

## Supplementary Information

### **Waste Rubber Seeds as a Renewable Energy Source: Direct Biodiesel Production Using Controlled Crushing Equipment**

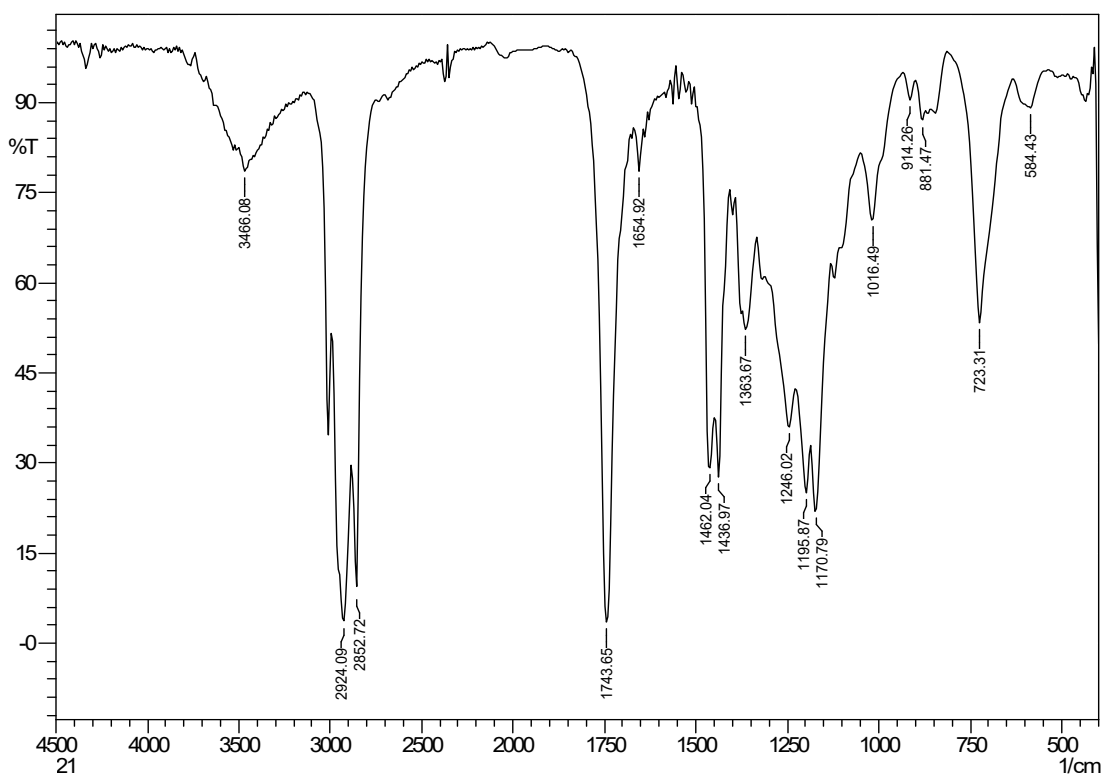
Juliati Br. Tarigan,<sup>a</sup> Raini Anggraini,<sup>a</sup> Ryan Pratama Sembiring,<sup>a</sup> Minto Supeno,<sup>a</sup> Kerista Tarigan,<sup>b</sup> Junedi Ginting,<sup>b</sup> Justaman A Karo-karo,<sup>c</sup> and Eko K. Sitepu,<sup>a\*</sup>

<sup>a</sup> Department of Chemistry, Universitas Sumatera Utara, Medan 20155, Indonesia

<sup>b</sup> Department of Physic, Universitas Sumatera Utara, Medan 20155, Indonesia

<sup>c</sup> Balai Riset dan Standarisasi, Kementerian Perindustrian, Medan 20214, Indonesia

\* Correspondence author: [ekositepu@usu.ac.id](mailto:ekositepu@usu.ac.id)



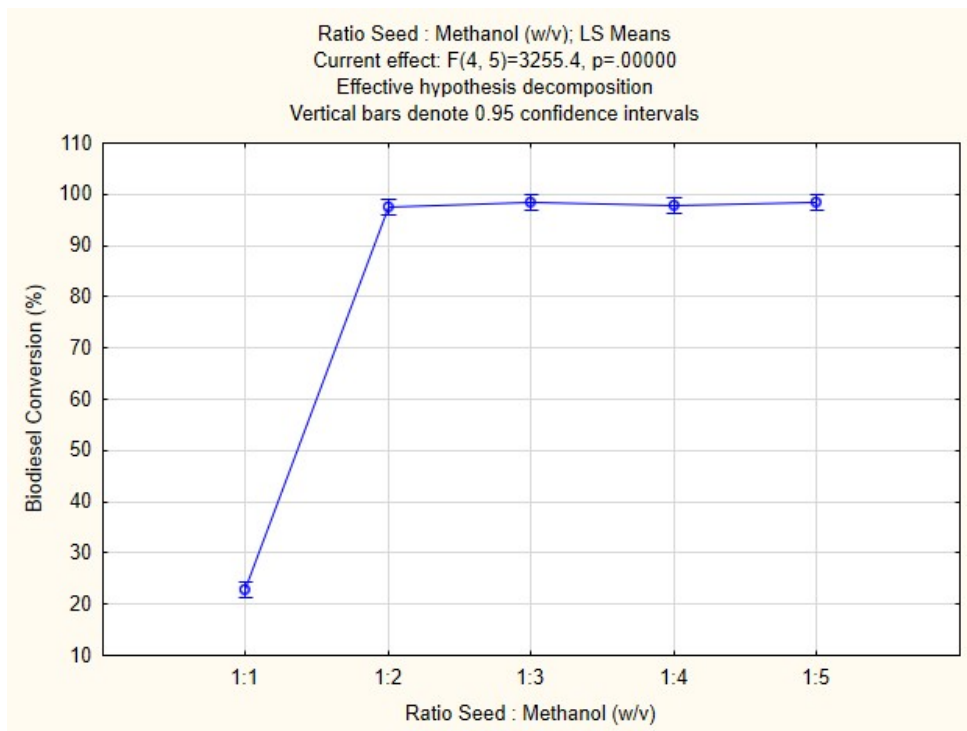
**Figure 1.** The FT-IR spectrum of methyl ester (biodiesel) produces from the CCD-assisted DT rubber seed.

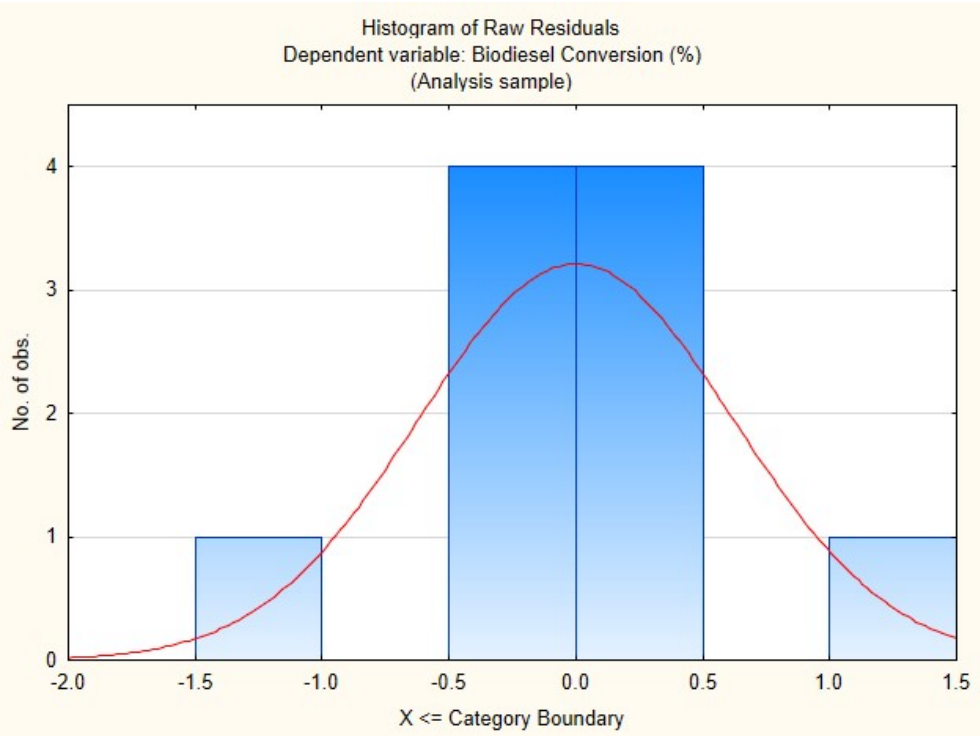
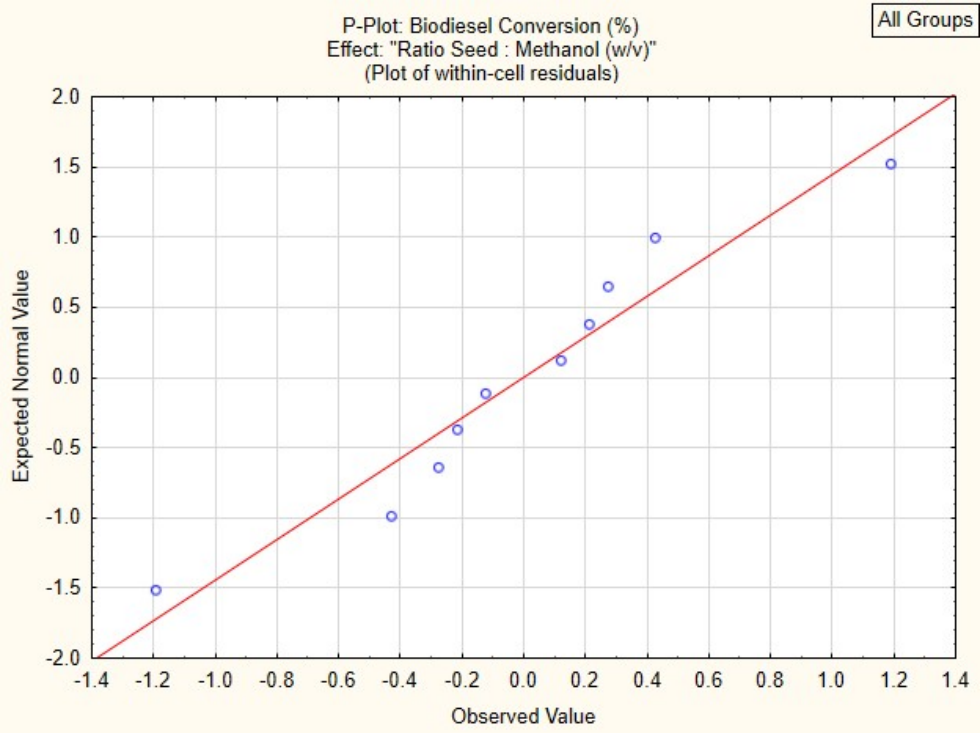
**Table 1.** ANOVA and Tukey post hoc test for biodiesel conversion and FA extraction yields of the CCD-assisted DT rubber seed. Significance values below  $\alpha < 0.05$  are colour coded in red.

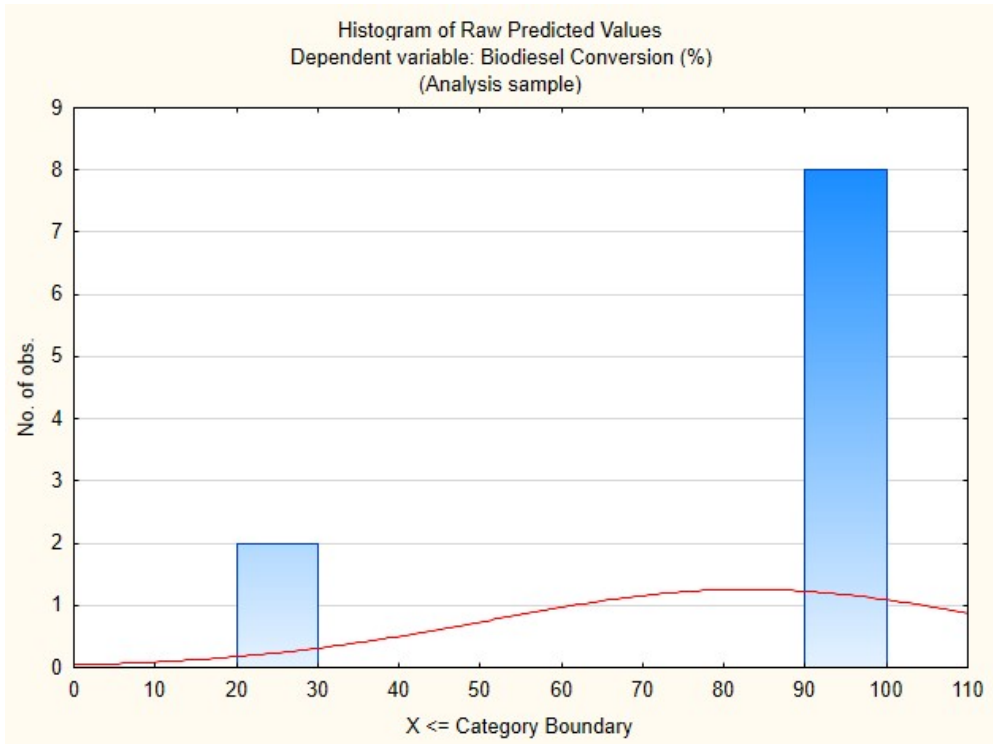
Effect of ratio seeds : methanol

Effect	Univariate Tests of Significance for Biodiesel Conversion (%) (Ratio) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	68919.88	1	68919.88	99179.57	0.000000
Ratio Seed : Methanol (w/v)	9048.77	4	2262.19	3255.42	0.000000
Error	3.47	5	0.69		

Cell No.	Ratio Seed : Methanol (w/v)	Tukey HSD test, variable Biodiesel Conversion (%) (Ratio) Approximate Probabilities for Post Hoc Tests Error: Between MS = .69490, df = 5.0000				
		{1}	{2}	{3}	{4}	{5}
		22.860	97.500	98.540	97.865	98.325
1	1:1		0.000271	0.000271	0.000271	0.000271
2	1:2	0.000271		0.729912	0.990067	0.850182
3	1:3	0.000271	0.729912		0.917039	0.998706
4	1:4	0.000271	0.990067	0.917039		0.976990
5	1:5	0.000271	0.850182	0.998706	0.976990	



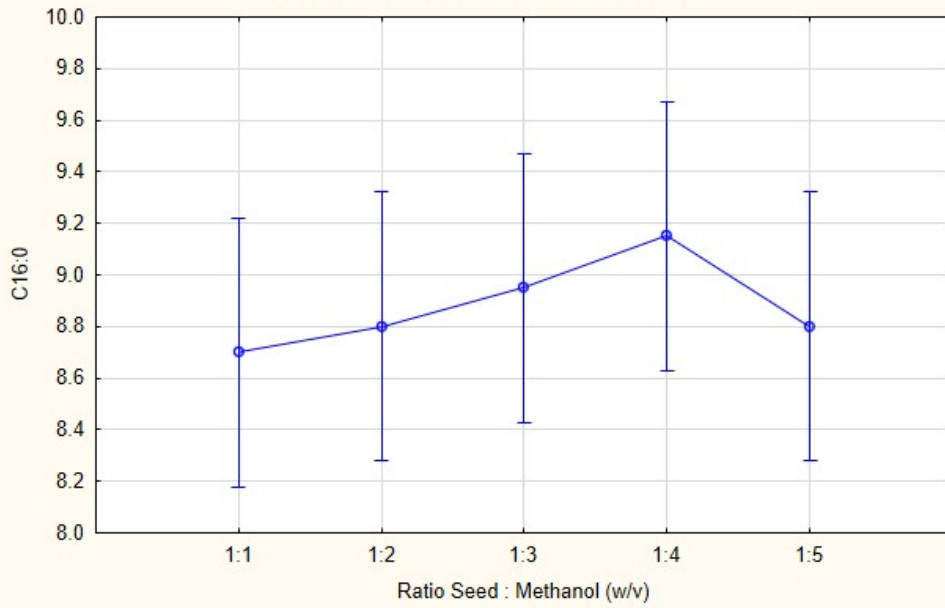




Univariate Tests of Significance for C16:0 (Ratio)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	788.5440	1	788.5440	9616.390	0.000000
Ratio Seed : Methanol (w/v)	0.2460	4	0.0615	0.750	0.598331
Error	0.4100	5	0.0820		

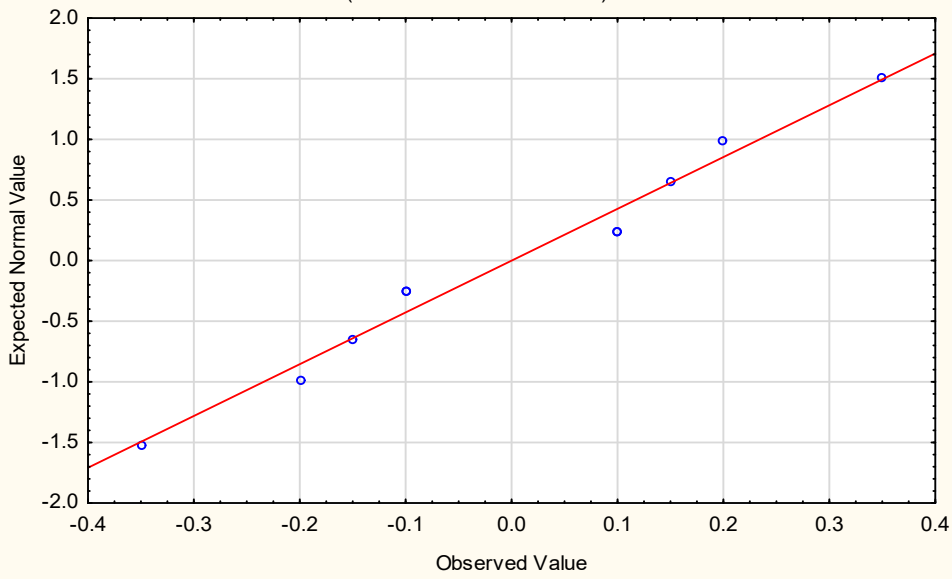
Tukey HSD test; variable C16:0 (Ratio)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = .08200, df = 5.0000						
Cell No.	Ratio Seed : Methanol (w/v)	{1}	{2}	{3}	{4}	{5}
1	1:1	8.7000	8.8000	8.9500	9.1500	8.8000
2	1:2	0.995775	0.995775	0.895622	0.567465	0.995775
3	1:3	0.895622	0.980887	0.980887	0.742500	1.000000
4	1:4	0.567465	0.742500	0.948353	0.948353	0.980887
5	1:5	0.995775	1.000000	0.980887	0.742500	0.742500

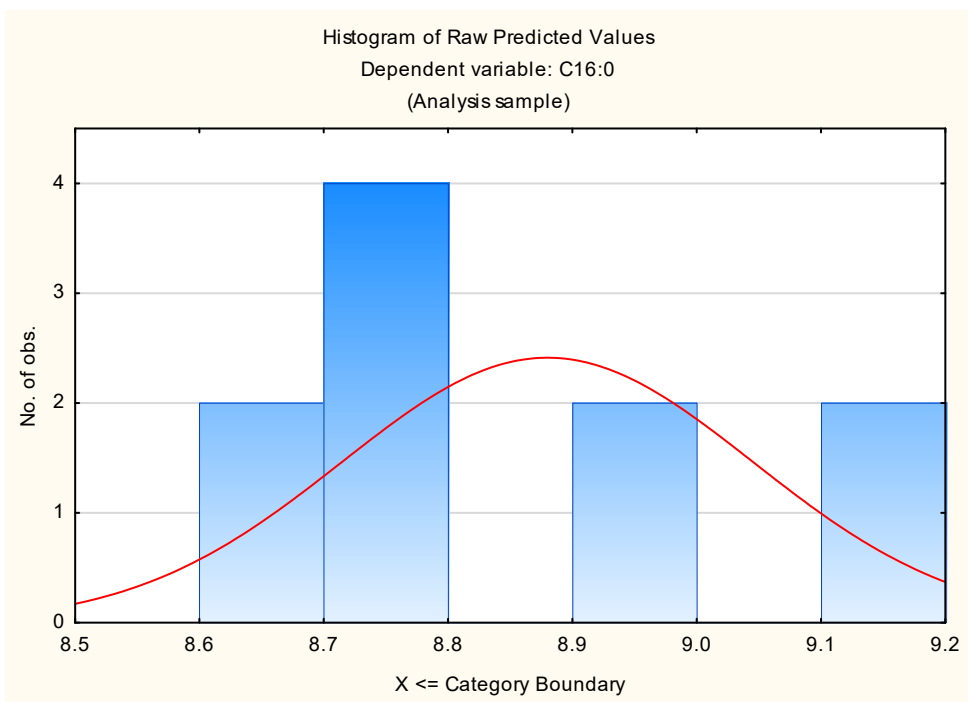
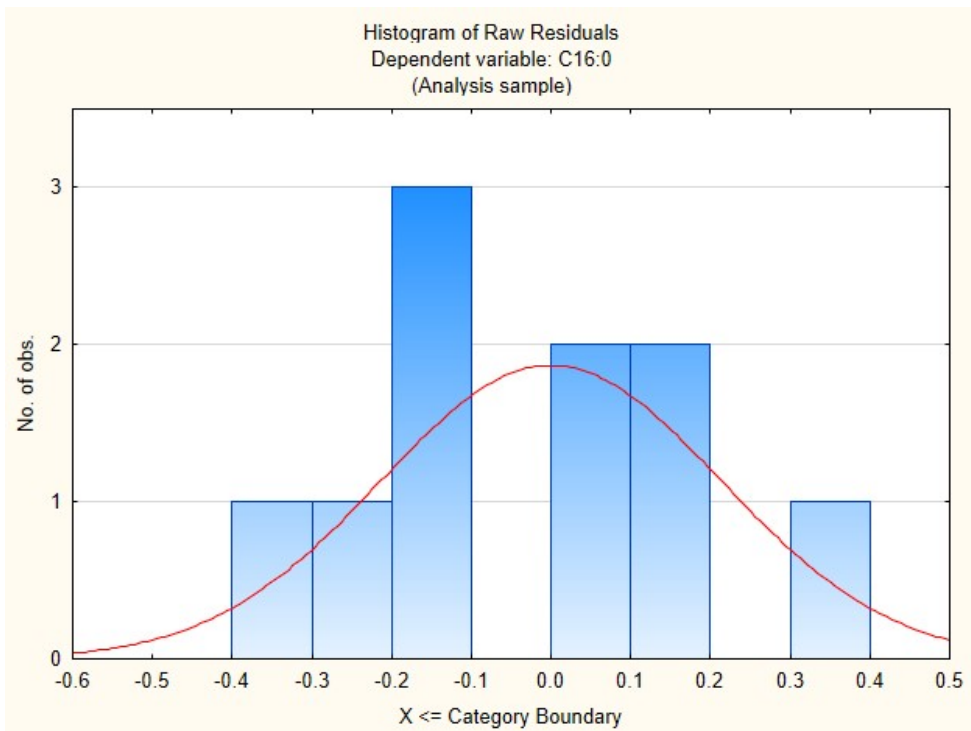
Ratio Seed : Methanol (w/v): LS Means  
Current effect:  $F(4, 5) = .75000$ ,  $p = .59833$   
Effective hypothesis decomposition  
Vertical bars denote 0.95 confidence intervals



P-Plot: C16:0  
Effect: "Ratio Seed : Methanol (w/v)"  
(Plot of within-cell residuals)

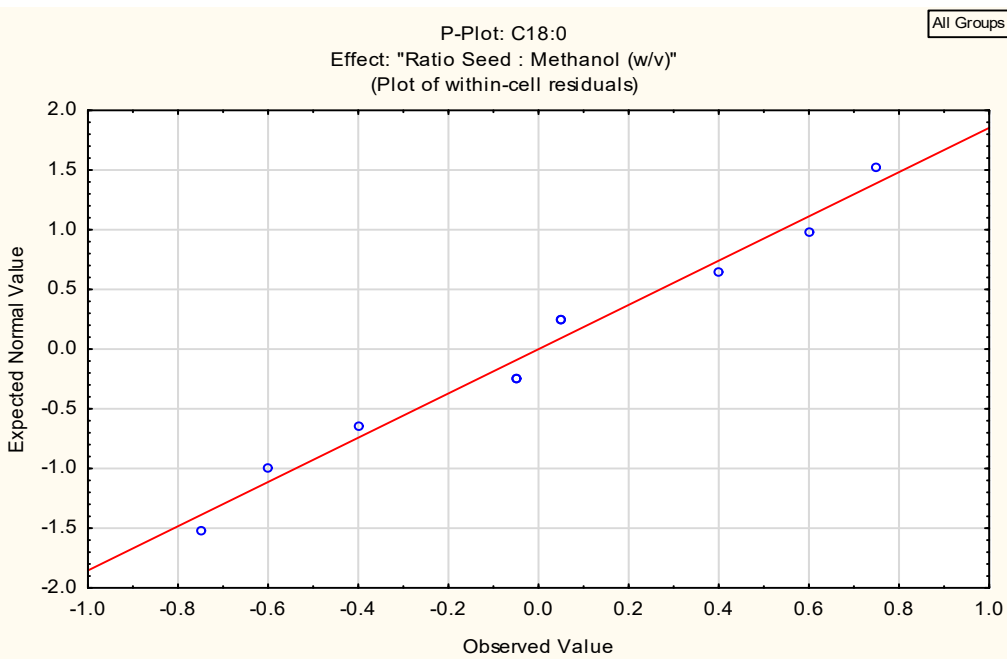
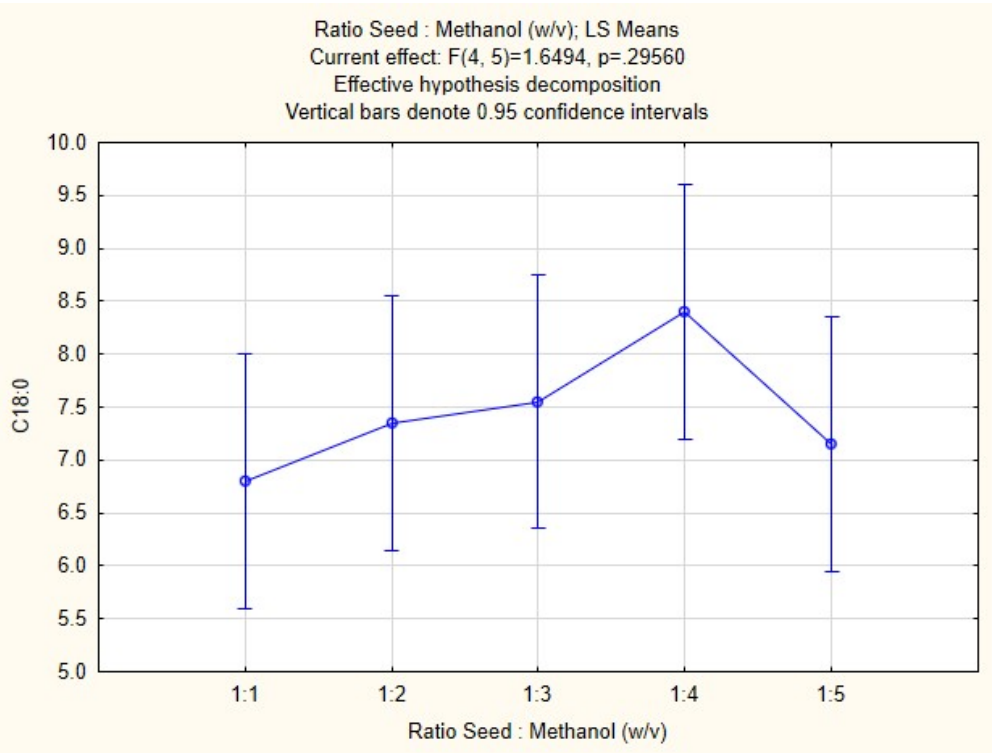
All Groups

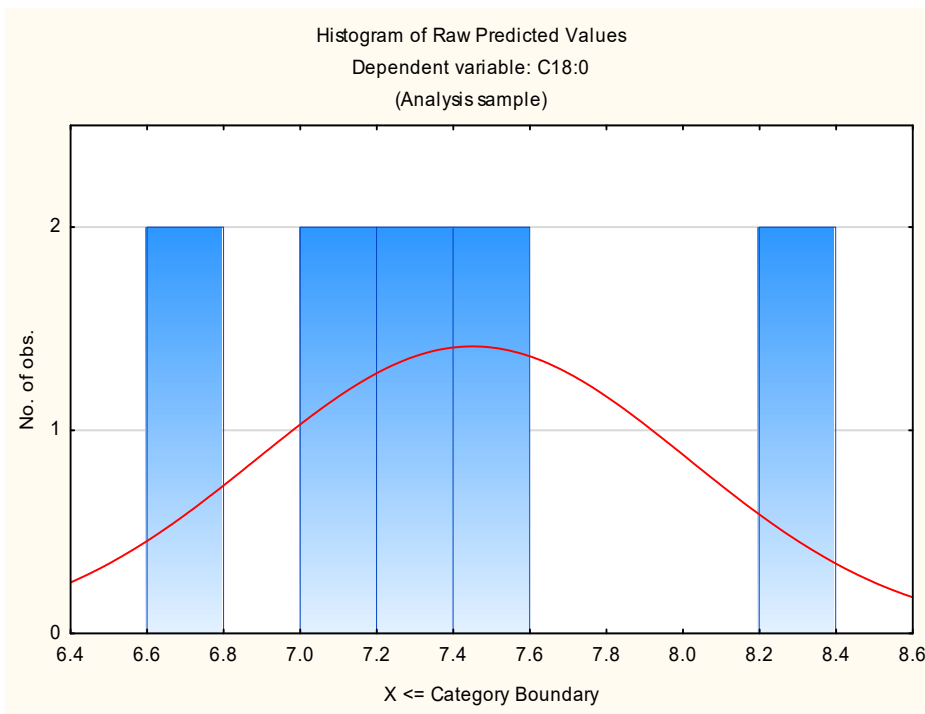
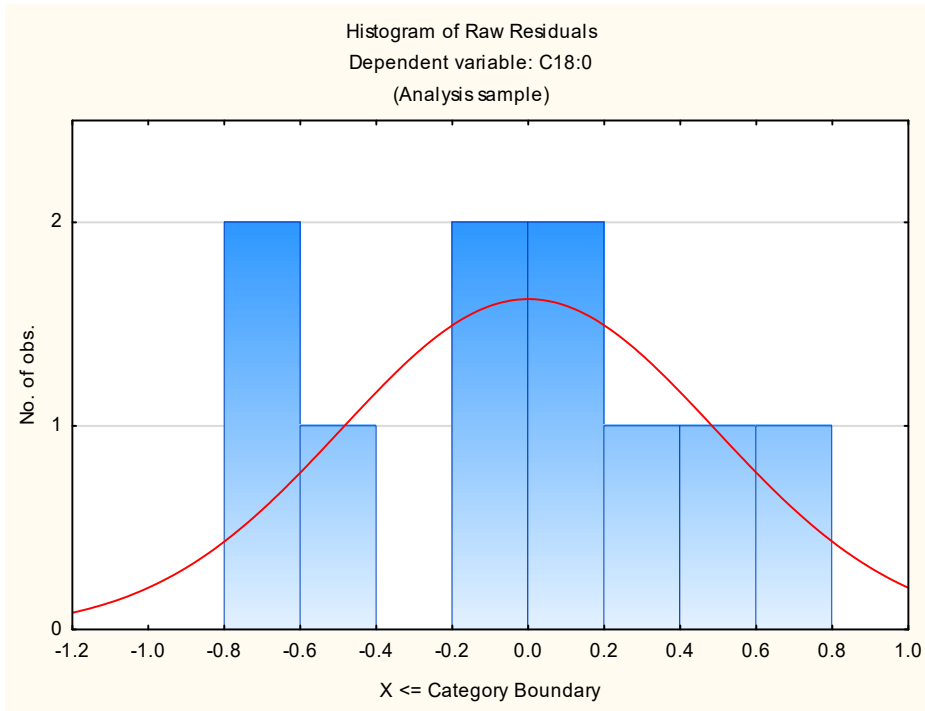




		Univariate Tests of Significance for C18:0 (Ratio)				
		Sigma-restricted parameterization				
		Effective hypothesis decomposition				
Effect		SS	Degr. of Freedom	MS	F	p
Intercept		555.0250	1	555.0250	1275.920	0.000000
Ratio Seed : Methanol (w/v)		2.8700	4	0.7175	1.649	0.295601
Error		2.1750	5	0.4350		

Tukey HSD test; variable C18:0 (Ratio)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = .43500, df = 5.0000						
Cell No.	Ratio Seed : Methanol (w/v)	{1}	{2}	{3}	{4}	{5}
		6.8000	7.3500	7.5500	8.4000	7.1500
1	1:1		0.909149	0.783861	0.246091	0.979973
2	1:2	0.909149		0.997543	0.557486	0.997543
3	1:3	0.783861	0.997543		0.709284	0.967957
4	1:4	0.246091	0.557486	0.709284		0.421283
5	1:5	0.979973	0.997543	0.967957	0.421283	

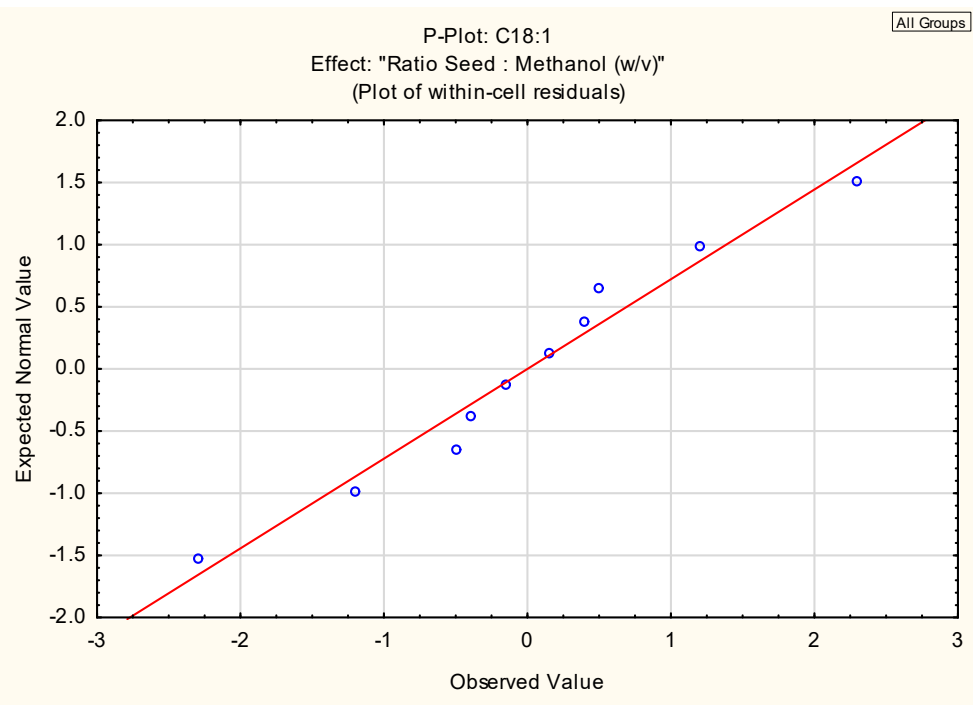
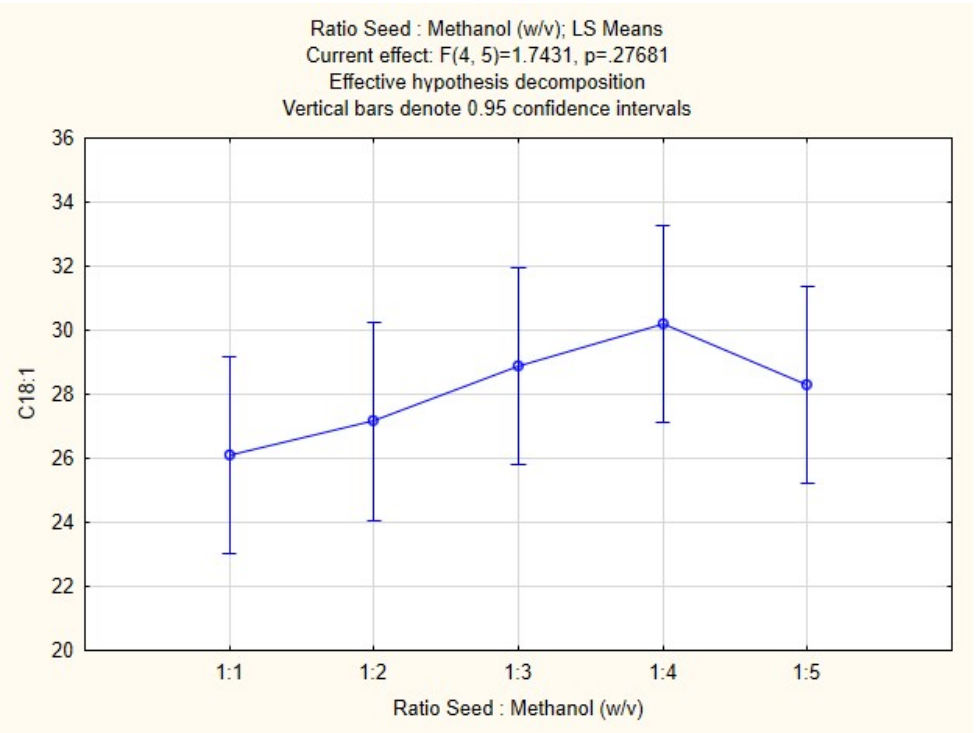


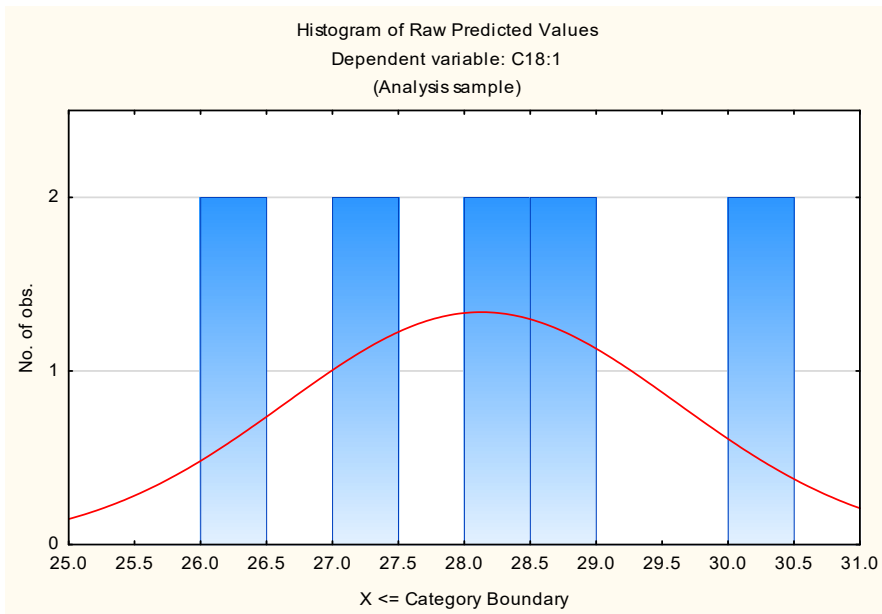
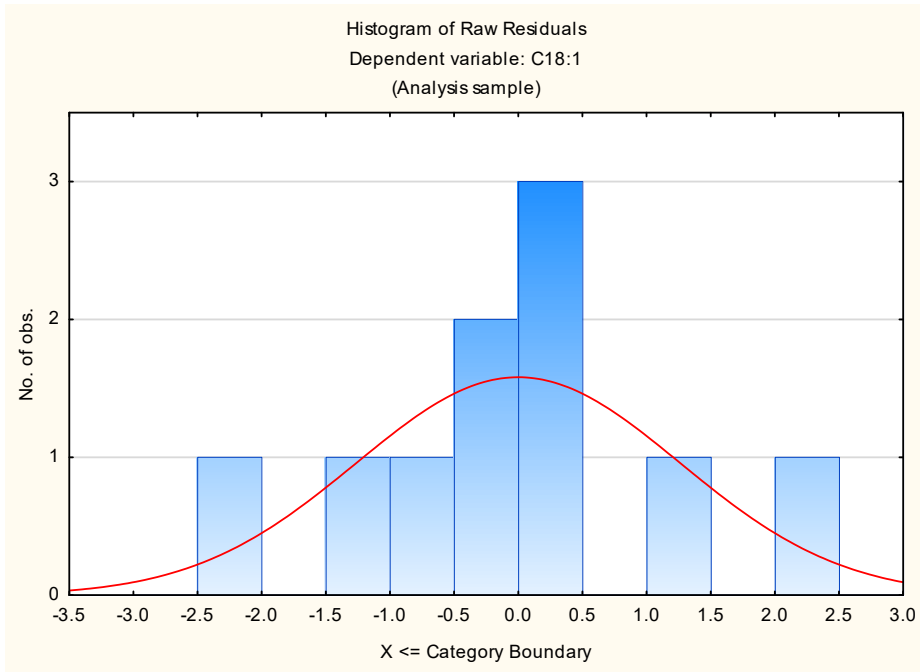


Univariate Tests of Significance for C18:1 (Ratio)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	7912.969	1	7912.969	2761.944	0.000000
Ratio Seed : Methanol (w/v)	19.976	4	4.994	1.743	0.276813
Error	14.325	5	2.865		



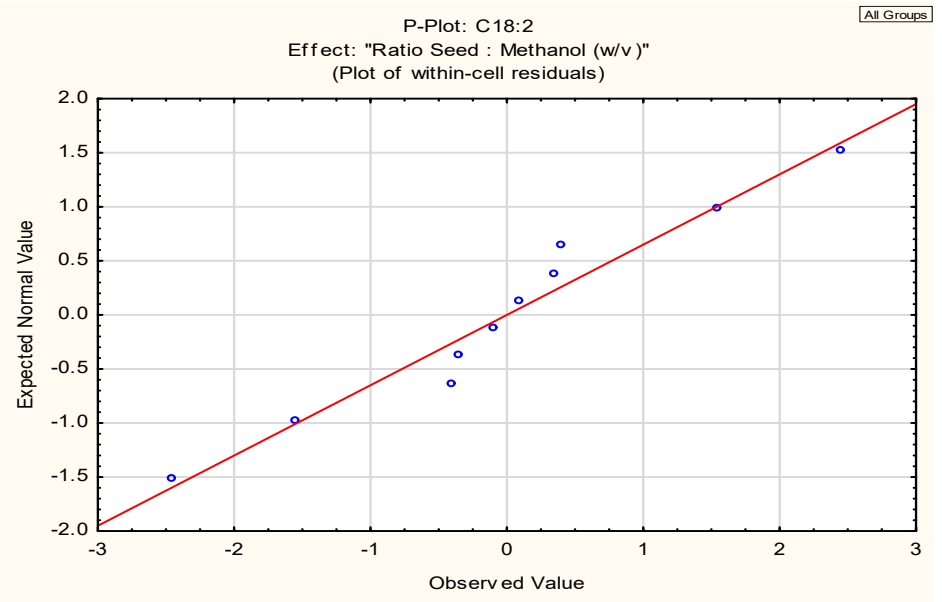
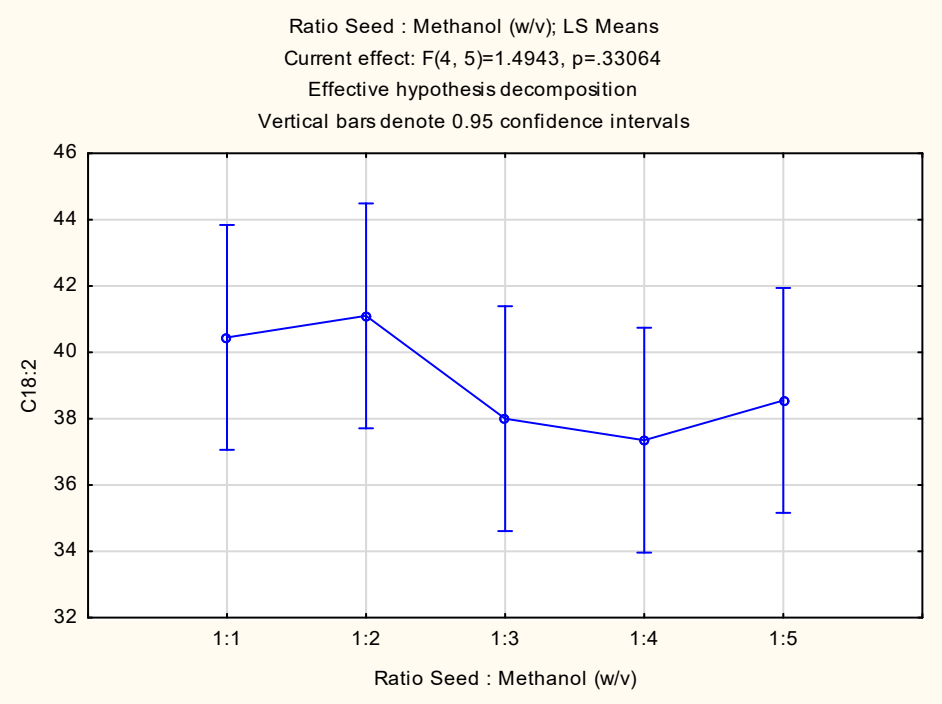
Tukey HSD test; variable C18:1 (Ratio)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 2.8650, df = 5.0000						
Cell No.	Ratio Seed : Methanol (w/v)	{1}	{2}	{3}	{4}	{5}
1	1:1	26.100	0.965361	0.527627	0.247025	0.703752
2	1:2	0.965361	27.150	0.831187	0.460610	0.952870
3	1:3	0.527627	0.831187	28.900	0.929735	0.995518
4	1:4	0.247025	0.460610	0.929735	30.200	0.790785
5	1:5	0.703752	0.952870	0.995518	0.790785	28.300

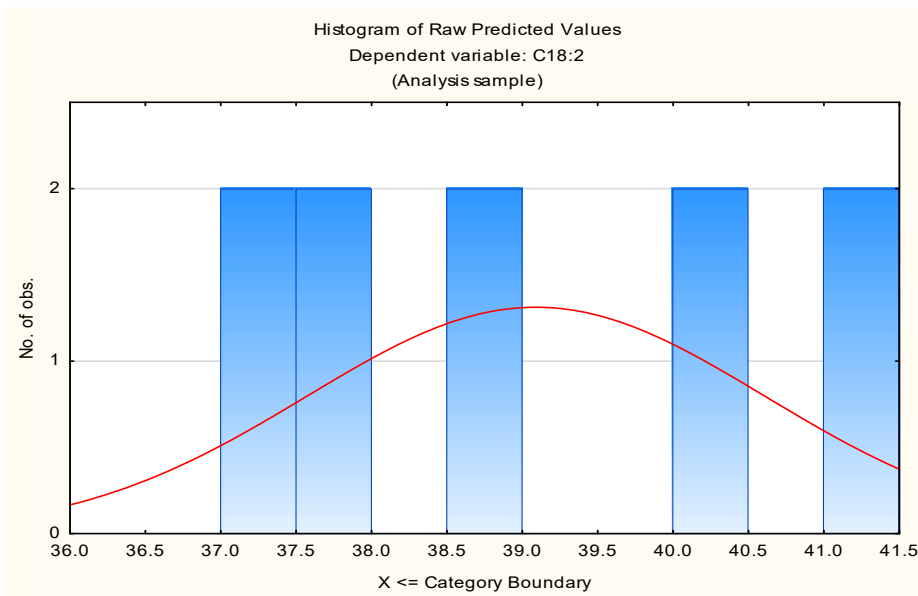
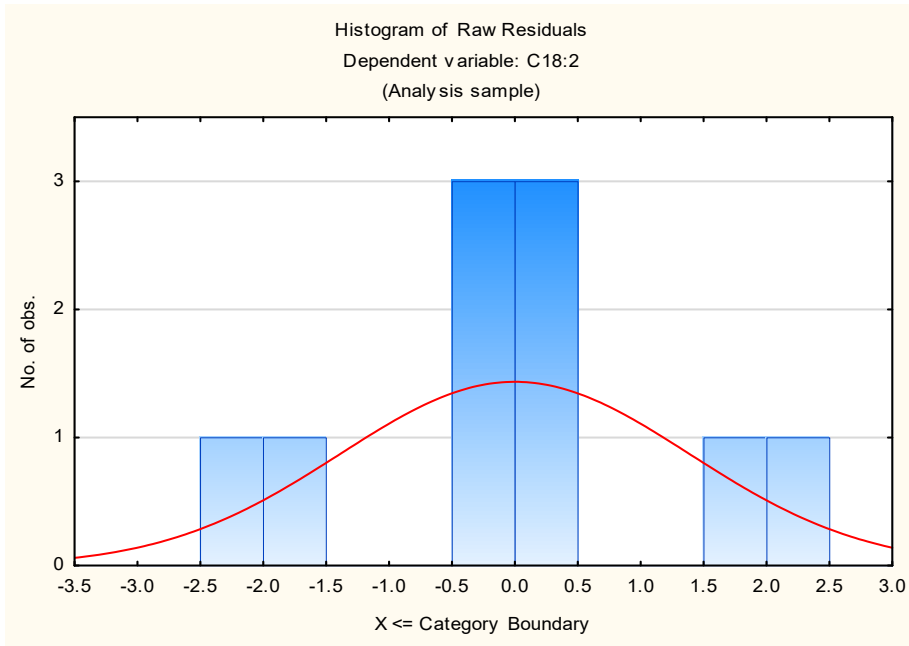




		Univariate Tests of Significance for C18:2 (Ratio)				
		Sigma-restricted parameterization				
		Effective hypothesis decomposition				
Effect		SS	Degr. of Freedom	MS	F	p
Intercept		15280.28	1	15280.28	4392.147	0.000000
Ratio Seed : Methanol (w/v)		20.79	4	5.20	1.494	0.330642
Error		17.40	5	3.48		

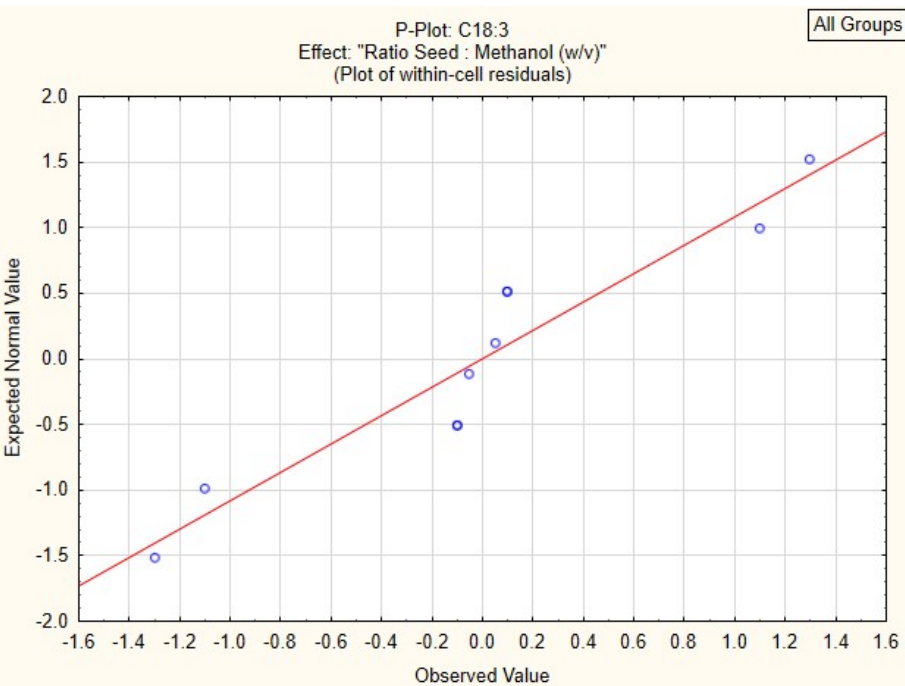
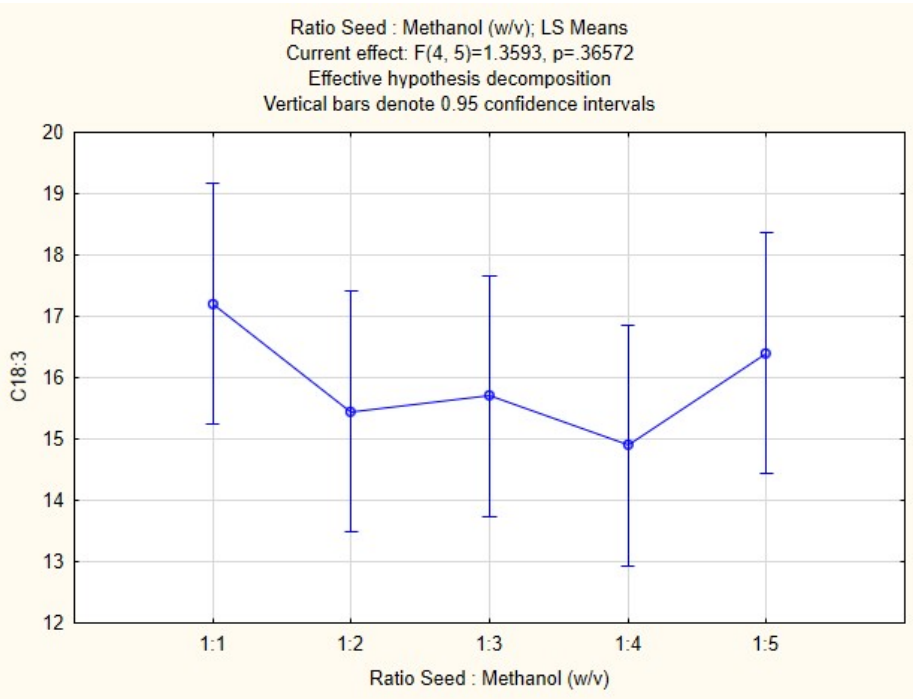
Tukey HSD test; variable C18:2 (Ratio)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 3.4790, df = 5.0000						
Cell No.	Ratio Seed : Methanol (w/v)	{1}	{2}	{3}	{4}	{5}
1	1:1	40.450	41.100	38.000	37.350	38.550
2	1:2	0.995808		0.696801	0.523963	0.837831
3	1:3	0.696801	0.523963		0.376241	0.669664
4	1:4	0.523963	0.376241	0.995808		0.997794
5	1:5	0.837831	0.669664	0.997794	0.960770	





Effect	Univariate Tests of Significance for C18:3 (Ratio) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	2537.649	1	2537.649	2170.786	0.000000
Ratio Seed : Methanol (w/v)	6.356	4	1.589	1.359	0.365716
Error	5.845	5	1.169		

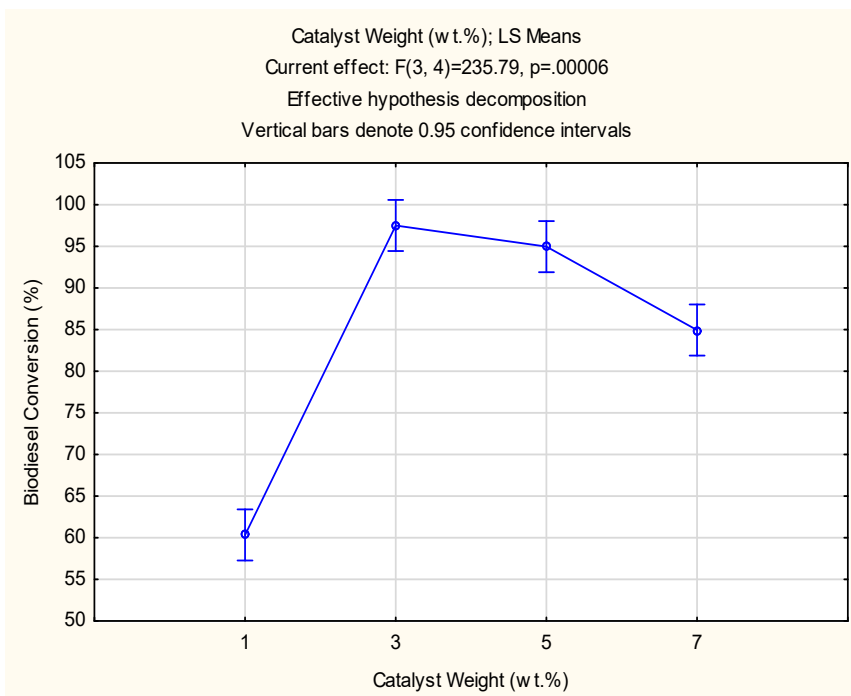
Tukey HSD test; variable C18:3 (Ratio)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 1.1690, df = 5.0000						
Cell No.	Ratio Seed : Methanol (w/v)	{1}	{2}	{3}	{4}	{5}
1	1:1	17.200	0.544703	0.659420	0.334538	0.937645
2	1:2	0.544703		0.999155	0.982796	0.893608
3	1:3	0.659420	0.999155		0.937645	0.959923
4	1:4	0.334538	0.982796	0.937645		0.659420
5	1:5	0.937645	0.893608	0.959923	0.659420	

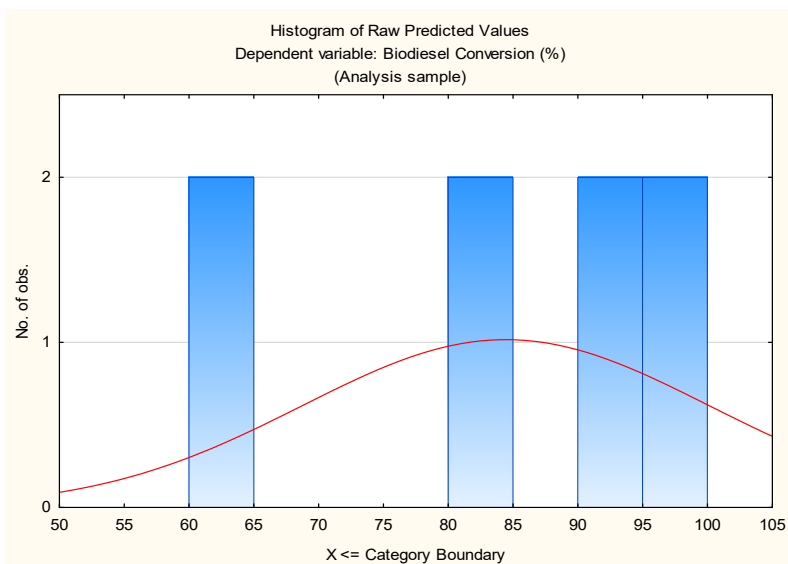
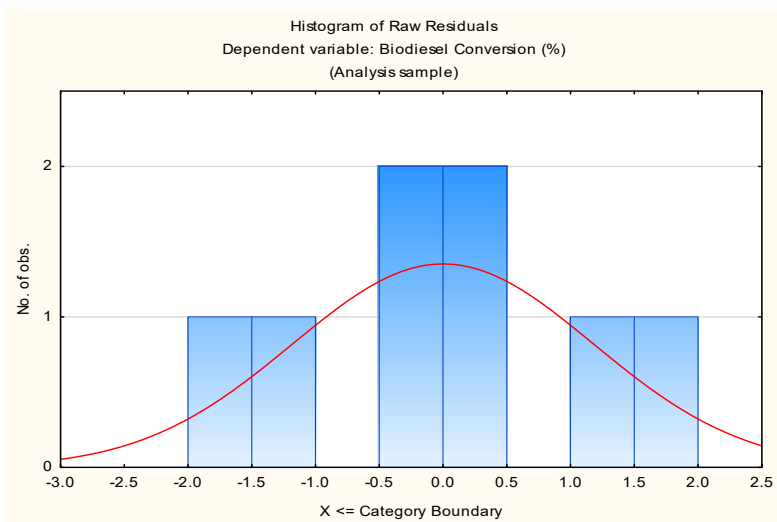
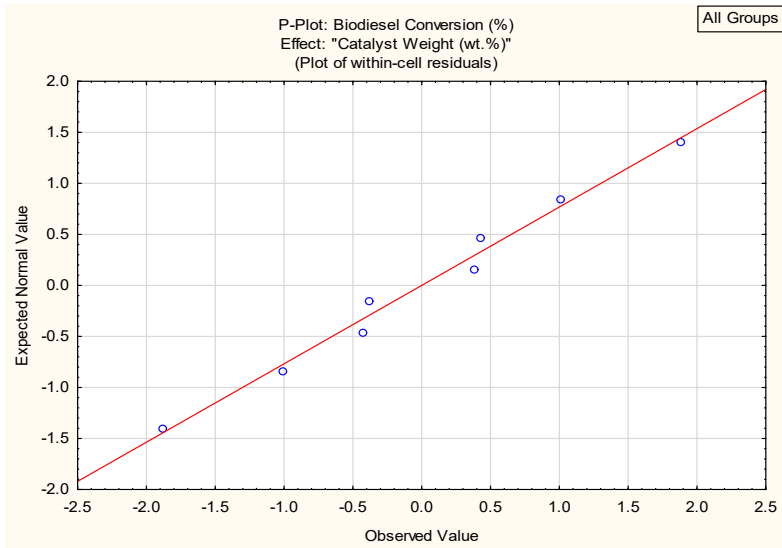


## Effect of catalyst concentration

Effect	Univariate Tests of Significance for Biodiesel Conversion (%) (Catalyst Weight) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	57034.15	1	57034.15	23386.39	0.000000
Catalyst Weight (wt.%)	1725.08	3	575.03	235.79	0.000059
Error	9.76	4	2.44		

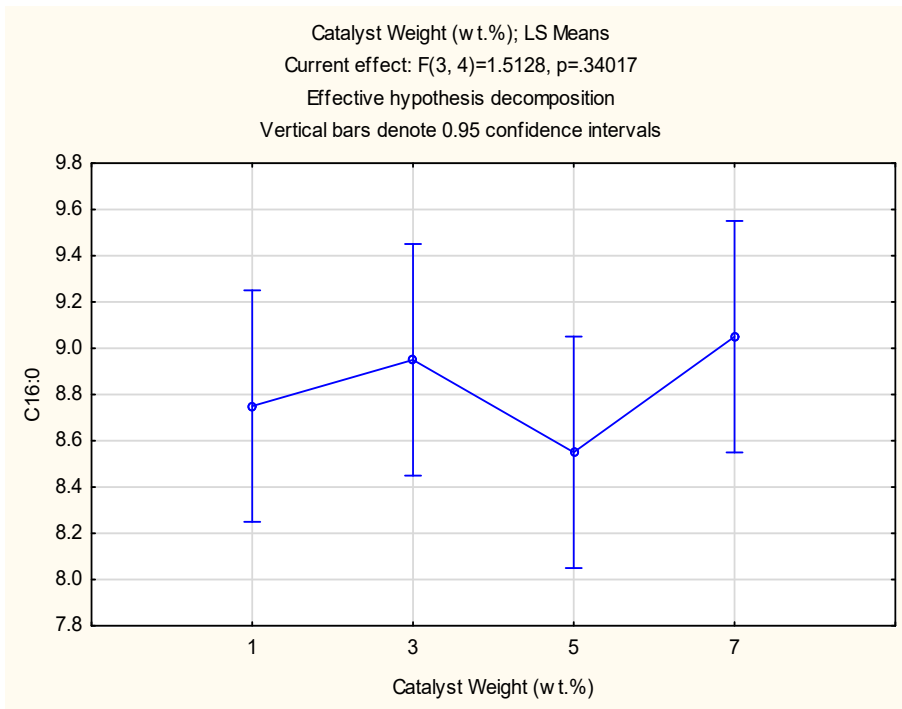
Cell No.	Catalyst Weight (wt.%)	Tukey HSD test; variable Biodiesel Conversion (%) (Catalyst Weight) Approximate Probabilities for Post Hoc Tests Error: Between MS = 2.4388, df = 4.0000			
		{1}	{2}	{3}	{4}
		60.335	97.500	94.960	84.945
1	1		0.000309	0.000321	0.000547
2	3	0.000309		0.458062	0.004672
3	5	0.000321	0.458062		0.010570
4	7	0.000547	0.004672	0.010570	



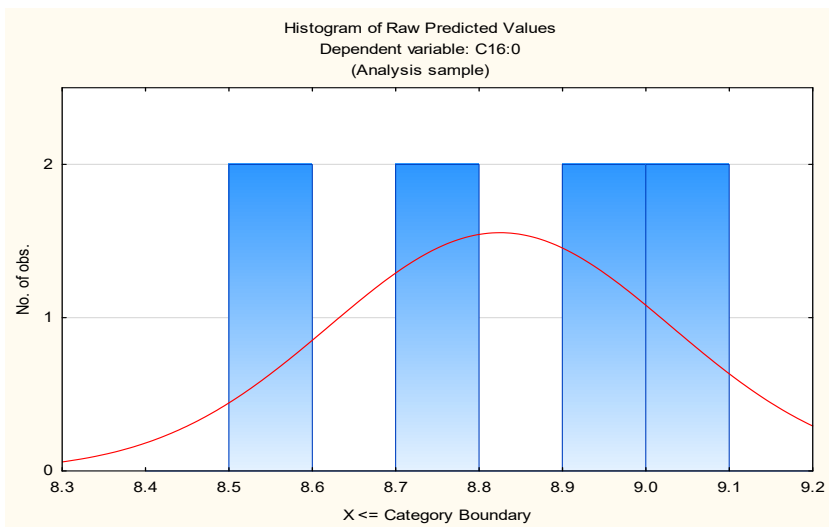
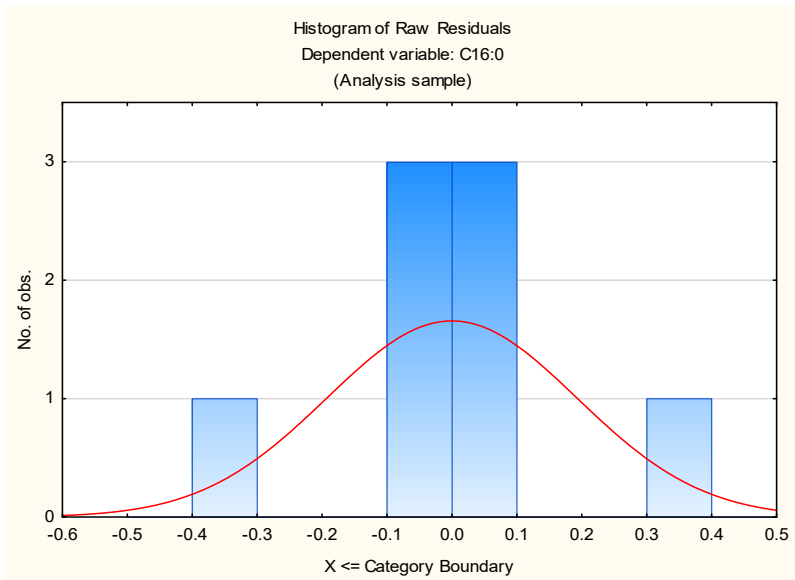
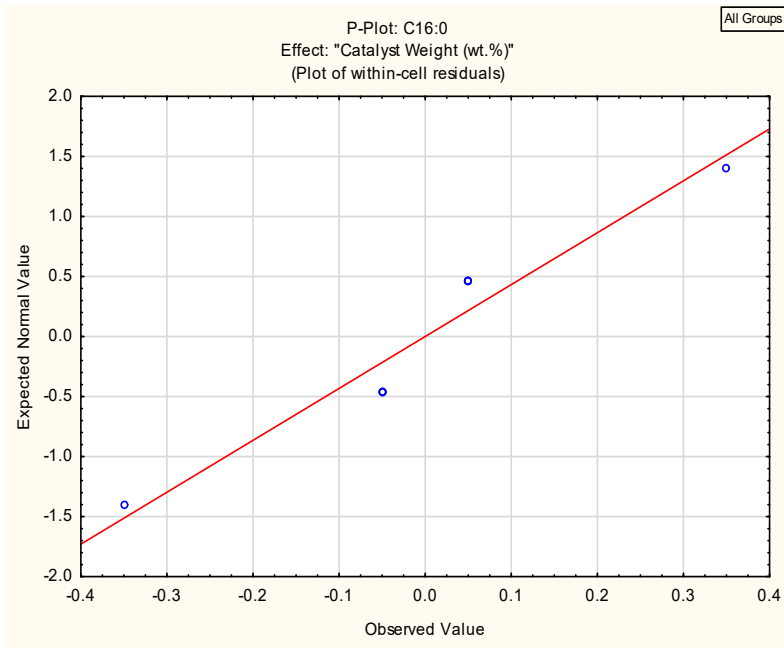


Effect	Univariate Tests of Significance for C16:0 (Catalyst Weight) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	623.0450	1	623.0450	9585.308	0.000000
Catalyst Weight (wt.%)	0.2950	3	0.0983	1.513	0.340170
Error	0.2600	4	0.0650		

Cell No.	Tukey HSD test; variable C16:0 (Catalyst Weight) Approximate Probabilities for Post Hoc Tests Error: Between MS = .06500, df = 4.0000				
	Catalyst Weight (wt.%)	{1} 8.7500	{2} 8.9500	{3} 8.5500	{4} 9.0500
1	1		0.858508	0.858508	0.669972
2	3	0.858508		0.482623	0.976963
3	5	0.858508	0.482623		0.334239
4	7	0.669972	0.976963	0.334239	

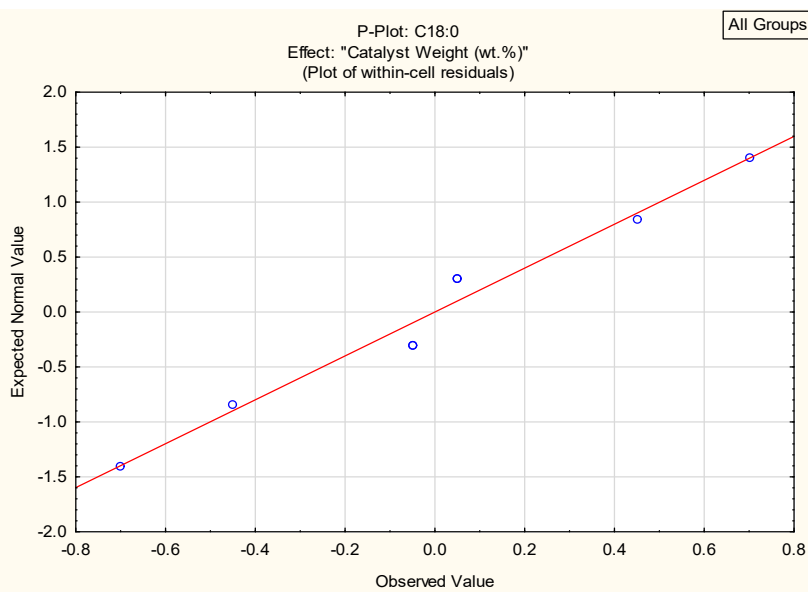
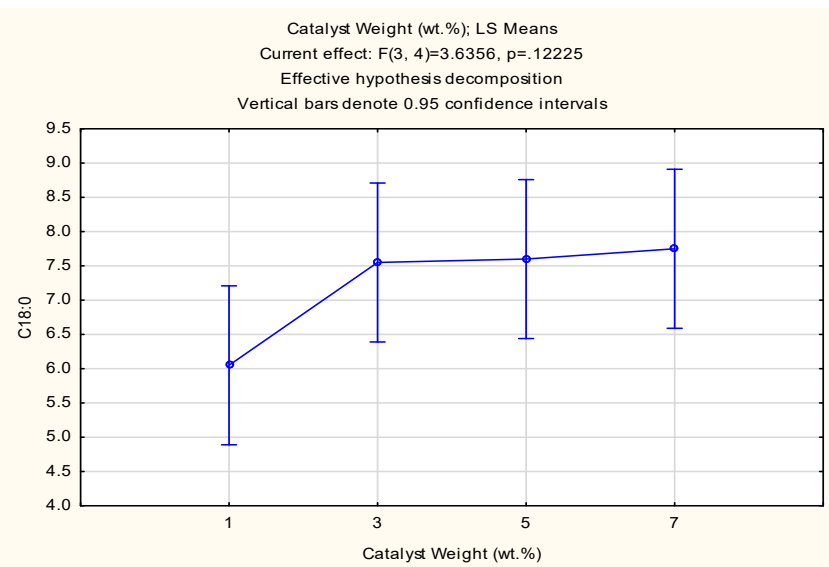


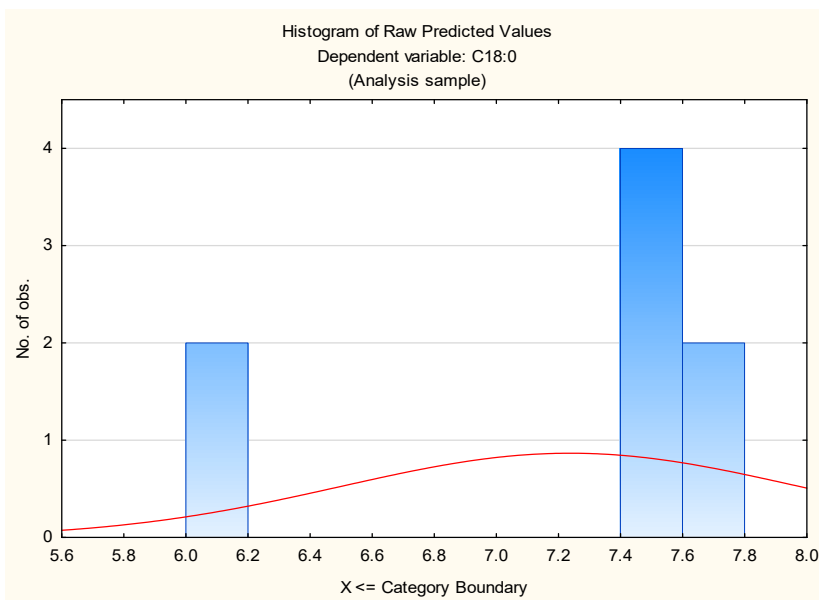
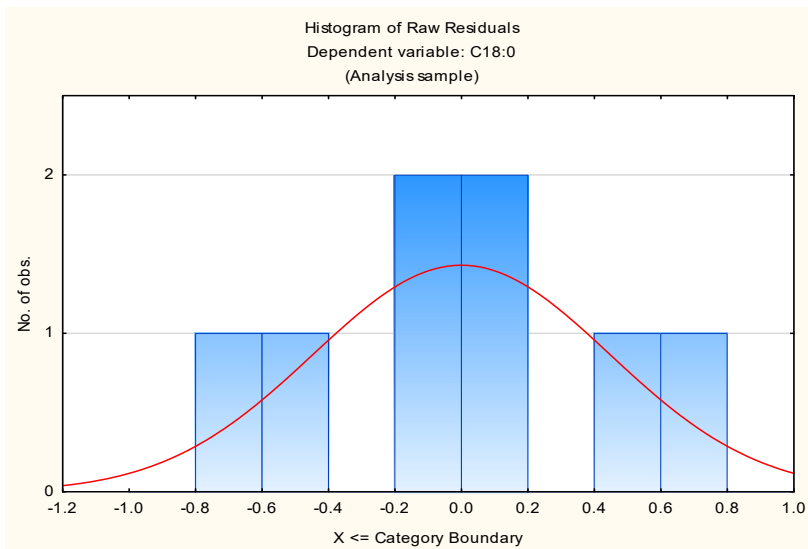




Univariate Tests of Significance for C18:0 (Catalyst Weight)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	419.0513	1	419.0513	1201.581	0.000004
Catalyst Weight (wt.%)	3.8038	3	1.2679	3.636	0.122246
Error	1.3950	4	0.3488		

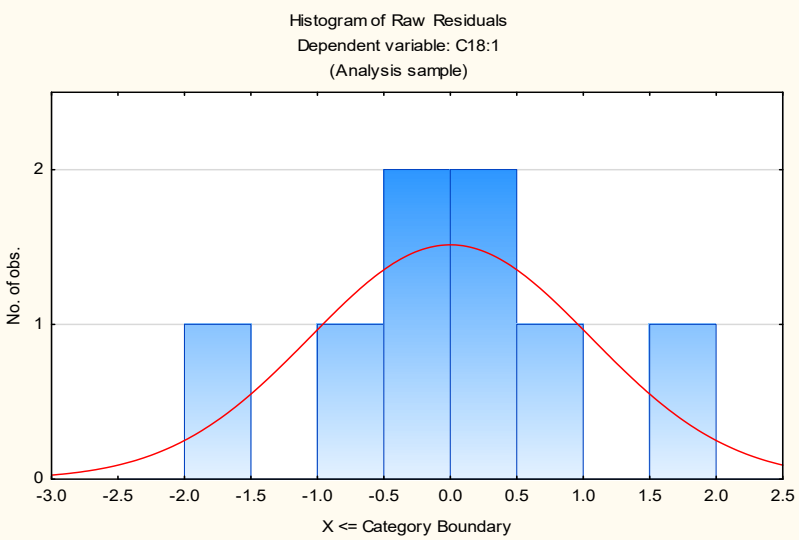
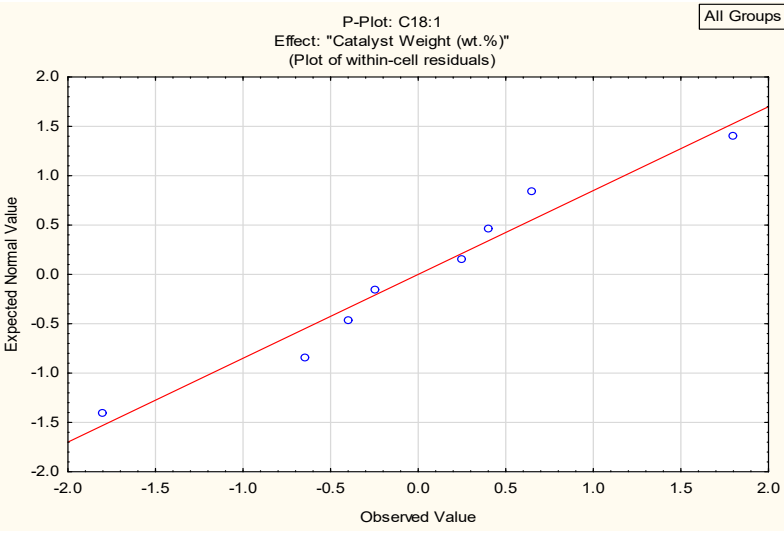
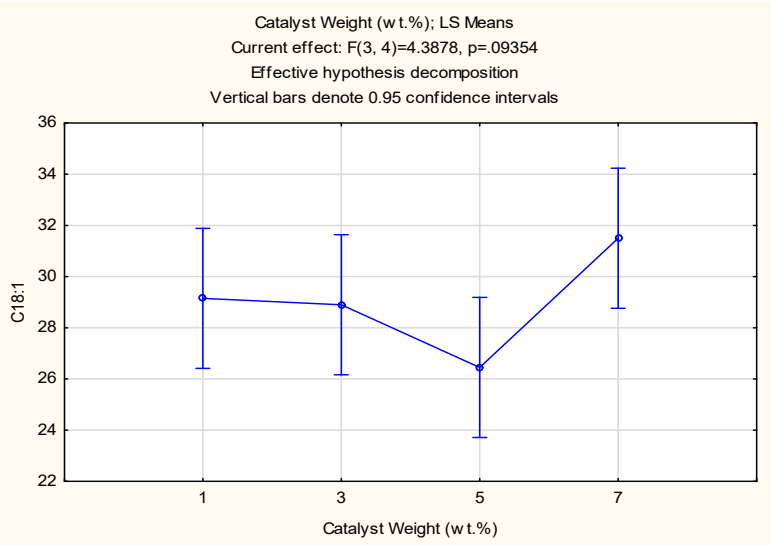
Tukey HSD test; variable C18:0 (Catalyst Weight)					
Approximate Probabilities for Post Hoc Tests					
Error: Between MS = .34875, df = 4.0000					
Cell No.	Catalyst Weight (wt.%)	{1}	{2}	{3}	{4}
1	1	6.0500	7.5500	7.6000	7.7500
2	3	0.191403	0.191403	0.176591	0.139207
3	5	0.176591	0.999755	0.999755	0.984832
4	7	0.139207	0.984832	0.993422	0.993422

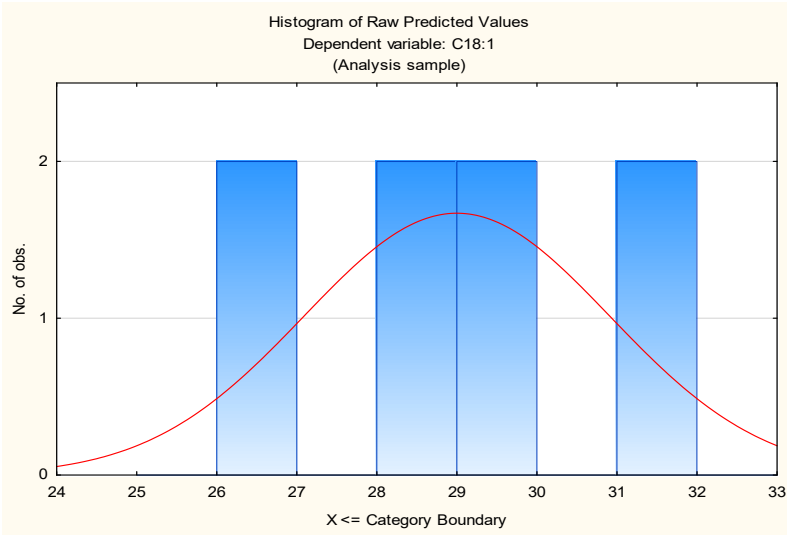




Univariate Tests of Significance for C18:1 (Catalyst Weight)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	6728.000	1	6728.000	3463.578	0.000000
Catalyst Weight (wt.%)	25.570	3	8.523	4.388	0.093545
Error	7.770	4	1.943		

Tukey HSD test; variable C18:1 (Catalyst Weight)					
Approximate Probabilities for Post Hoc Tests					
Error: Between MS = 1.9425, df = 4.0000					
Cell No.	Catalyst Weight (wt.%)	{1}	{2}	{3}	{4}
1	1	29.150	28.900	26.450	31.500
2	3	0.997663	0.997663	0.405553	0.366327
3	5	0.341992	0.405553	0.072089	0.072089
4	7	0.433610	0.366327	0.072089	0.072089



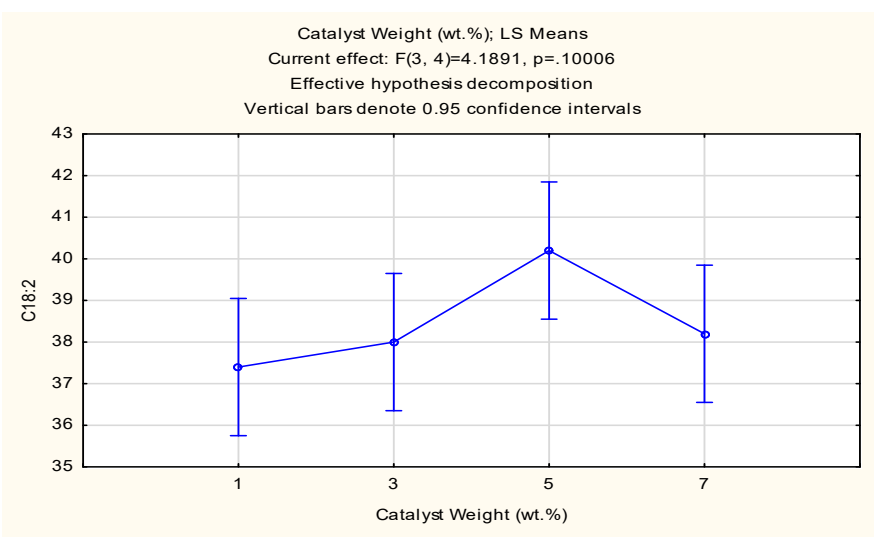


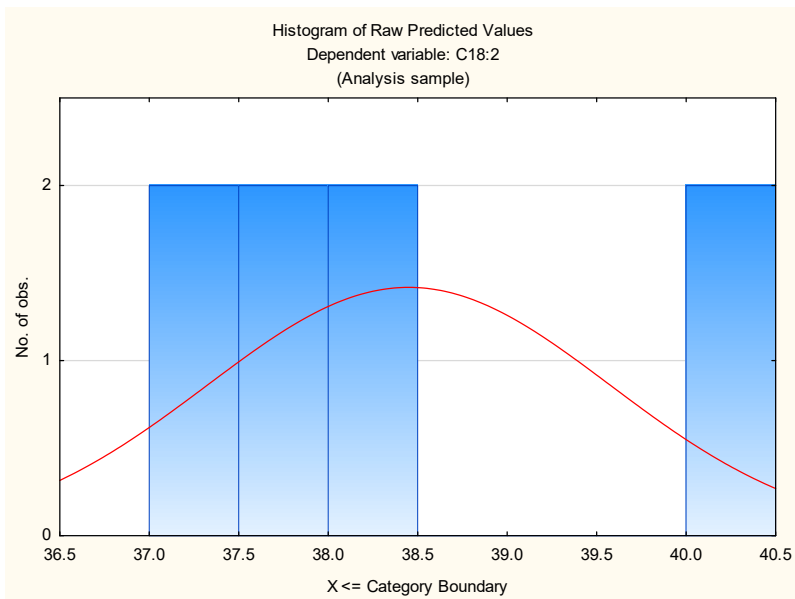
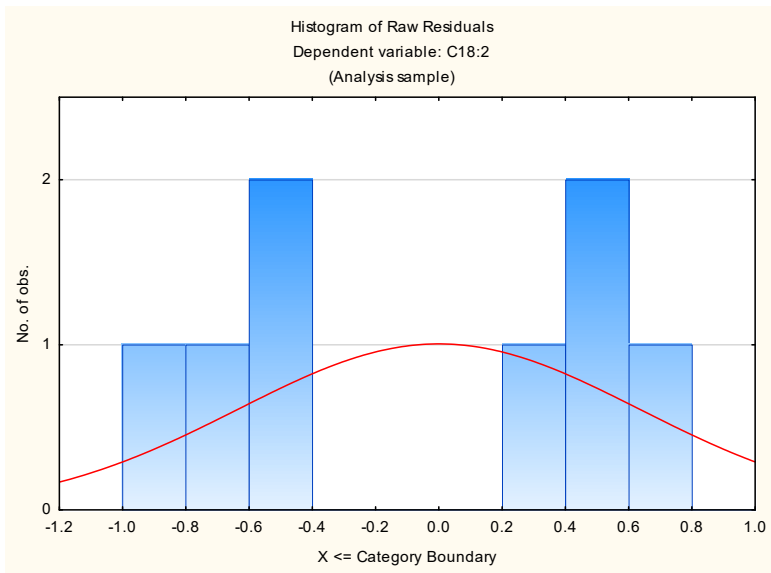
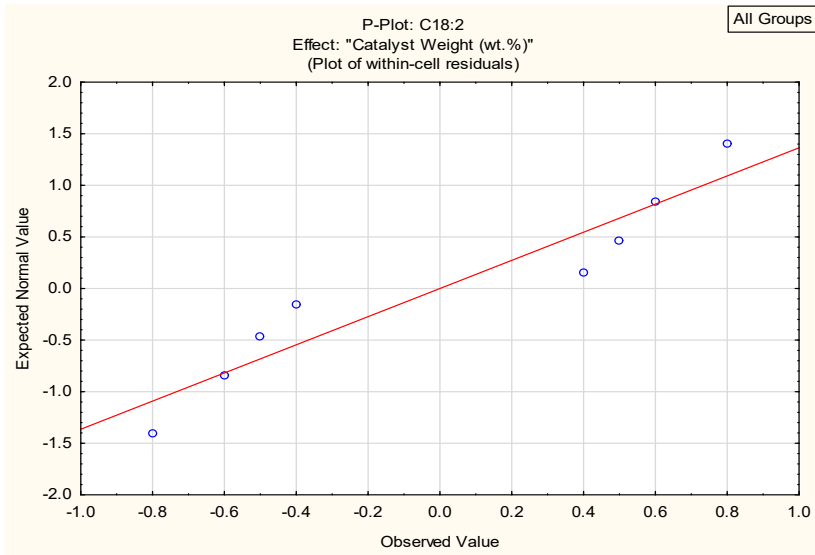
Univariate Tests of Significance for C18:2 (Catalyst Weight)  
Sigma-restricted parameterization  
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	11827.22	1	11827.22	16776.20	0.000000
Catalyst Weight (wt.%)	8.86	3	2.95	4.19	0.100060
Error	2.82	4	0.71		

Tukey HSD test; variable C18:2 (Catalyst Weight)  
Approximate Probabilities for Post Hoc Tests  
Error: Between MS = .70500, df = 4.0000

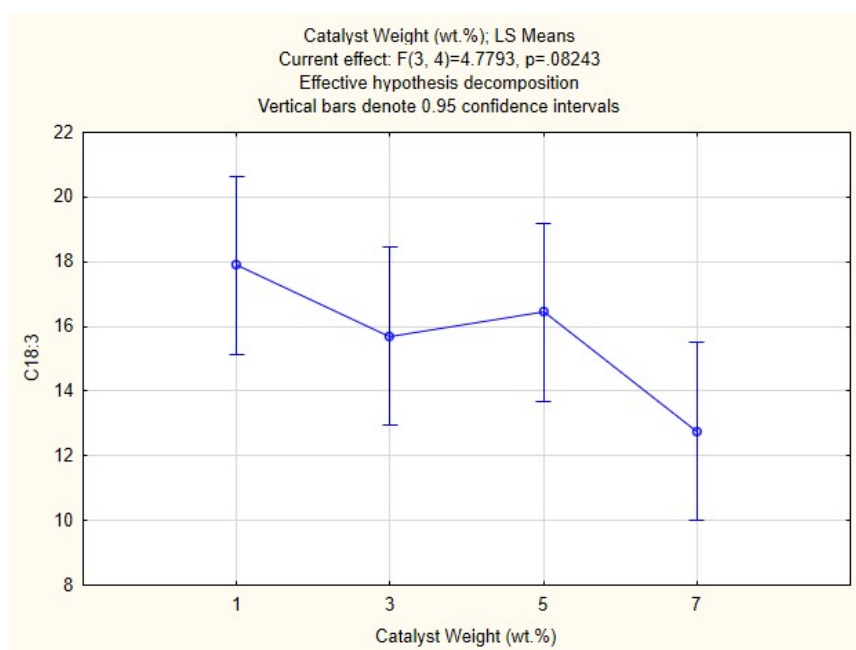
Cell No.	Catalyst Weight (wt.%)	{1}	{2}	{3}	{4}
1	1	37.400	38.000	40.200	38.200
2	3	0.886785		0.177357	0.994547
3	5	0.092317	0.177357		0.222740
4	7	0.781701	0.994547	0.222740	

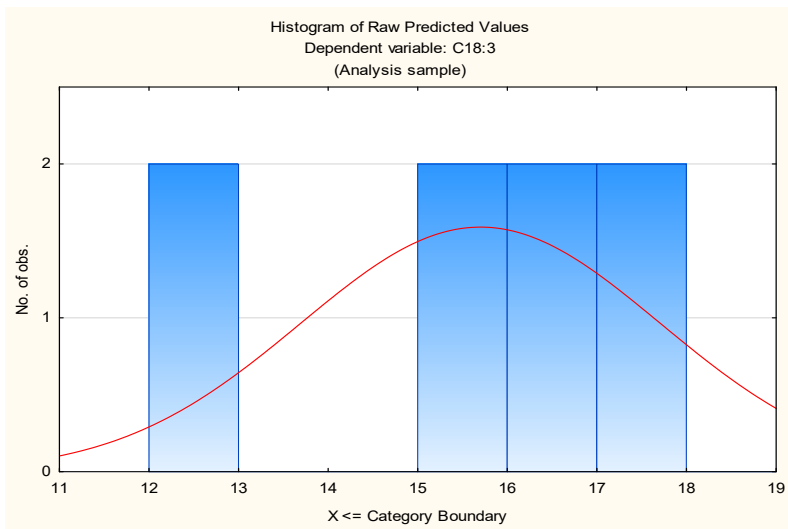
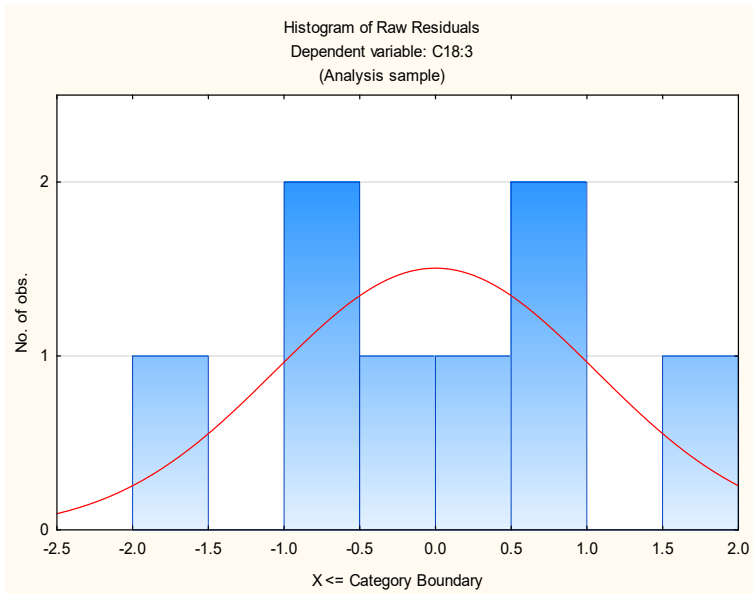
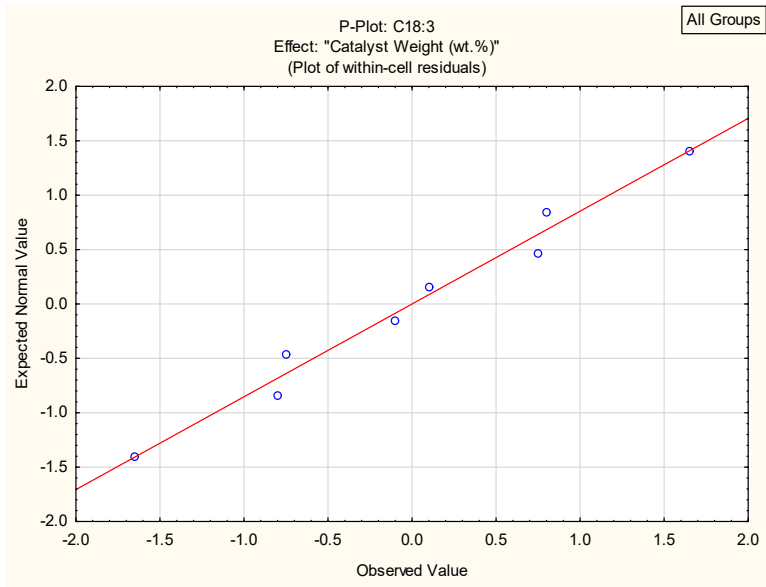




Univariate Tests of Significance for C18:3 (Catalyst Weight)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1971.920	1	1971.920	1002.247	0.000006
Catalyst Weight (wt.%)	28.210	3	9.403	4.779	0.082433
Error	7.870	4	1.968		

Tukey HSD test; variable C18:3 (Catalyst Weight)					
Approximate Probabilities for Post Hoc Tests					
Error: Between MS = 1.9675, df = 4.0000					
Cell No.	Catalyst Weight (wt.%)	{1}	{2}	{3}	{4}
1	1	17.900	15.700	16.450	12.750
2	3	0.482839		0.946097	0.291528
3	5	0.741924	0.946097		0.174407
4	7	0.069241	0.291528	0.174407	



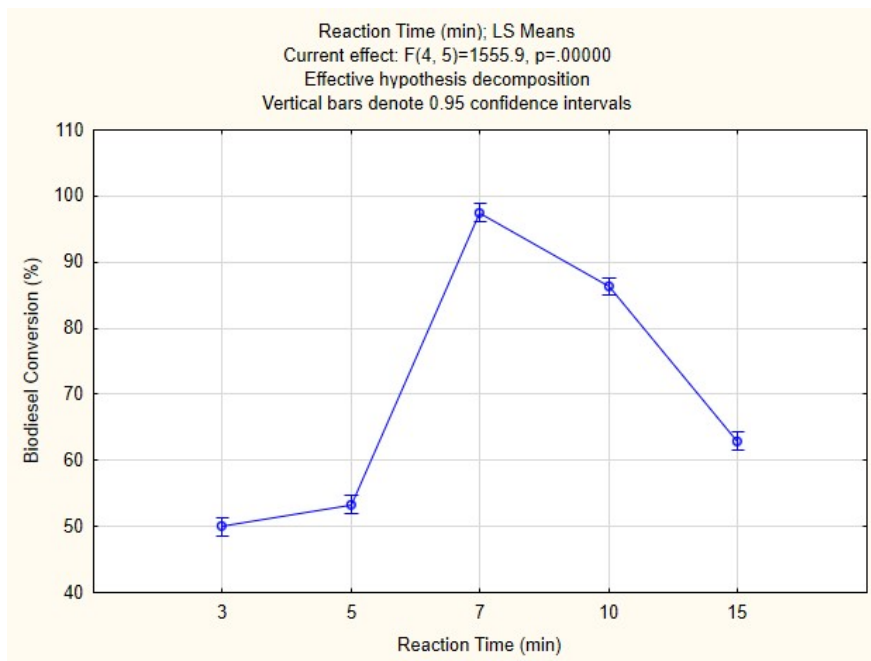


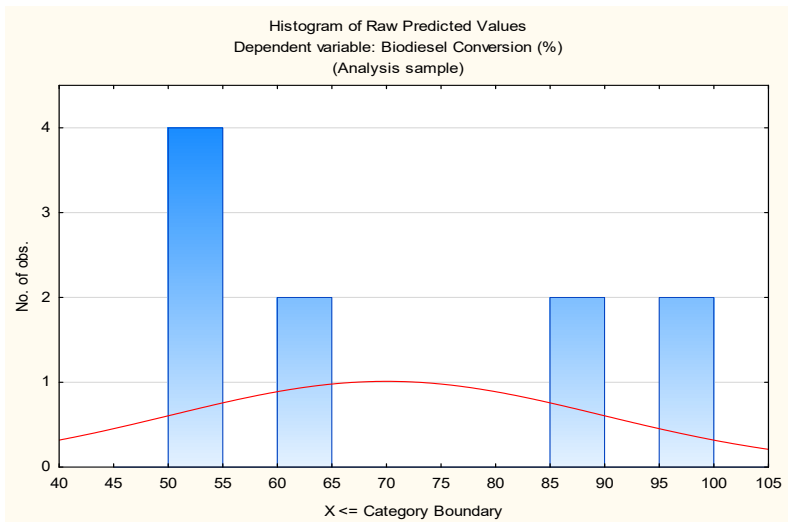
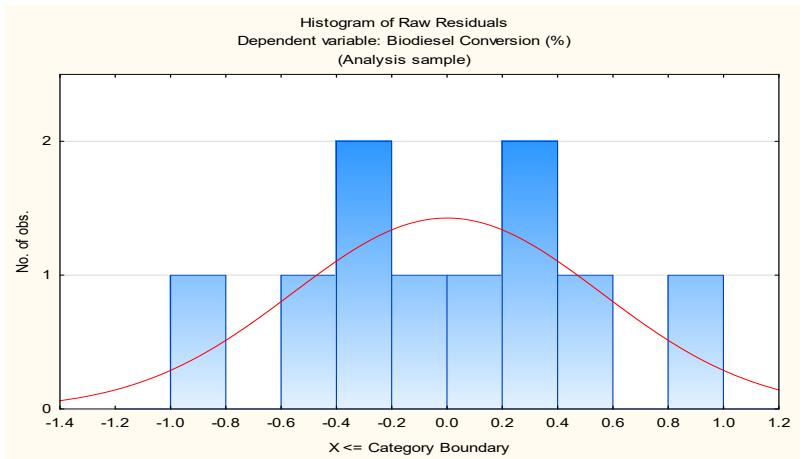
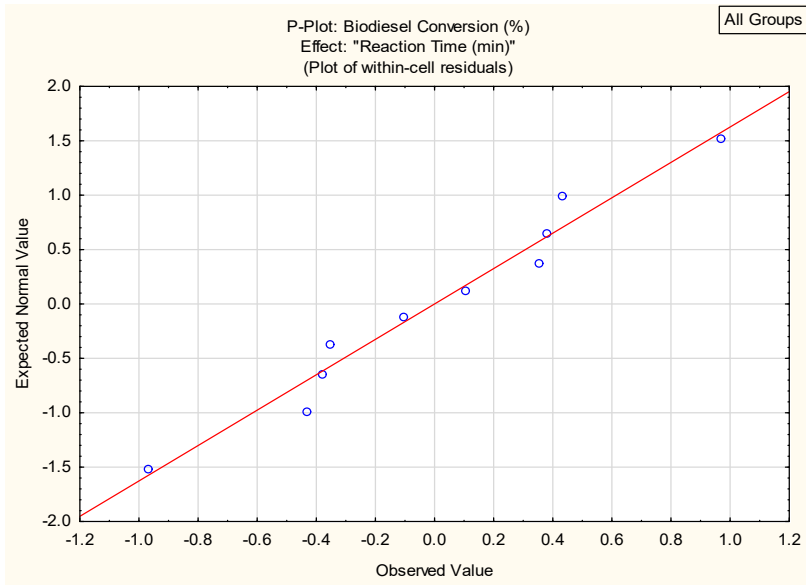


## Effect of Reaction Time

Univariate Tests of Significance for Biodiesel Conversion (%) (Reaction Time)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	48997.20	1	48997.20	87044.24	0.000000
Reaction Time (min)	3503.27	4	875.82	1555.90	0.000000
Error	2.81	5	0.56		

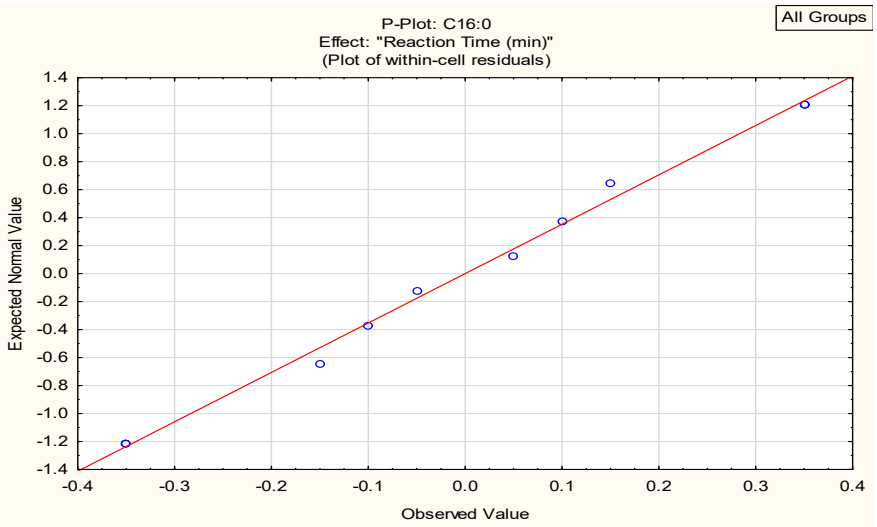
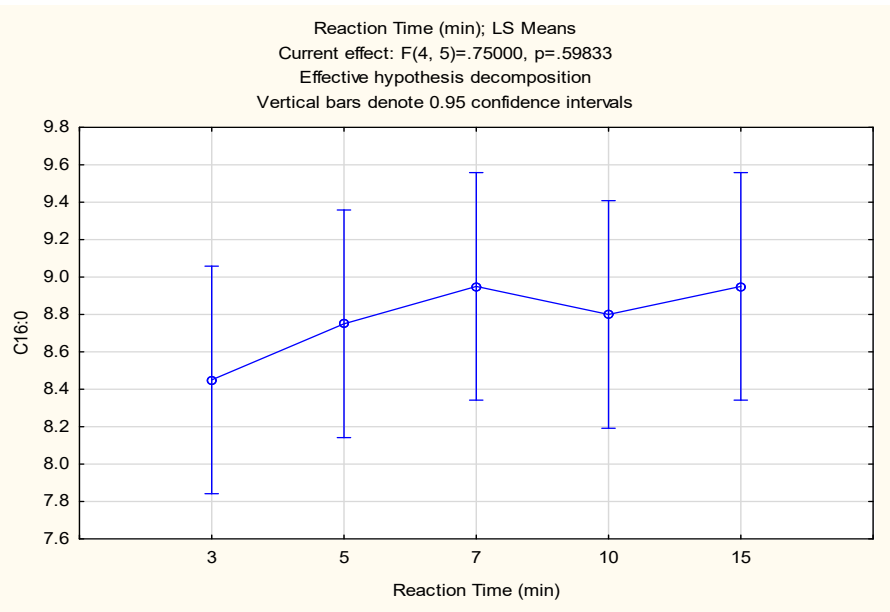
Tukey HSD test; variable Biodiesel Conversion (%) (Reaction Time)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = .56290, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
		50.005	53.280	97.500	86.300	62.905
1	3		0.036294	0.000271	0.000271	0.000291
2	5	0.036294		0.000271	0.000271	0.000471
3	7	0.000271	0.000271		0.000337	0.000271
4	10	0.000271	0.000271	0.000337		0.000271
5	15	0.000291	0.000471	0.000271	0.000271	

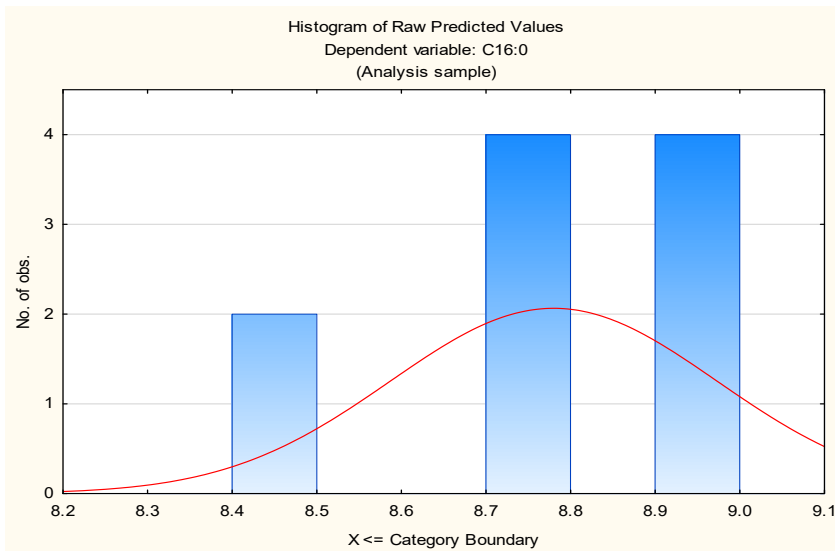
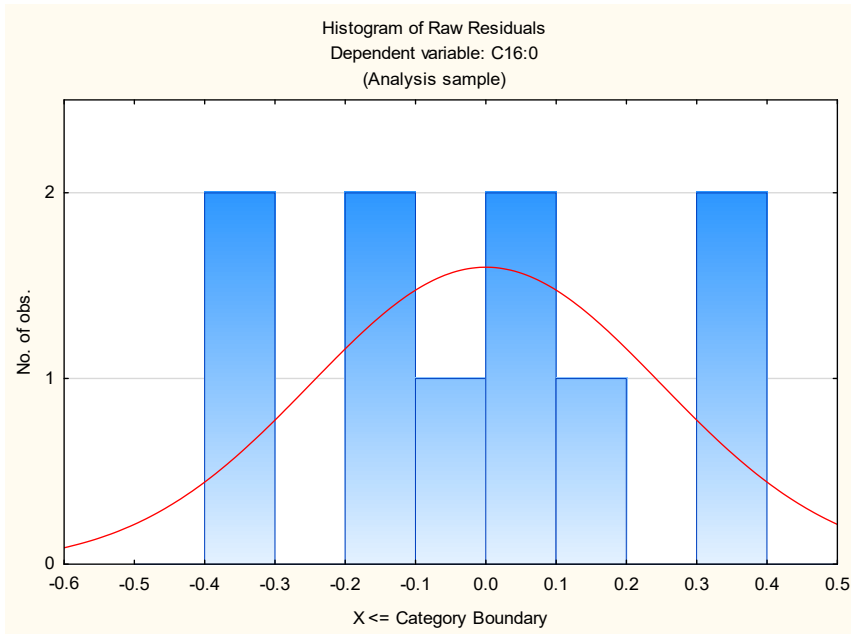




Univariate Tests of Significance for C16:0 (Reaction Time)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	770.8840	1	770.8840	6882.893	0.000000
Reaction Time (min)	0.3360	4	0.0840	0.750	0.598331
Error	0.5600	5	0.1120		

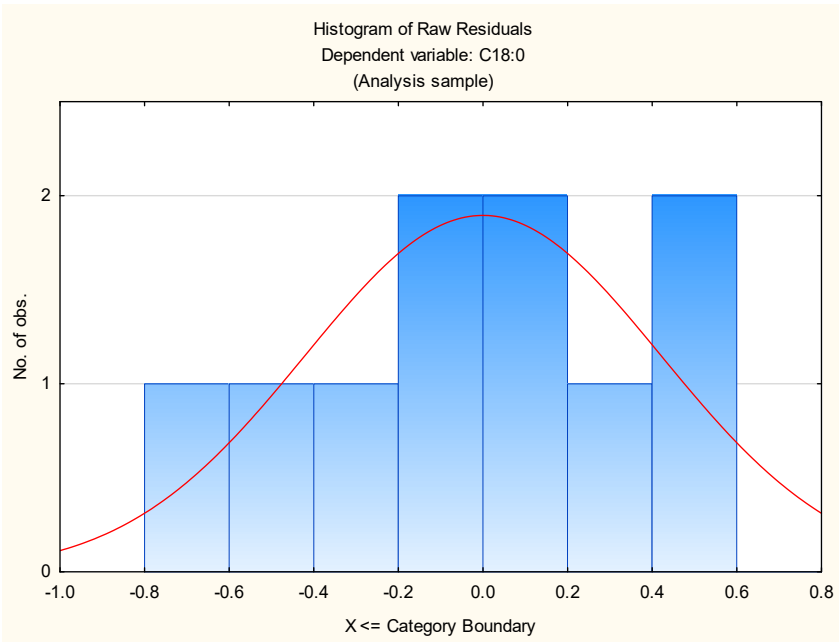
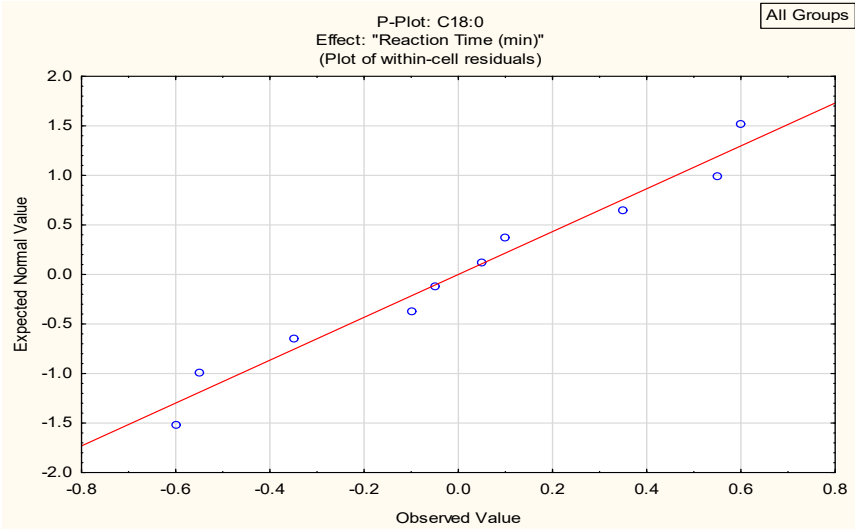
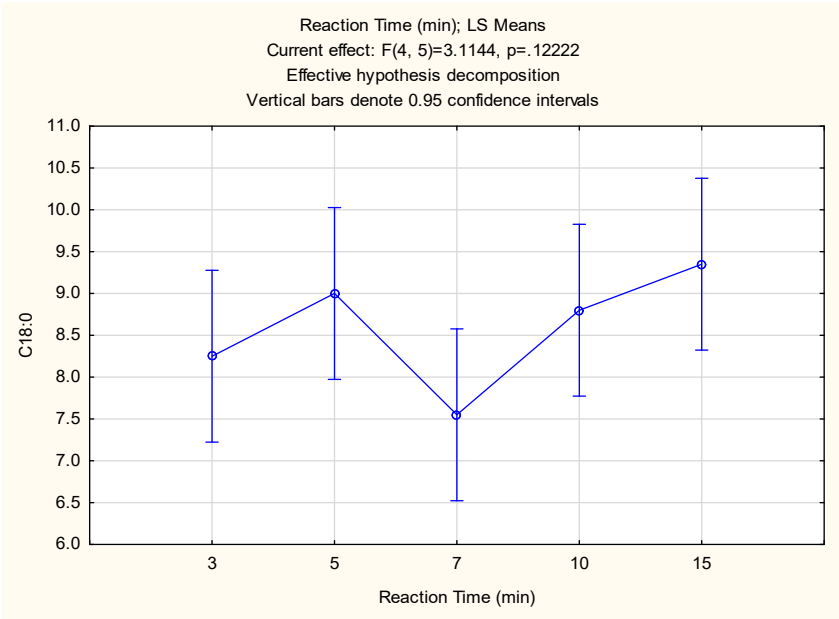
Tukey HSD test; variable C16:0 (Reaction Time)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = .11200, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
		8.4500	8.7500	8.9500	8.8000	8.9500
1	3		0.887111	0.605692	0.825918	0.605692
2	5	0.887111		0.969548	0.999849	0.969548
3	7	0.605692	0.969548		0.989172	1.000000
4	10	0.825918	0.999849	0.989172		0.989172
5	15	0.605692	0.969548	1.000000	0.989172	

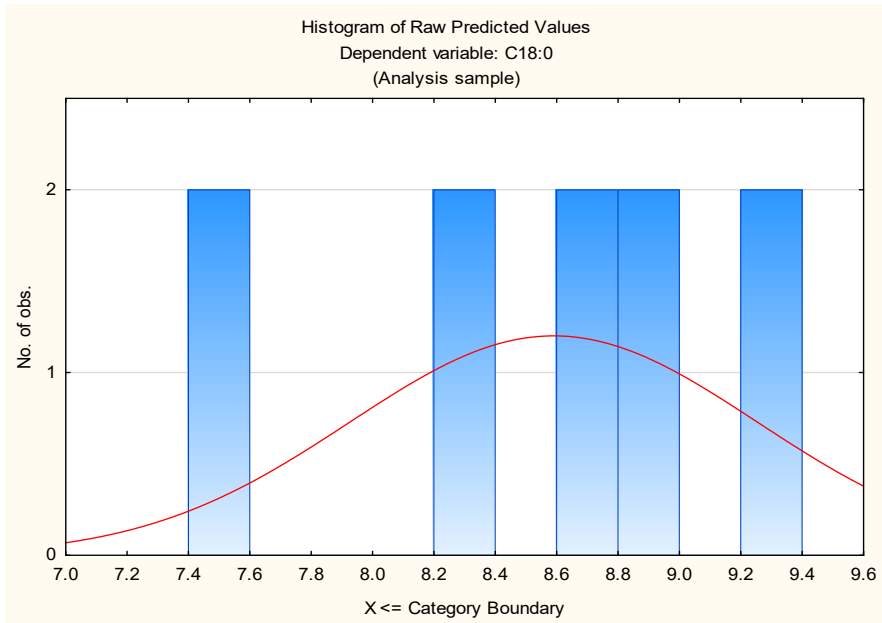




Univariate Tests of Significance for C18:0 (Reaction Time) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	737.8810	1	737.8810	2313.107	0.000000
Reaction Time (min)	3.9740	4	0.9935	3.114	0.122215
Error	1.5950	5	0.3190		

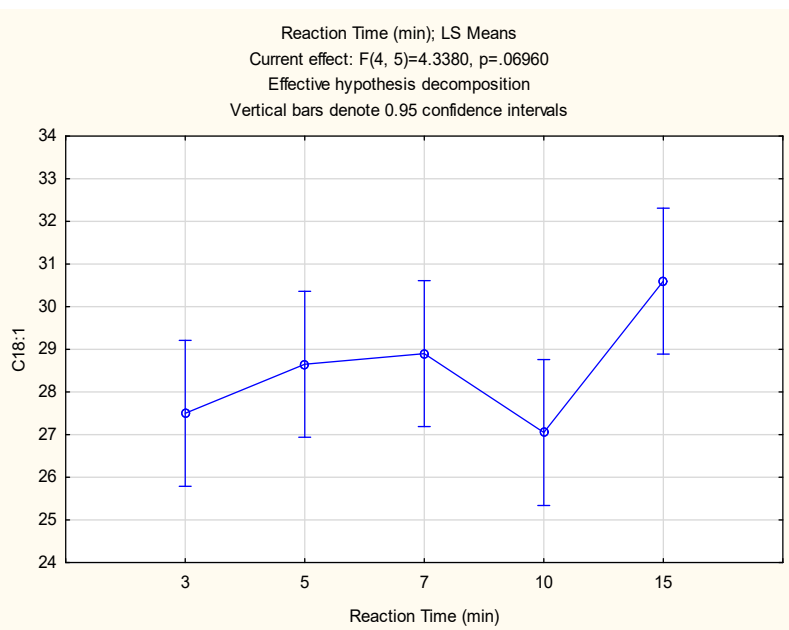
Tukey HSD test; variable C18:0 (Reaction Time) Approximate Probabilities for Post Hoc Tests Error: Between MS = .31900, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
1	3	8.2500	0.689537	0.734002	0.856785	0.400338
2	5	0.689537	9.0000	0.212377	0.995536	0.965485
3	7	0.734002	0.212377		0.306520	0.111964
4	10	0.856785	0.995536	0.306520		0.856785
5	15	0.400338	0.965485	0.111964	0.856785	

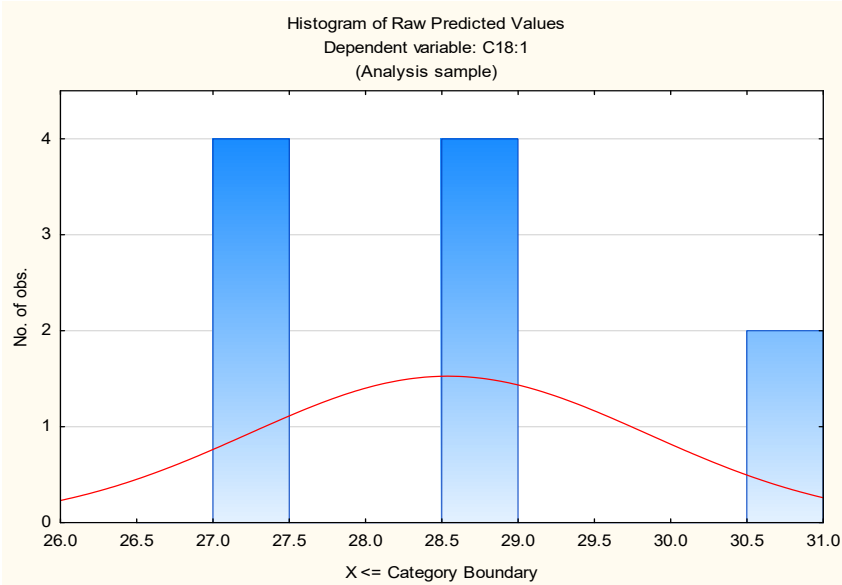
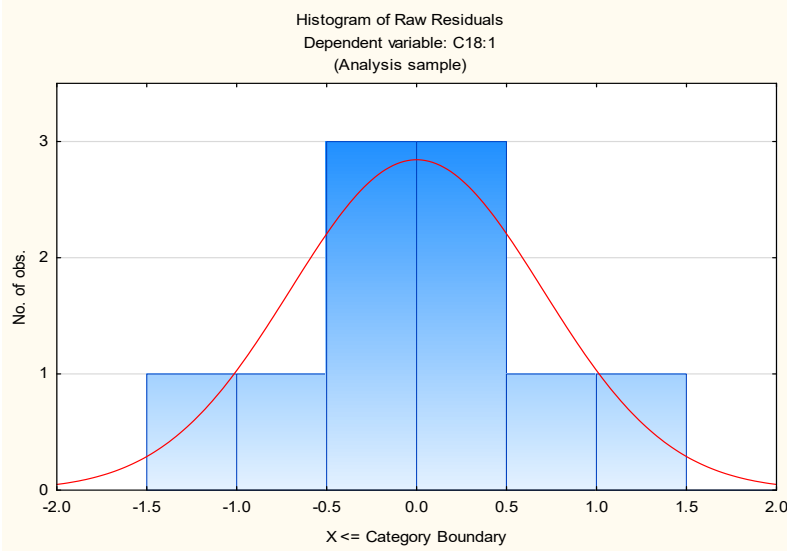
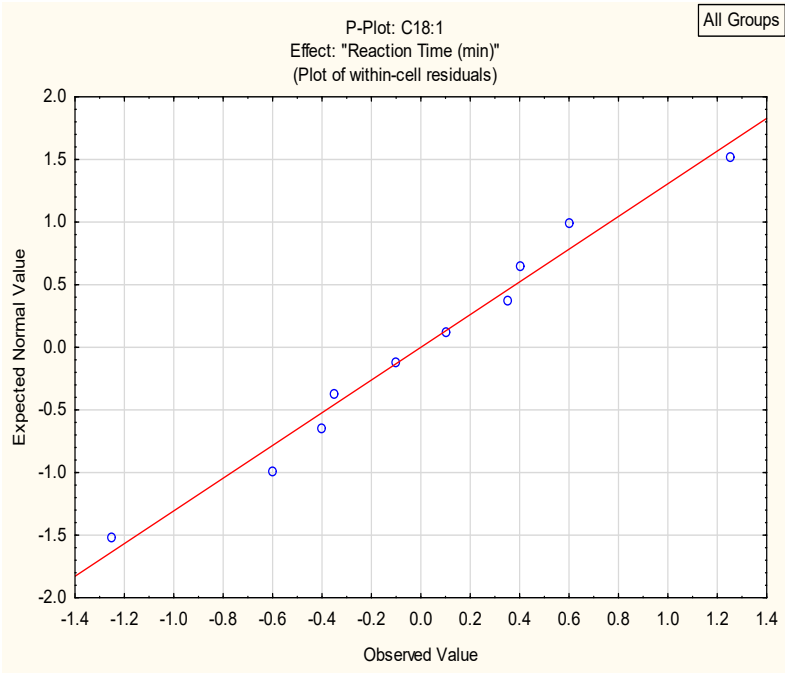




Univariate Tests of Significance for C18:1 (Reaction Time)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	8145.316	1	8145.316	9193.359	0.000000
Reaction Time (min)	15.374	4	3.844	4.338	0.069597
Error	4.430	5	0.886		

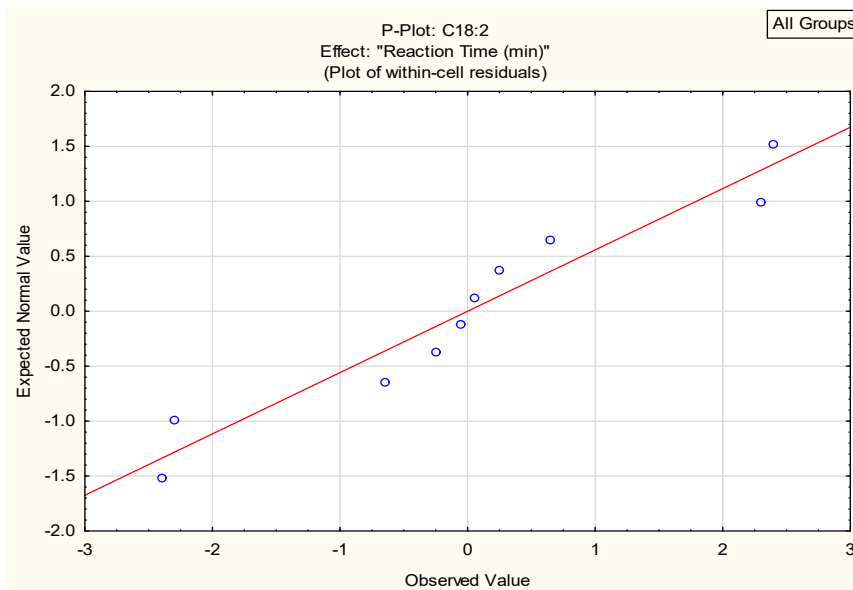
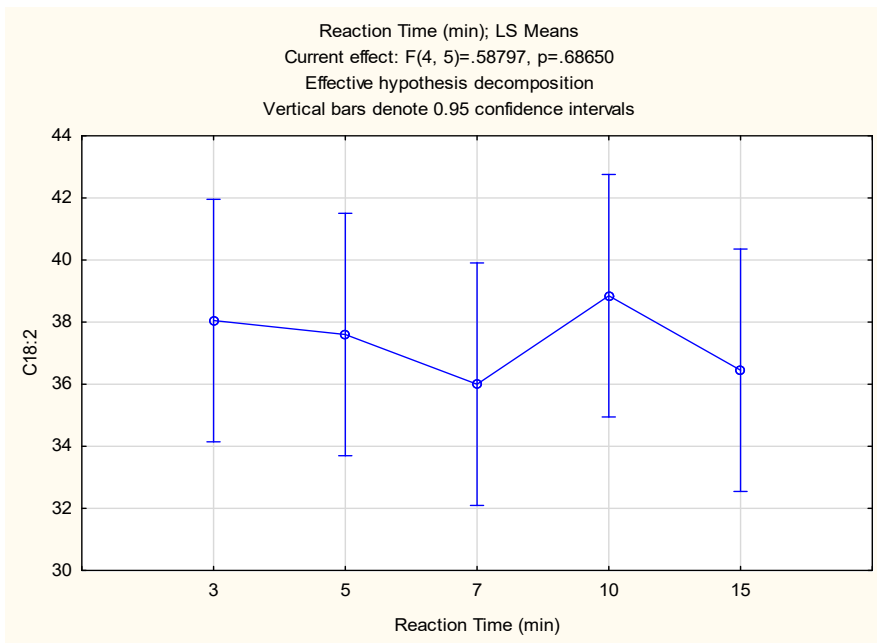
Tukey HSD test; variable C18:1 (Reaction Time)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = .88600, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
1	3		0.742750	0.609033	0.986269	0.100543
2	5	0.742750		0.998550	0.506363	0.353844
3	7	0.609033	0.998550		0.393390	0.458817
4	10	0.986269	0.506363	0.393390		0.062854
5	15	0.100543	0.353844	0.458817	0.062854	



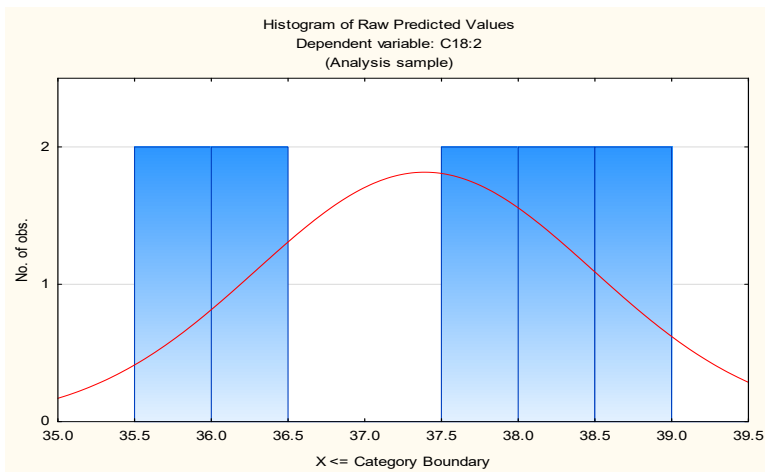
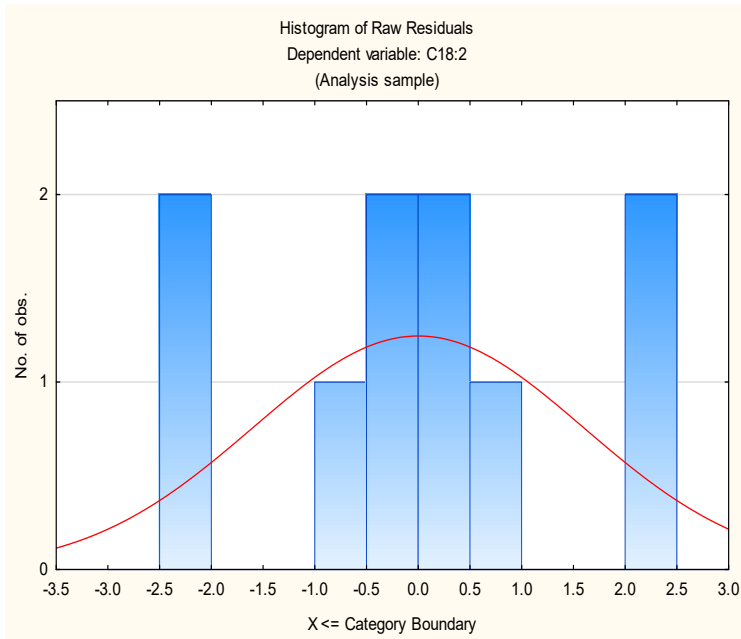


Univariate Tests of Significance for C18:2 (Reaction Time)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	13980.12	1	13980.12	3029.279	0.000000
Reaction Time (min)	10.85	4	2.71	0.588	0.686500
Error	23.08	5	4.62		

Tukey HSD test; variable C18:2 (Reaction Time)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = 4.6150, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
1	3	38.050	0.999426	0.864741	0.994590	0.936311
2	5	0.999426		0.936311	0.972249	0.979340
3	7	0.864741	0.936311		0.690165	0.999426
4	10	0.994590	0.972249	0.690165		0.793289
5	15	0.936311	0.979340	0.999426	0.793289	

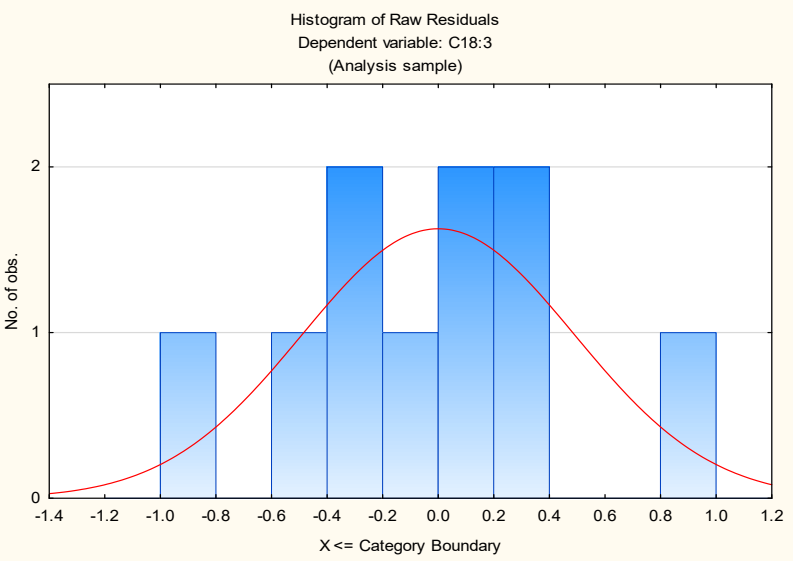
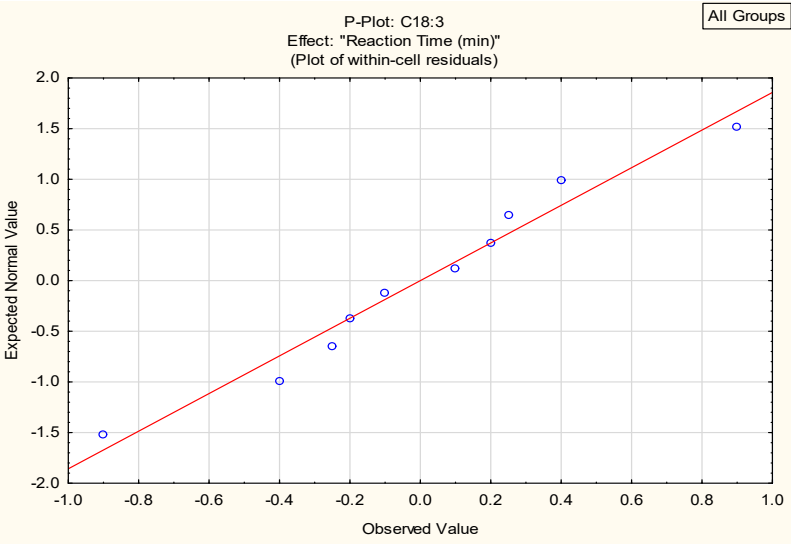
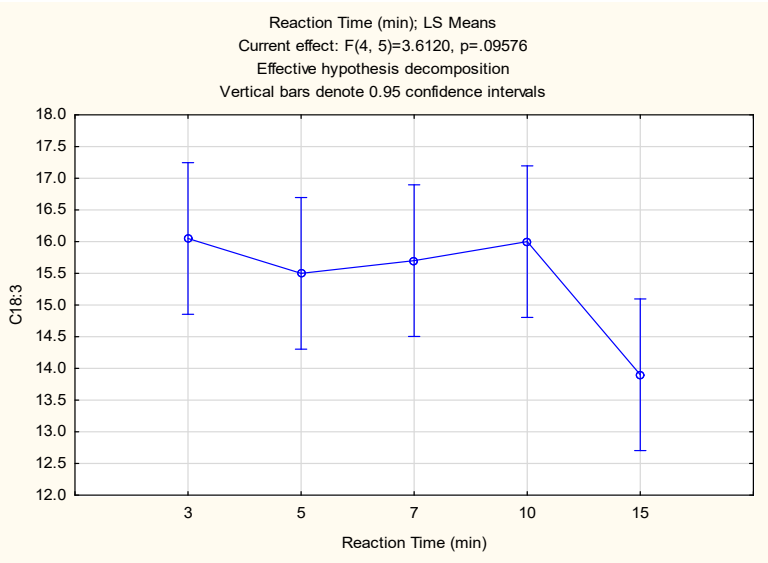


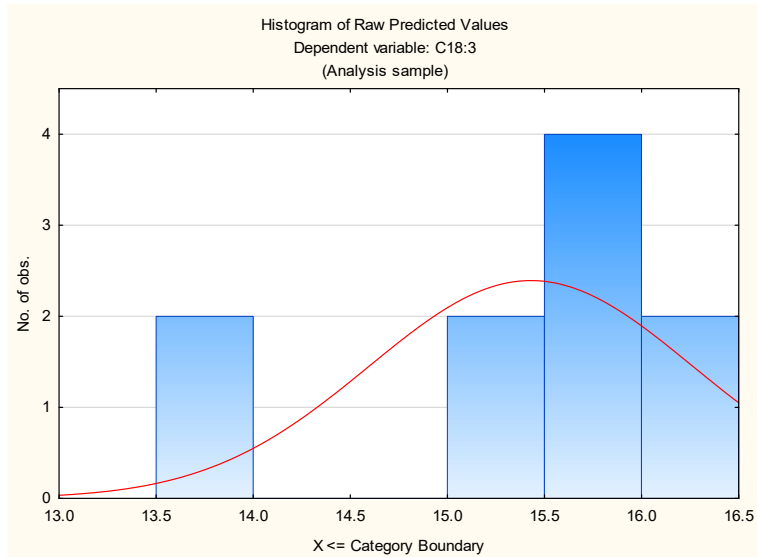




Univariate Tests of Significance for C18:3 (Reaction Time)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	2380.849	1	2380.849	5498.497	0.000000
Reaction Time (min)	6.256	4	1.564	3.612	0.095760
Error	2.165	5	0.433		

Tukey HSD test, variable C18:3 (Reaction Time)						
Approximate Probabilities for Post Hoc Tests						
Error: Between MS = .43300, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
1	3		0.908507	0.979808	0.999990	0.103216
2	5	0.908507		0.997521	0.932092	0.244665
3	7	0.979808	0.997521		0.988464	0.178242
4	10	0.999990	0.932092	0.988464		0.111466
5	15	0.103216	0.244665	0.178242	0.111466	

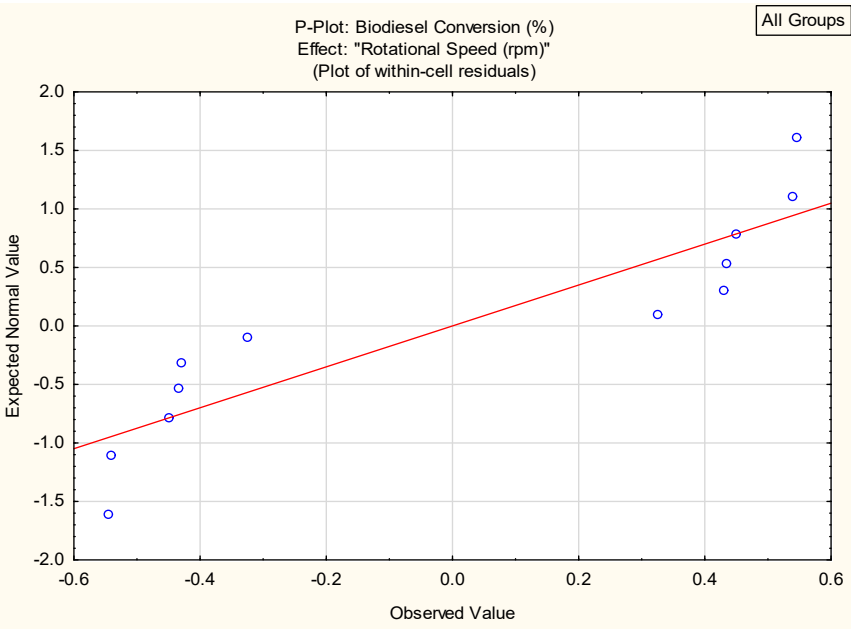
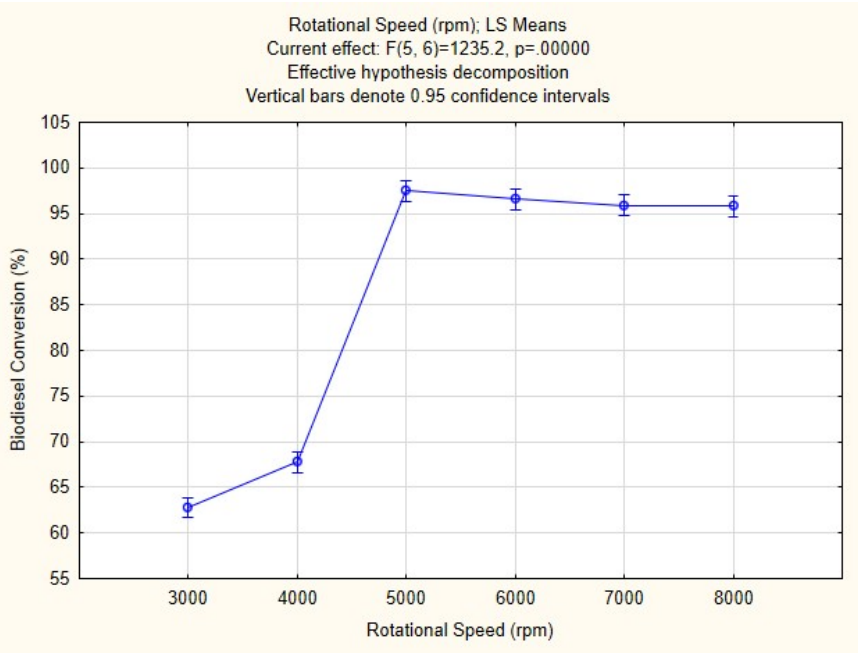


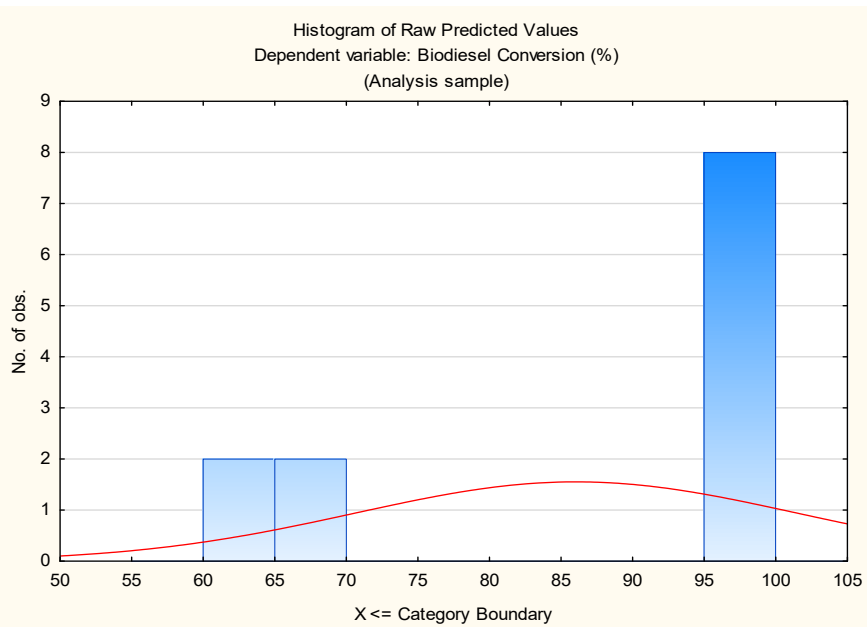
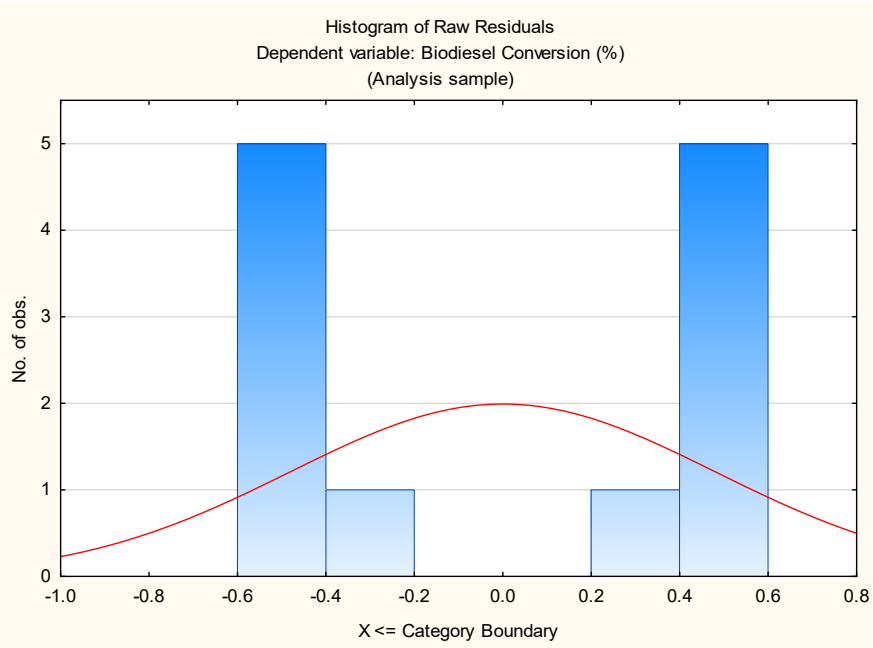


## Effect of Rotational Speed

Univariate Tests of Significance for Biodiesel Conversion (%) (Rotational Speed)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	88860.39	1	88860.39	209761.9	0.000000
Rotational Speed (rpm)	2616.25	5	523.25	1235.2	0.000000
Error	2.54	6	0.42		

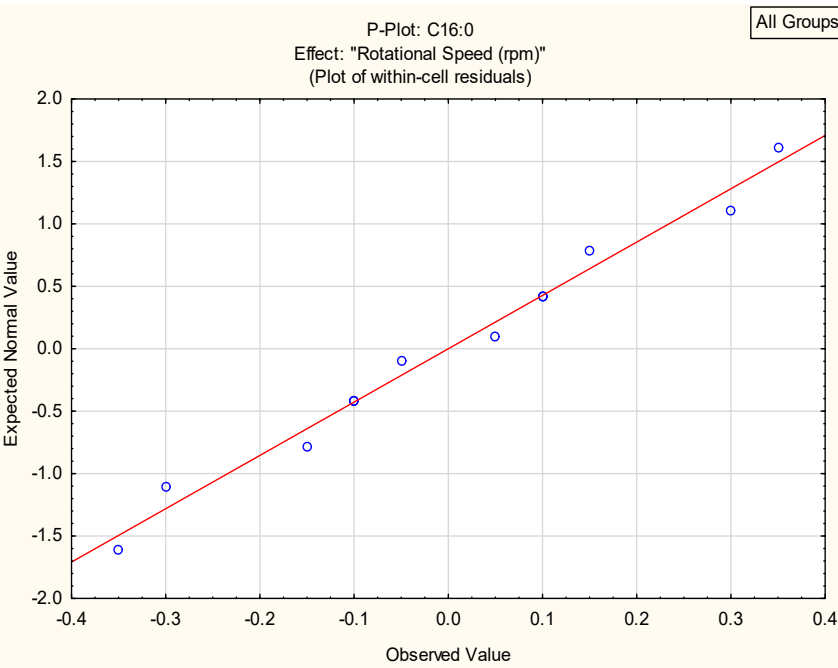
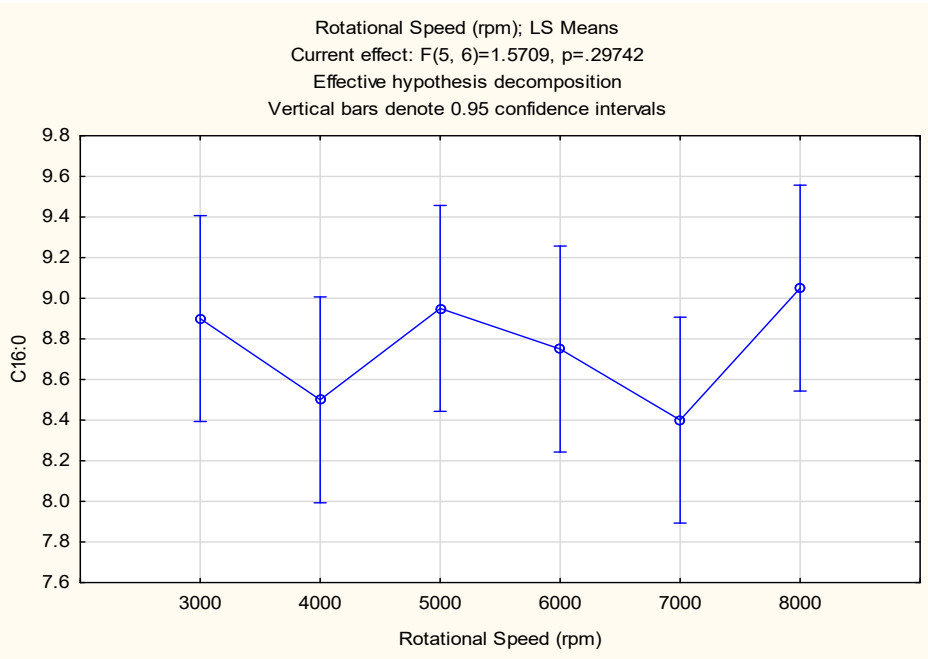
Tukey HSD test; variable Biodiesel Conversion (%) (Rotational Speed)							
Approximate Probabilities for Post Hoc Tests							
Error: Between MS = .42362, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1} 62.795	{2} 67.775	{3} 97.500	{4} 96.560	{5} 95.895	{6} 95.790
1	3000		0.002155	0.000249	0.000249	0.000249	0.000249
2	4000	0.002155		0.000249	0.000249	0.000249	0.000249
3	5000	0.000249	0.000249		0.705821	0.265939	0.222497
4	6000	0.000249	0.000249	0.705821		0.894937	0.830979
5	7000	0.000249	0.000249	0.265939	0.894937		0.999975
6	8000	0.000249	0.000249	0.222497	0.830979	0.999975	

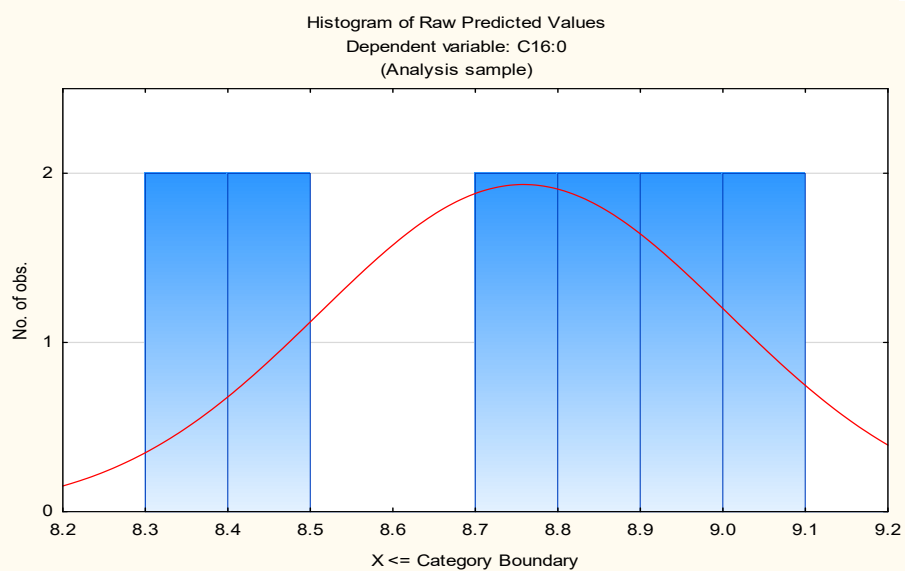
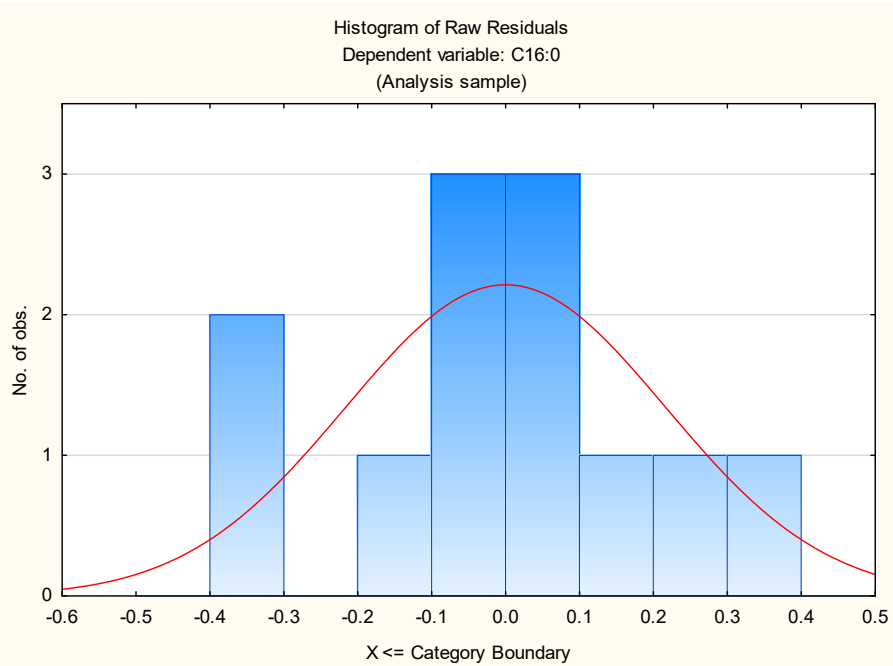




Univariate Tests of Significance for C16:0 (Rotational Speed)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	920.5008	1	920.5008	10724.28	0.000000
Rotational Speed (rpm)	0.6742	5	0.1348	1.57	0.297421
Error	0.5150	6	0.0858		

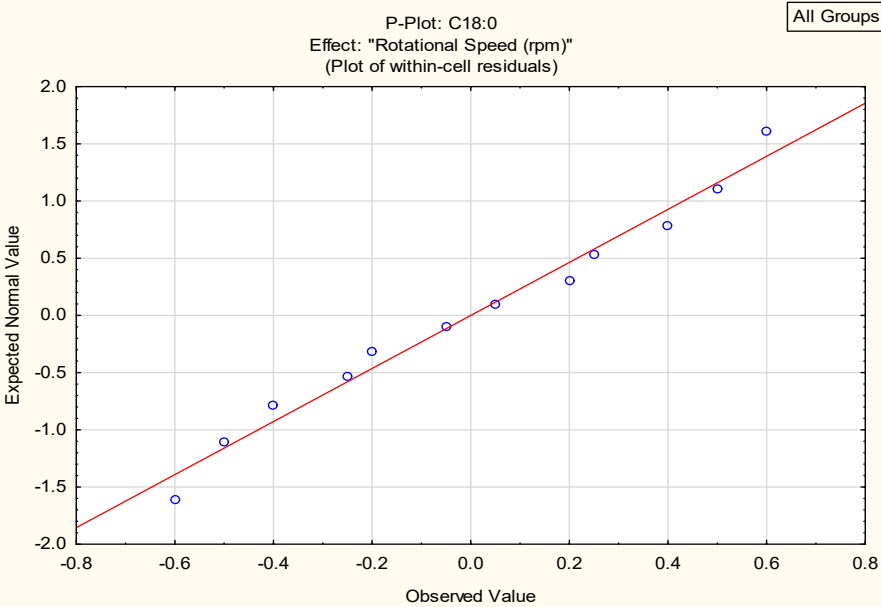
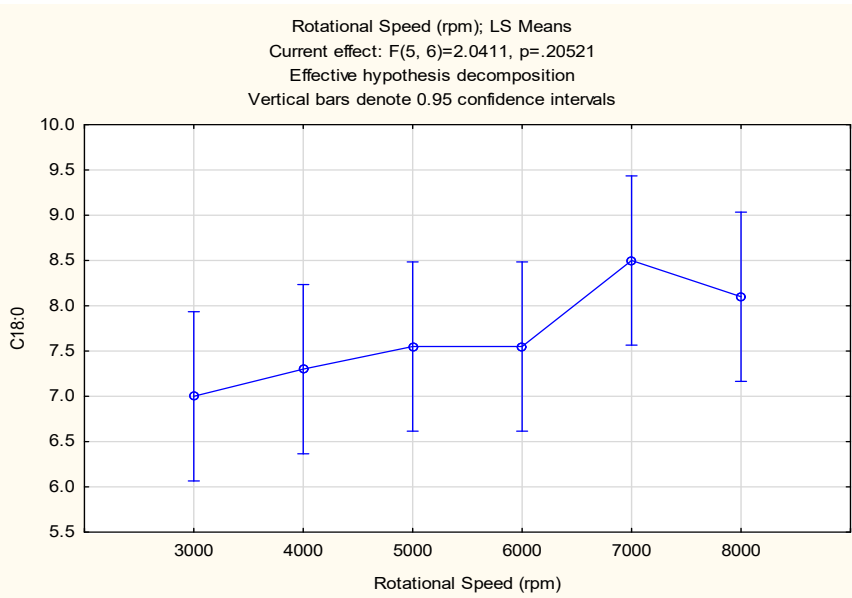
Tukey HSD test; variable C16:0 (Rotational Speed)							
Approximate Probabilities for Post Hoc Tests							
Error: Between MS = .08583, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1}	{2}	{3}	{4}	{5}	{6}
1	3000	8.9000	8.5000	8.9500	8.7500	8.4000	9.0500
2	4000	0.745445	0.745445	0.999968	0.993629	0.572215	0.993629
3	5000	0.999968	0.658935		0.977614	0.489521	0.999047
4	6000	0.993629	0.945272	0.977614		0.825885	0.894138
5	7000	0.572215	0.999047	0.489521	0.825885		0.347072
6	8000	0.993629	0.489521	0.999047	0.894138	0.347072	



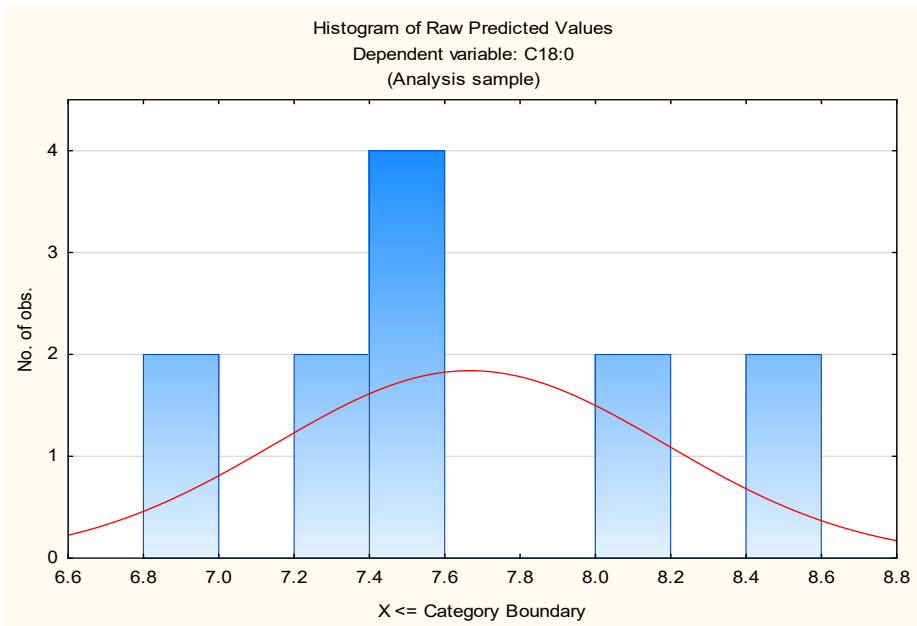
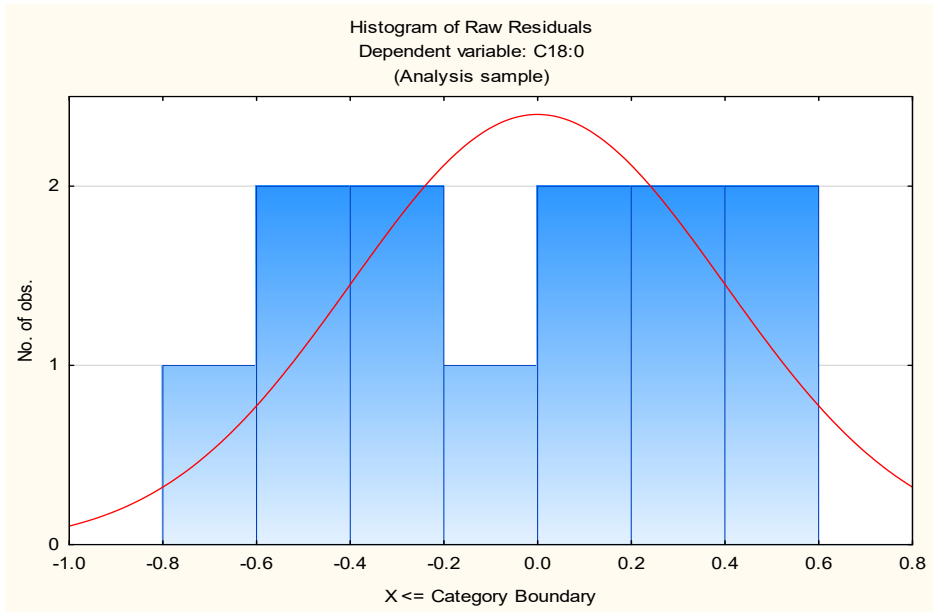


Univariate Tests of Significance for C18:0 (Rotational Speed)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	705.3333	1	705.3333	2418.286	0.000000
Rotational Speed (rpm)	2.9767	5	0.5953	2.041	0.205208
Error	1.7500	6	0.2917		

Tukey HSD test; variable C18:0 (Rotational Speed)							
Approximate Probabilities for Post Hoc Tests							
Error: Between MS = .29167, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1}	{2}	{3}	{4}	{5}	{6}
		7.0000	7.3000	7.5500	7.5500	8.5000	8.1000
1	3000		0.990809	0.896100	0.896100	0.188167	0.418749
2	4000	0.990809		0.995984	0.995984	0.345850	0.686927
3	5000	0.896100	0.995984		1.000000	0.546264	0.896100
4	6000	0.896100	0.995984	1.000000		0.546264	0.896100
5	7000	0.188167	0.345850	0.546264	0.546264		0.968674
6	8000	0.418749	0.686927	0.896100	0.896100	0.968674	

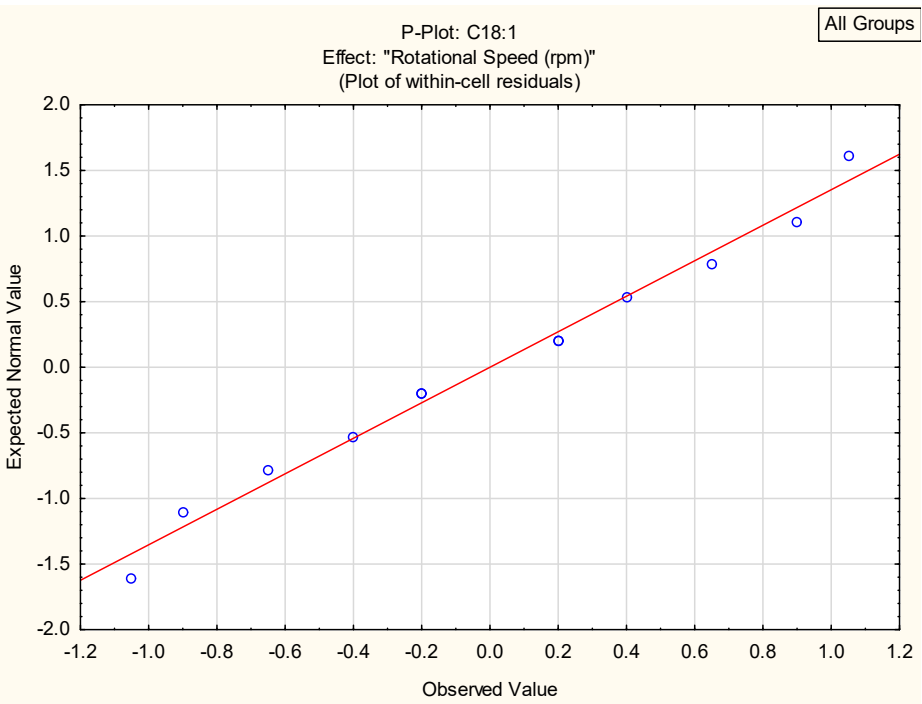
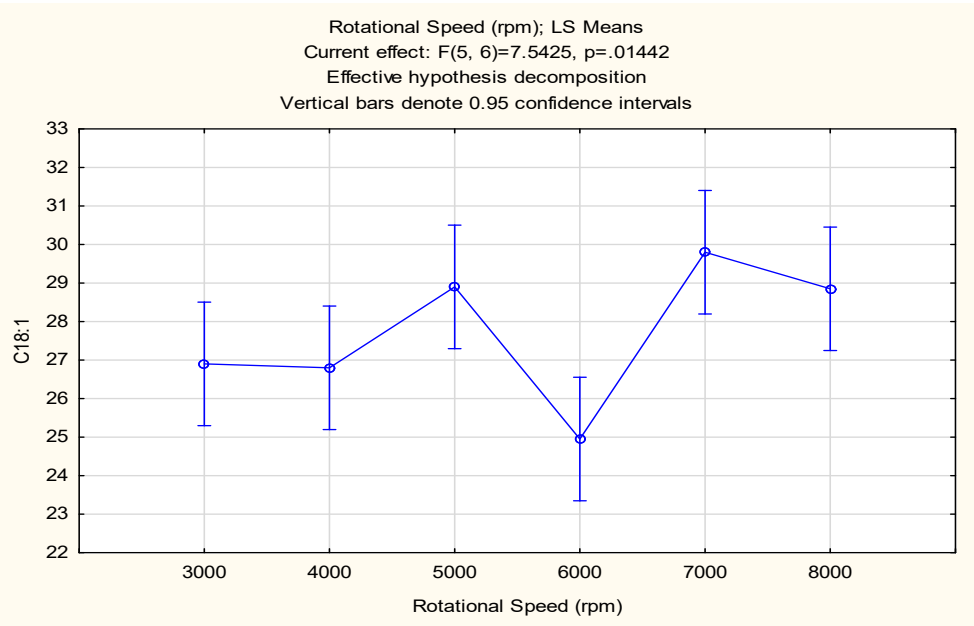


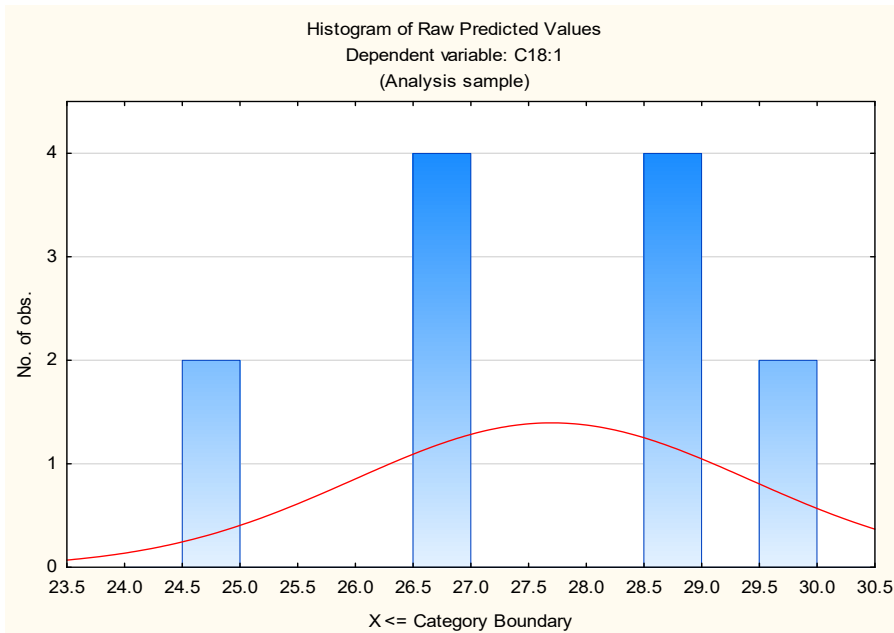
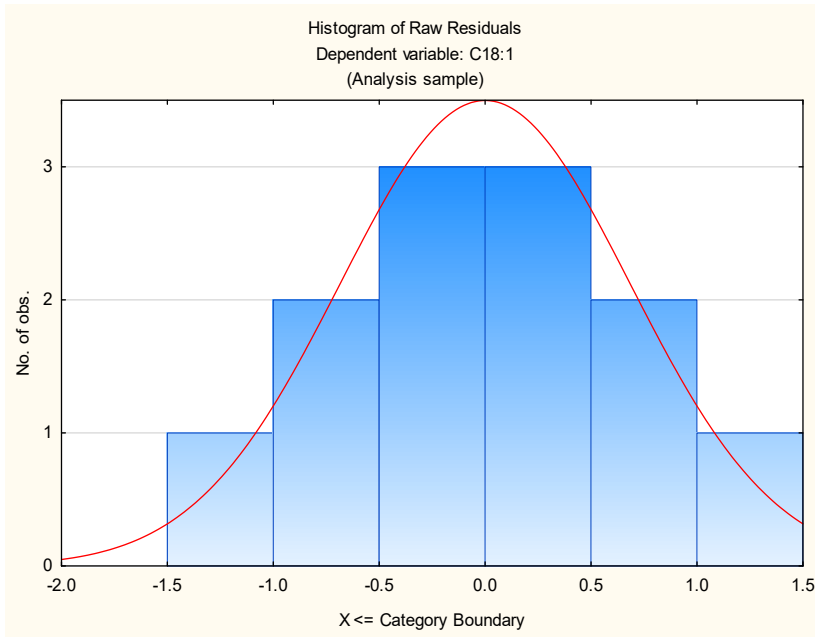




Univariate Tests of Significance for C18:1 (Rotational Speed)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	9207.480	1	9207.480	10727.16	0.000000
Rotational Speed (rpm)	32.370	5	6.474	7.54	0.014424
Error	5.150	6	0.858		

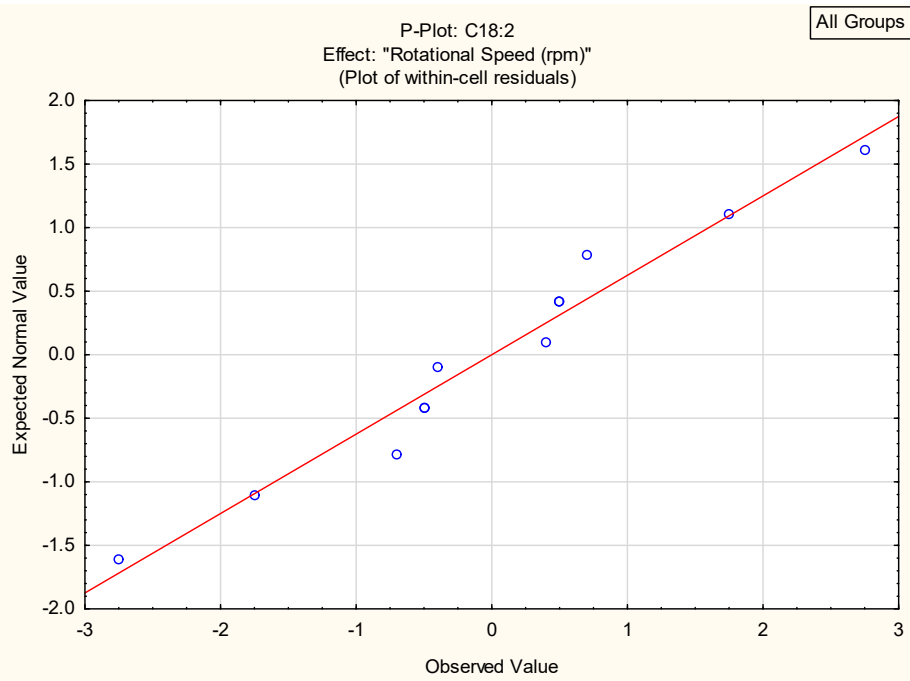
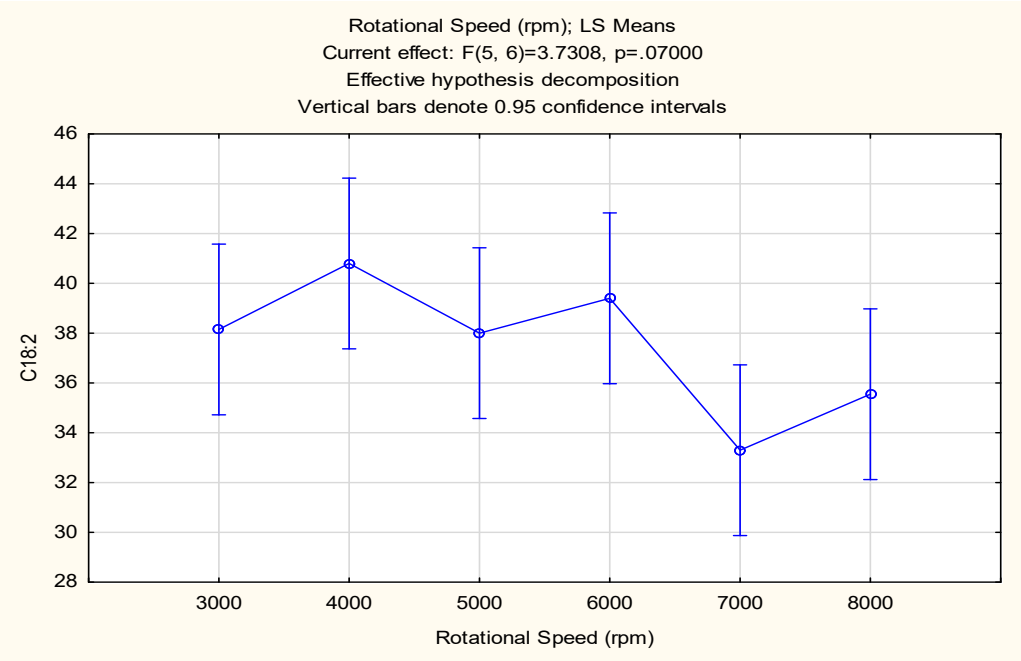
Tukey HSD test; variable C18:1 (Rotational Speed)							
Approximate Probabilities for Post Hoc Tests							
Error: Between MS = .85833, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1} 26.900	{2} 26.800	{3} 28.900	{4} 24.950	{5} 29.800	{6} 28.850
1	3000		0.999997	0.369529	0.390818	0.126724	0.390818
2	4000	0.999997		0.329844	0.435809	0.112335	0.349241
3	5000	0.369529	0.329844		0.037253	0.911860	1.000000
4	6000	0.390818	0.435809	0.037253		0.014482	0.039381
5	7000	0.126724	0.112335	0.911860	0.014482		0.893635
6	8000	0.390818	0.349241	1.000000	0.039381	0.893635	

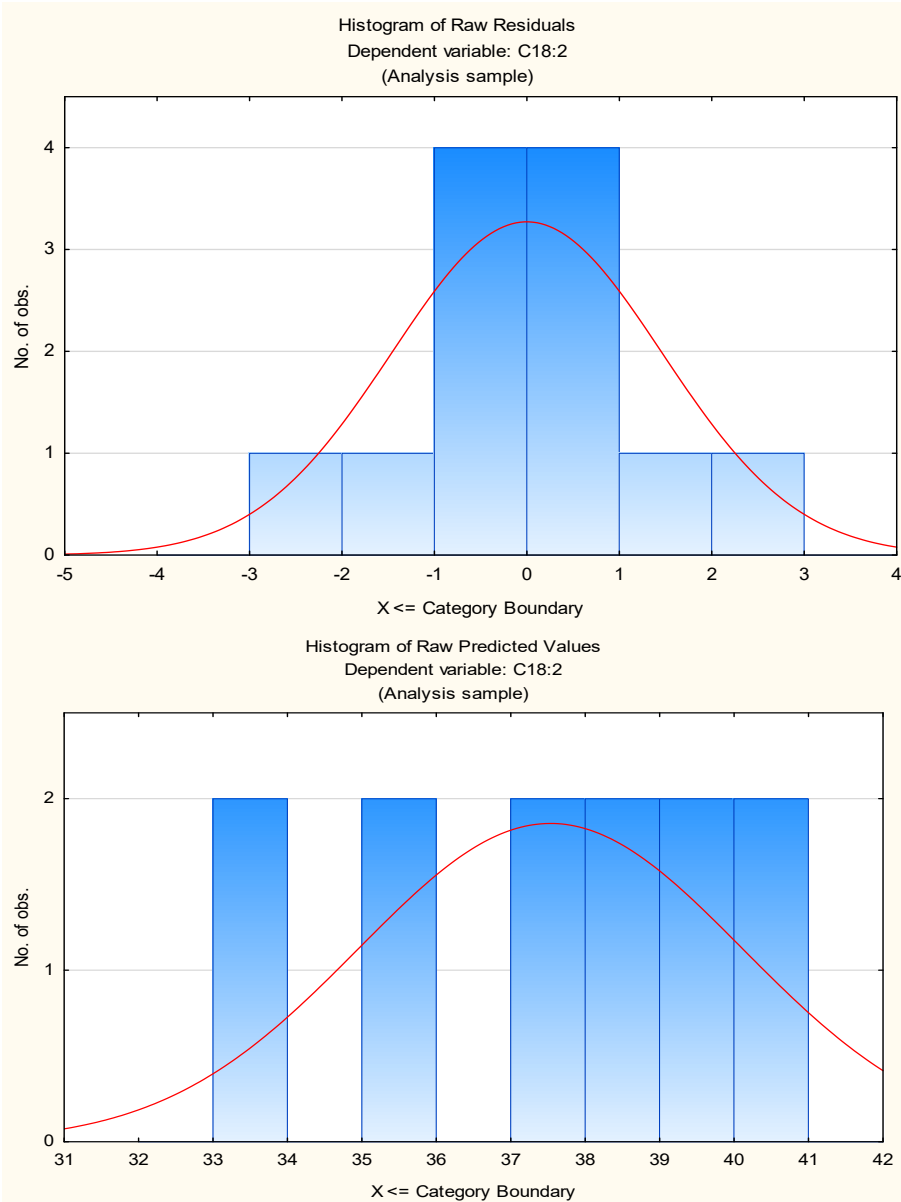




Univariate Tests of Significance for C18:2 (Rotational Speed)					
Sigma-restricted parameterization					
Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	16905.01	1	16905.01	4307.010	0.000000
Rotational Speed (rpm)	73.22	5	14.64	3.731	0.070002
Error	23.55	6	3.93		

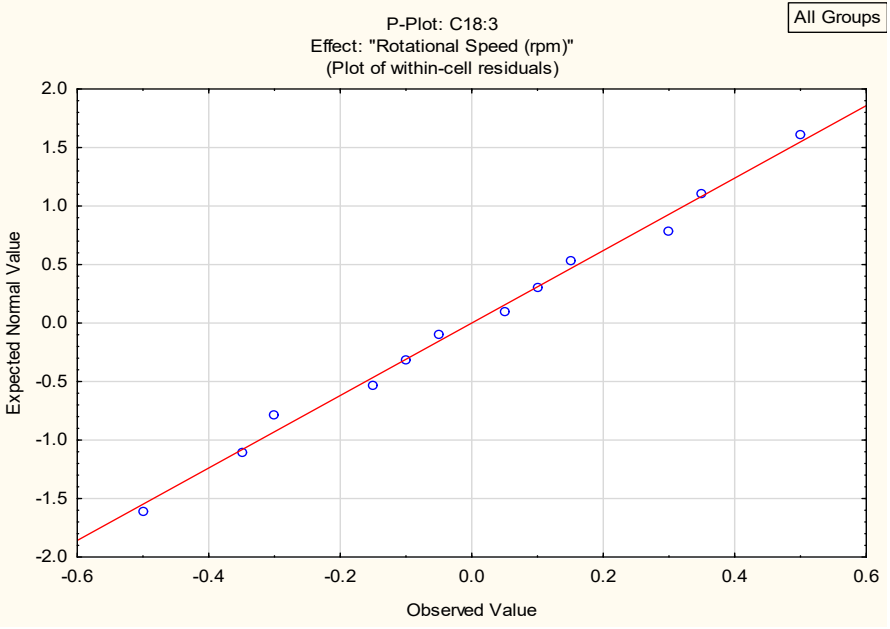
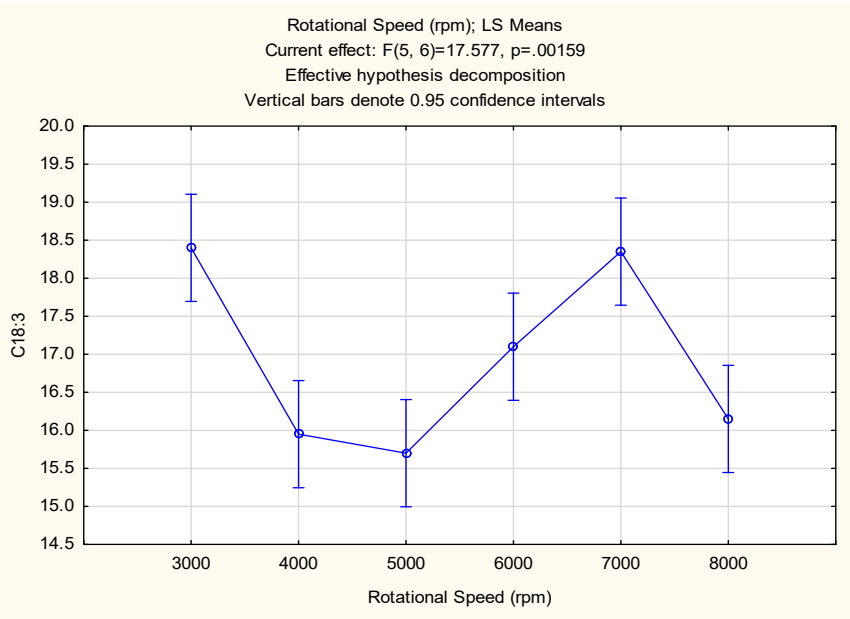
Tukey HSD test; variable C18:2 (Rotational Speed)							
Approximate Probabilities for Post Hoc Tests							
Error: Between MS = 3.9250, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1}	{2}	{3}	{4}	{5}	{6}
		38.150	40.800	38.000	39.400	33.300	35.550
1	3000		0.759082	0.999999	0.983977	0.271199	0.771341
2	4000	0.759082		0.721455	0.974159	0.061602	0.216954
3	5000	0.999999	0.721455		0.974159	0.294478	0.806988
4	6000	0.983977	0.974159	0.974159		0.134194	0.459381
5	7000	0.271199	0.061602	0.294478	0.134194		0.851126
6	8000	0.771341	0.216954	0.806988	0.459381	0.851126	



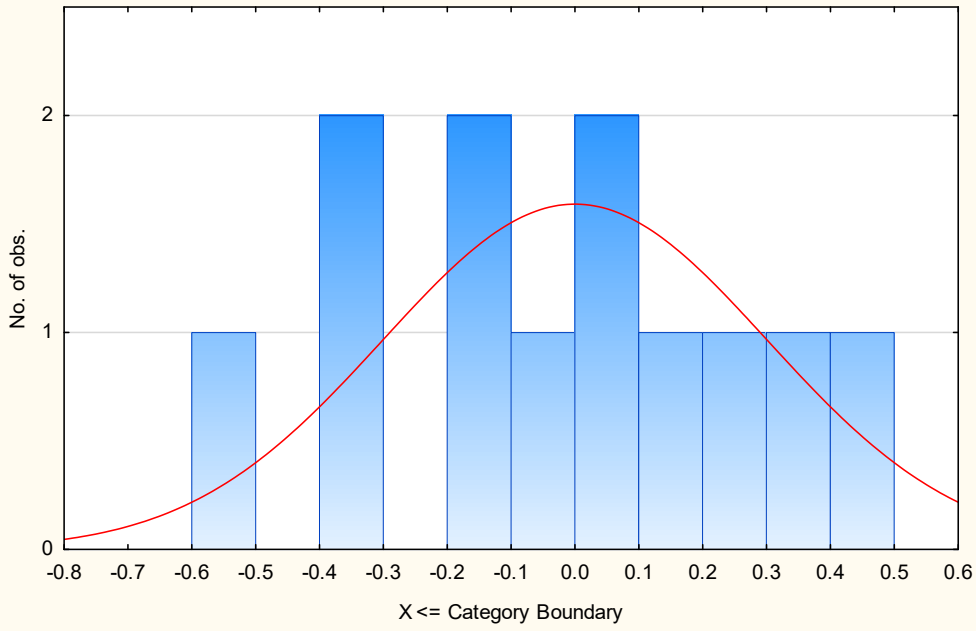


Univariate Tests of Significance for C18:3 (Rotational Speed) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	3444.241	1	3444.241	20769.29	0.000000
Rotational Speed (rpm)	14.574	5	2.915	17.58	0.001591
Error	0.995	6	0.166		

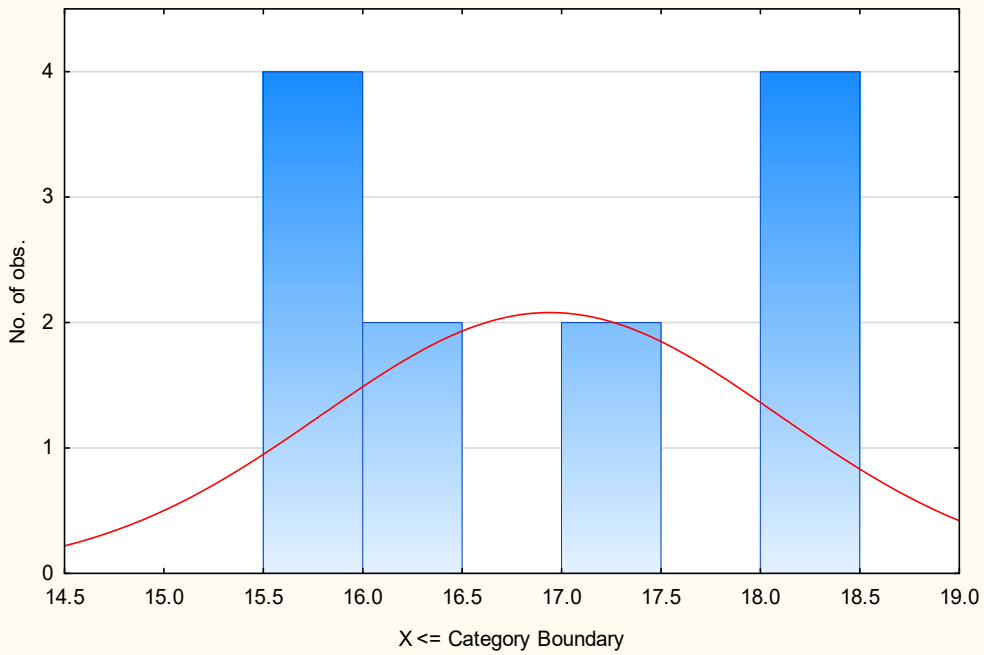
Tukey HSD test, variable C18:3 (Rotational Speed)							
Approximate Probabilities for Post Hoc Tests							
Error: Between MS = .16583, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1}	{2}	{3}	{4}	{5}	{6}
1	3000						
2	4000	0.007304	0.007304	0.004472	0.118222	0.999994	0.011140
3	5000	0.004472	0.985756		0.089995	0.004917	0.863595
4	6000	0.118222	0.178615	0.089995		0.135623	0.307301
5	7000	0.999994	0.008097	0.004917	0.135623		0.012433
6	8000	0.011140	0.994728	0.863595	0.307301	0.012433	



Histogram of Raw Residuals  
Dependent variable: C18:3  
(Analysis sample)



Histogram of Raw Predicted Values  
Dependent variable: C18:3  
(Analysis sample)



**Table 2.** ANOVA and Tukey post hoc test for cetane number of the CCD-assisted DT rubber seed. Significance values below  $\alpha < 0.05$  are colour coded in red.

Univariate Tests of Significance for Cetane Number (CN - Ratio) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	34645.00	1	34645.00	8056.976	0.000000
Ratio Seed : Methanol	98.12	4	24.53	5.705	0.041778
Error	21.50	5	4.30		

Tukey HSD test; variable Cetane Number (CN - Ratio) Approximate Probabilities for Post Hoc Tests Error: Between MS = 4.3000, df = 5.0000						
Cell No.	Ratio Seed : Methanol	{1}	{2}	{3}	{4}	{5}
1	1:2	57.350	0.953852	0.942061	0.072980	1.000000
2	1:3	0.953852		0.653769	0.038767	0.959164
3	1:1	0.942061	0.653769		0.151287	0.935570
4	1:4	0.072980	0.038767	0.151287		0.071289
5	1:5	1.000000	0.959164	0.935570	0.071289	

Univariate Tests of Significance for Cetane Number (Spreadsheet14) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	25821.28	1	25821.28	1516.780	0.000003
Catalyst Concentration (wt./v,%)	39.67	3	13.22	0.777	0.564931
Error	68.10	4	17.02		

Tukey HSD test; variable Cetane Number (Spreadsheet14) Approximate Probabilities for Post Hoc Tests Error: Between MS = 17.024, df = 4.0000					
Cell No.	Catalyst Concentration (wt./v,%)	{1}	{2}	{3}	{4}
1	1	56.300	0.846728	0.983145	0.904667
2	3	0.846728		0.964020	0.523041
3	5	0.983145	0.964020		0.749775
4	7	0.904667	0.523041	0.749775	

Univariate Tests of Significance for Cetane Number (Spreadsheet39) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	39350.53	1	39350.53	2629.504	0.000000
Reaction Time (min)	463.68	4	115.92	7.746	0.022689
Error	74.82	5	14.96		



Tukey HSD test; variable Cetane Number (Spreadsheet39) Approximate Probabilities for Post Hoc Tests Error: Between MS = 14.965, df = 5.0000						
Cell No.	Reaction Time (min)	{1}	{2}	{3}	{4}	{5}
		58.300	74.850	55.700	65.200	59.600
1	3		0.039250	0.954542	0.468595	0.996357
2	5	0.039250		0.021974	0.229100	0.053463
3	7	0.954542	0.021974		0.238578	0.842350
4	10	0.468595	0.229100	0.238578		0.628969
5	15	0.996357	0.053463	0.842350	0.628969	

Univariate Tests of Significance for Cetane Number (Spreadsheet52) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	39560.08	1	39560.08	10610.66	0.000000
Rotational Speed (rpm)	77.35	5	15.47	4.15	0.056259
Error	22.37	6	3.73		

Tukey HSD test; variable Cetane Number (Spreadsheet52) Approximate Probabilities for Post Hoc Tests Error: Between MS = 3.7283, df = 6.0000							
Cell No.	Rotational Speed (rpm)	{1}	{2}	{3}	{4}	{5}	{6}
		60.350	61.050	55.700	53.800	57.000	56.600
1	3000		0.998731	0.283238	0.094652	0.558141	0.459916
2	4000	0.998731		0.189586	0.063685	0.393751	0.316750
3	5000	0.283238	0.189586		0.907778	0.978875	0.995855
4	6000	0.094652	0.063685	0.907778		0.597032	0.702830
5	7000	0.558141	0.393751	0.978875	0.597032		0.999916
6	8000	0.459916	0.316750	0.995855	0.702830	0.999916	