269.3	4	67.3	8.00	0.003676
Error	84.1	10	8.4		

Tukey HSD test; variable Biodiesel Yield (%) (Spreadsheet14) Approximate Probabilities for Post Hoc Tests Error: Between MS = 8.4143, df = 10.000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
		79.537	89.127	84.450	90.600	90.213
1	5		0.015615	0.301230	0.006224	0.007877
2	10	0.015615		0.342655	0.968125	0.989517
3	20	0.301230	0.342655		0.144514	0.183411
4	30	0.006224	0.968125	0.144514		0.999819
5	40	0.007877	0.989517	0.183411	0.999819	

Effect of rotational speed

Univariate Tests of Significance for Biodiesel Yield (%) (Spreadsheet19) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	121097.1	1	121097.1	23017.72	0.000000
Rotational Speed (rpm)	14.0	4	3.5	0.66	0.630667
Error	52.6	10	5.3		

Tukey HSD test; variable Biodiesel Yield (%) (Spreadsheet19)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 5.2610, df = 10.000						
Cell No.	Rotational Speed (rpm)	{1} 89.573	{2} 90.600	{3} 90.907	{4} 90.020	{5} 88.153
1	3000		0.979749	0.949060	0.999193	0.936998
2	4000	0.979749		0.999817	0.997703	0.693793
3	5000	0.949060	0.999817		0.988214	0.601493
4	6000	0.999193	0.997703	0.988214		0.851145
5	7000	0.936998	0.693793	0.601493	0.851145	