

APPENDICS

APPENDIX A

Physical properties of ethanol, palm oil and rice-bran oil

Table A.1 Specification of Ethanol.

Chemical properties	
Chemical Formula	$\text{CH}_3\text{CH}_2\text{OH}$
Molecular Weight	46.07
Weight of 1 Gallon	6.59 lbs (100% / 200 proof)
	6.80 lbs (95% / 190 proof)
Density in Grams / cm ³	0.791 (100%)

Table A.2 Specification of Palm Oil.

Chemical properties	%
Moisture (%w/w)	0.02
Acid value (mg KOH/g)	6.9
Lauric acid	0-0.4
Myristic acid	0.6-1.6
Palmitic acid	41-47
Palmitoleic acid	0-0.6
Stearic acid	3.7-5.6
Oleic acid	38.2-43.5
Linoleic acid	6.6-11.9
Linolenic acid	0-0.5
Arachidic acid	0-0.8
Mean molecular weight (g)	847.3
Unsaturated fatty acids (%)	44.8-57.3
Saturated fatty acid (%)	45.3-55.4

Table A.3 Specification of Rice Bran Oil.

Chemical properties	Quantity
Iodine Value	99 – 108
Peroxide Value (mcg/kg)	1.0 max
Moisture (%)	0.05 max
Color (5 ¼" Lovibond red)	3.5 max
Free Fatty Acid (% as Oleic)	0.1 max
Flavor/Odor	7 min
Chlorophyll (ppb)	75 max
Saponification Value	180 – 190
Unsaponifiable matter	3 – 5
Smoke Point	213 C
Refractive Index	1.470 – 1.473
Specific Gravity	0.916
Saponifiable Lipids	90 – 96%
Neutral Lipids	88 – 89%
Triglycerides	83 – 86%
Diglycerides	3 – 4%
Monoglycerides	6 – 7%
Free Fatty Acids	2 – 4%
Waxes	3 – 4%
Glycolipids	6 – 7%
Phospholipids	4 – 5%
Unsaponifiable Lipids	4.2%
Phytosterols	43%
Sterolsters	10%
Triterpene Alcohols	28%
Hydrocarbons	18%

Table A.4 Comparative Fatty Acid Compositions and Oxidative Stability of Rice Bran Oil.

Fatty acid	%
Palmitic C16:0	14.0%
Stearic C18:0	2.0%
Oleic C18:1	45.0%
Linoleic C18:2	34.0%
Linolenic C18:3	1.5%

APPENDIX B

Calculation of reactants

The example of calculation shown below is for molar ratio of palm oil in ethanol equal to 1 in 50. The volume of reactor used for all preparation was 5 ml.

Base on the molecular weight of palm oil and ethanol is 847.3 and 46.069 respectively. The density of ethanol and palm oil is 0.79 and 1.092 g/ml respectively.

$$1. \text{ Molar ratio of palm oil and ethanol} \quad \frac{N_{oil}}{N_{ethanol}} = \frac{1}{50}$$

$$N_{oil} = \frac{N_{ethanol}}{50}$$

$$2. \text{ Ethanol volume} \quad \frac{MW_{oil} N_{oil}}{\rho_{oil}} + \frac{MW_{ethanol} N_{ethanol}}{\rho_{ethanol}} = 5$$

$$\frac{847.3(N_{ethanol})}{50(\rho_{oil})} + \frac{46.07(N_{ethanol})}{0.79} = 5$$

$$N_{ethanol} = 0.067719$$

$$V_{ethanol} = \frac{(46.07)(0.067719)}{0.79}$$

$$V_{ethanol} = 3.95 \text{ ml}$$

$$3. \text{ Palm oil volume} \quad 5 - 3.95 = 1.09 \text{ ml}$$

APPENDIX C

GC collecting raw data

Table C.1 GC collecting raw data of transesterification reaction of palm oil.

Conditions	Area, %		
	Esters	Glycerine	Ethanol
350°C, 120s, 1:50	0.98204	0.69553	97.49825
350°C, 120s, 1:40	0.76469	0.59998	97.69723
350°C, 120s, 1:30	0.64555	0.51149	98.07359
350°C, 120s, 1:20	0.31729	0.24108	98.81202
350°C, 120s, 1:10	0.2646	0.20193	98.55421
350°C, 360s, 1:50	5.64552	3.80105	88.32698
350°C, 300s, 1:50	4.13212	2.88705	90.44806
350°C, 240s, 1:50	2.72578	1.9553	93.55836
350°C, 180s, 1:50	3.08182	2.15527	92.93493
250°C, 1:50, 30s	0.17517	0.13008	99.6151
250°C, 1:50, 60s	0.04978	0.0361	99.84071
250°C, 1:50, 120s	0.02328	0.01824	99.71023
250°C, 1:50, 240s	0.03091	0.0246	99.82049
280°C, 1:50, 30s	0.02144	0.01693	99.83563
280°C, 1:50, 60s	0.03107	0.02173	99.73826
280°C, 1:50, 120s	0.05603	0.04336	99.62375
280°C, 1:50, 240s	0.16811	0.1279	99.13086
310°C, 1:50, 30s	0.09786	0.07497	99.55616
310°C, 1:50, 60s	0.17977	0.14146	99.38446
310°C, 1:50, 120s	0.24041	0.18021	99.22914
310°C, 1:50, 240s	0.47555	0.36337	98.71023
350°C, 1:50, 30s	0.43238	0.31968	98.65094
350°C, 1:50, 60s	0.62081	0.4659	98.13341

Table C.2 GC collecting raw data of transesterification reaction of rice-bran oil.

Conditions	Area, %		
	Esters	Glycerine	Ethanol
350°C, 120s, 1:50	3.15539	0.00	95.79416
350°C, 120s, 1:40	2.65321	0.00	96.16439
350°C, 120s, 1:30	2.81637	0.00	95.83946
350°C, 120s, 1:20	2.73381	0.00	95.35273
350°C, 120s, 1:10	4.30861	0.00	95.53213
350°C, 360s, 1:50	6.60463	0.00	93.39537
350°C, 240s, 1:50	5.63518	0.00	94.35142
350°C, 180s, 1:50	3.67726	0.00	96.22414
250°C, 1:50, 30s	0.08227	0.00	99.91726
250°C, 1:50, 60s	0.07102	0.00	99.92898
250°C, 1:50, 120s	0.12905	0.00	99.87096
250°C, 1:50, 240s	0.15593	0.00	99.84407
280°C, 1:50, 30s	0.09723	0.00	99.90277
280°C, 1:50, 60s	0.27973	0.00	99.72027
280°C, 1:50, 120s	0.2058	0.00	99.7942
280°C, 1:50, 240s	0.46186	0.00	99.53814
310°C, 1:50, 30s	0.90733	0.00	99.09267
310°C, 1:50, 60s	0.48264	0.00	99.51736
310°C, 1:50, 120s	0.60566	0.00	99.39434
310°C, 1:50, 240s	1.5524	0.00	98.43265
350°C, 1:50, 30s	1.44157	0.00	98.55843
350°C, 1:50, 60s	1.32586	0.00	98.6734