Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supplementary information

Current advances and future outlook of heterogeneous catalytic transesterification towards biodiesel production from waste cooking oil

Nabanita Ghosh[1], Mehulee Patra[1], Gopinath Halder*[1]

[1]Department of Chemical Engineering, National Institute of Technology Durgapur, Durgapur-713209, West Bengal, India

*Corresponding Author: Prof. Gopinath Halder

E-mail address: gopinath.halder@che.nitdgp.ac.in

Ms. Nabanita Ghosh

E-mail address: ng.21ch1102@phd.nitdgp.ac.in

Ms. Mehulee Patra

E-mail address: mp.20u10808@btech.nitdgp.ac.in

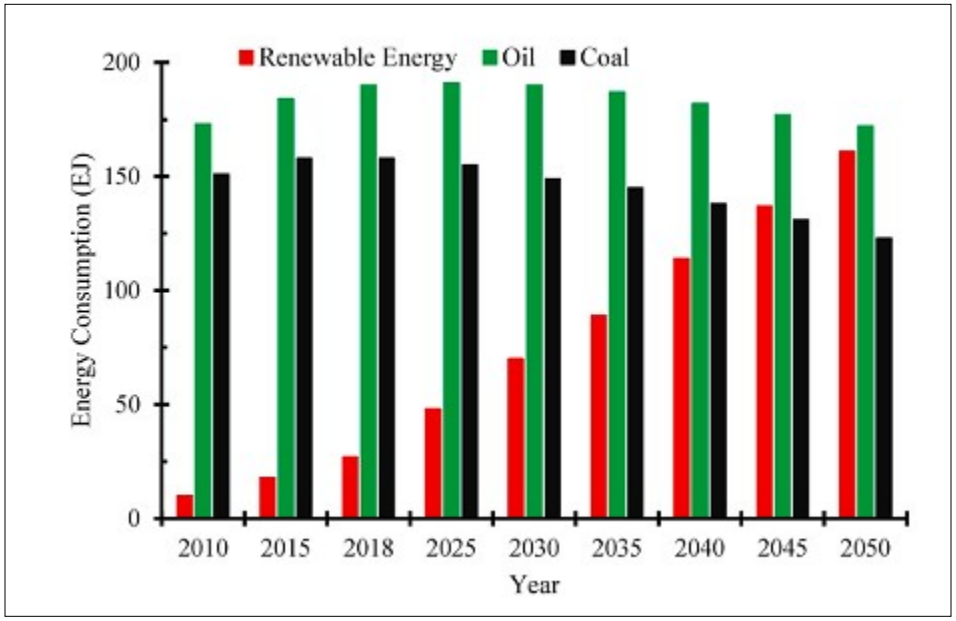

Fig. S1. Global coal, oil, and renewable energy (EJ) consumption and forecast to 2050. Reprinted figure with permission from [5]. Copyright (2021) Elsevier.

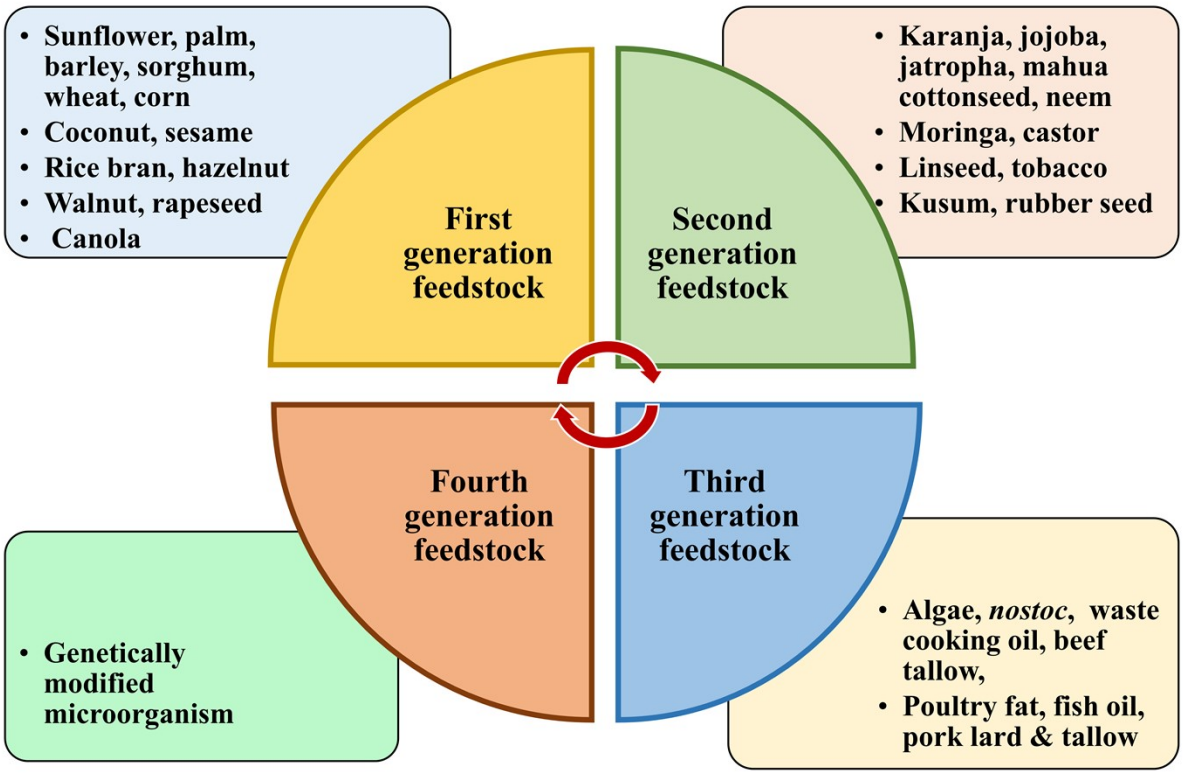

Fig. S2. Classification of feedstocks for the production of biodiesel.

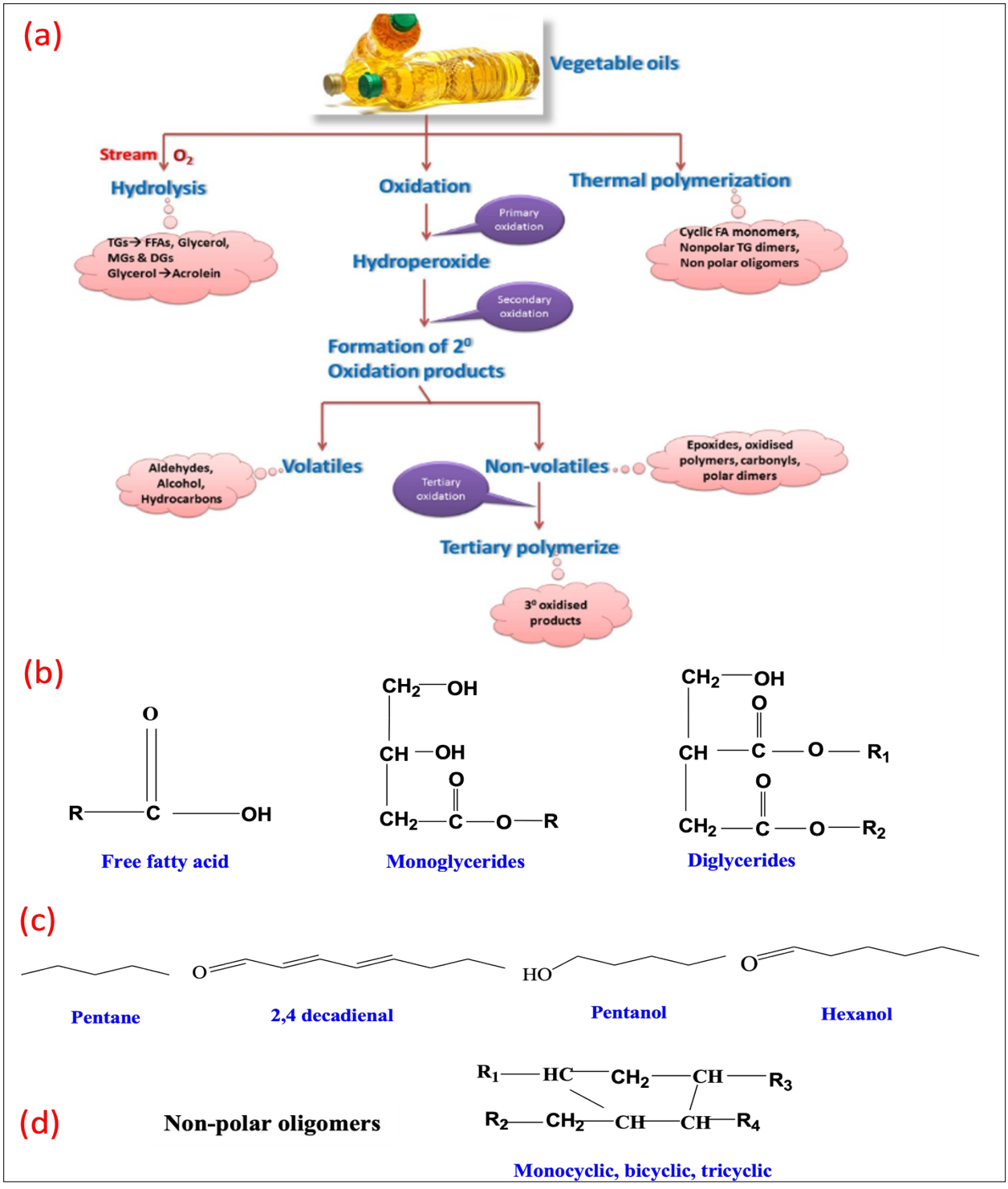

Fig S3. (a) Main events and products formed during the deep-frying of food at high temperature. Reprinted figure with permission from [31]. Copyright (2021) ACS, **(b)** Hydrolysis reaction, **(c)** Oxidation reaction, and **(d)** Polymerisation reaction of Waste cooking oil.

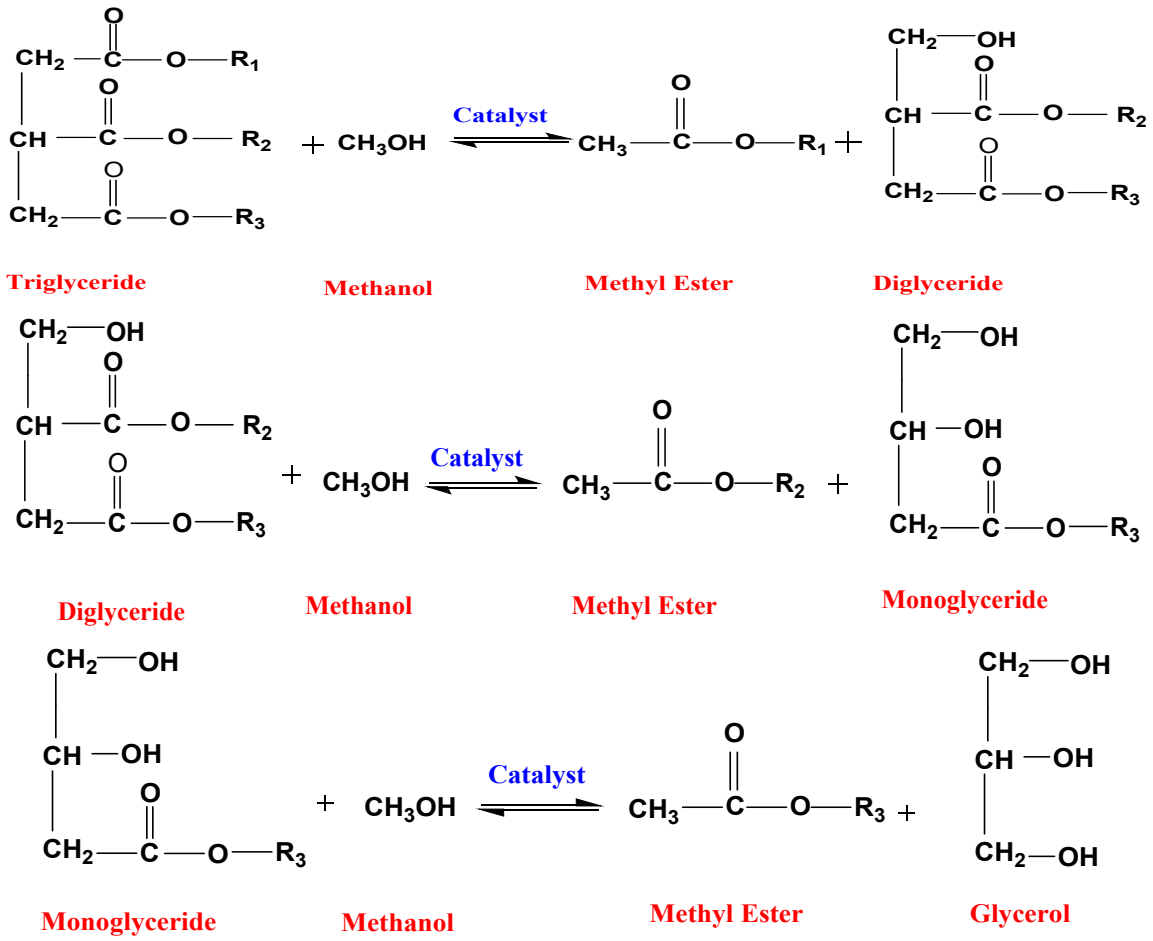

Fig. S4. Stoichiometric representation of individual steps of catalytic transesterification reaction mechanism. Reprinted figure with permission from [70]. Copyright (2022) Elsevier

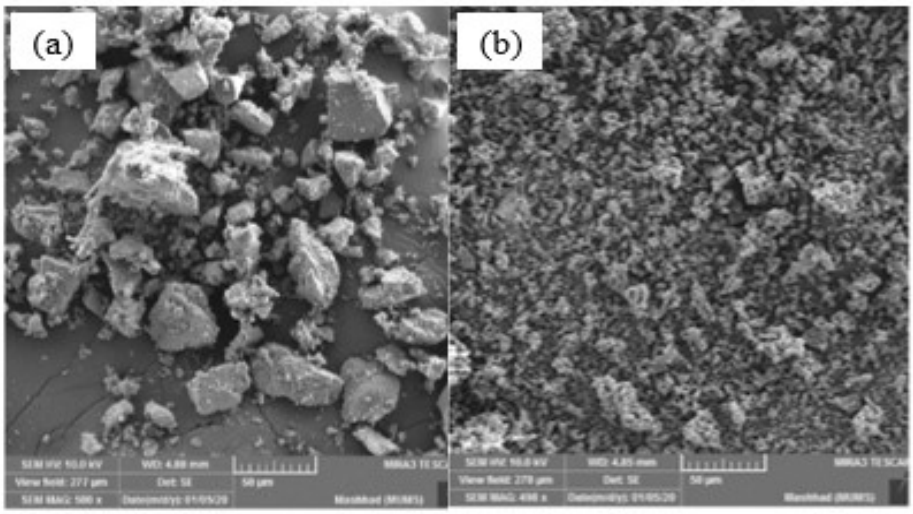

Fig. S5. FE-SEM image of raw chicken eggshells at different magnifications **(a)** and calcined chicken eggshells **(b)**. Reprinted figure with permission from [131]. Copyright (2022) Elsevier

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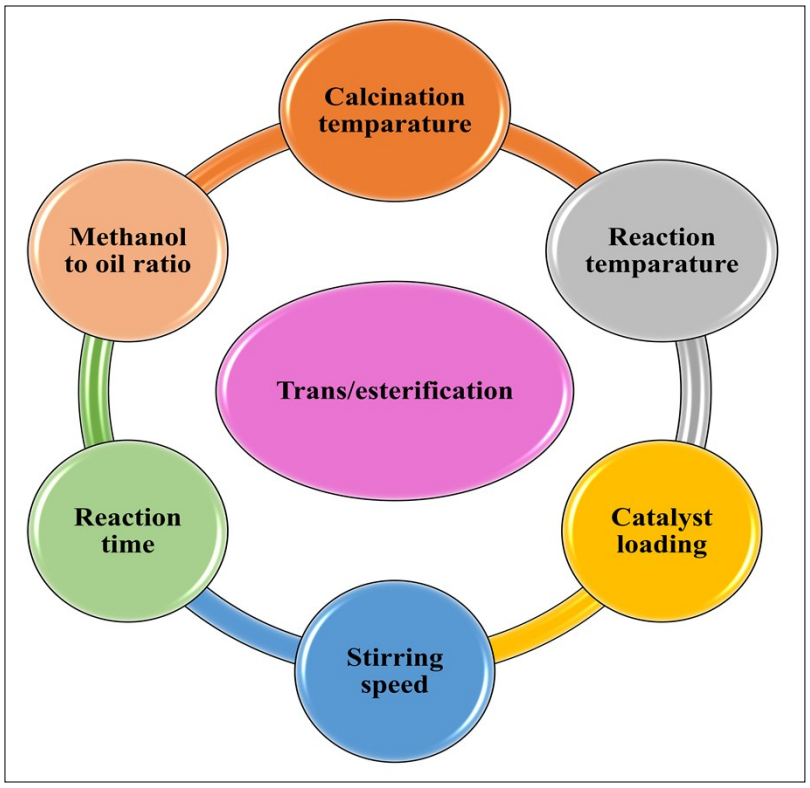

Fig. S6. Factors affecting Trans/esterification reaction.

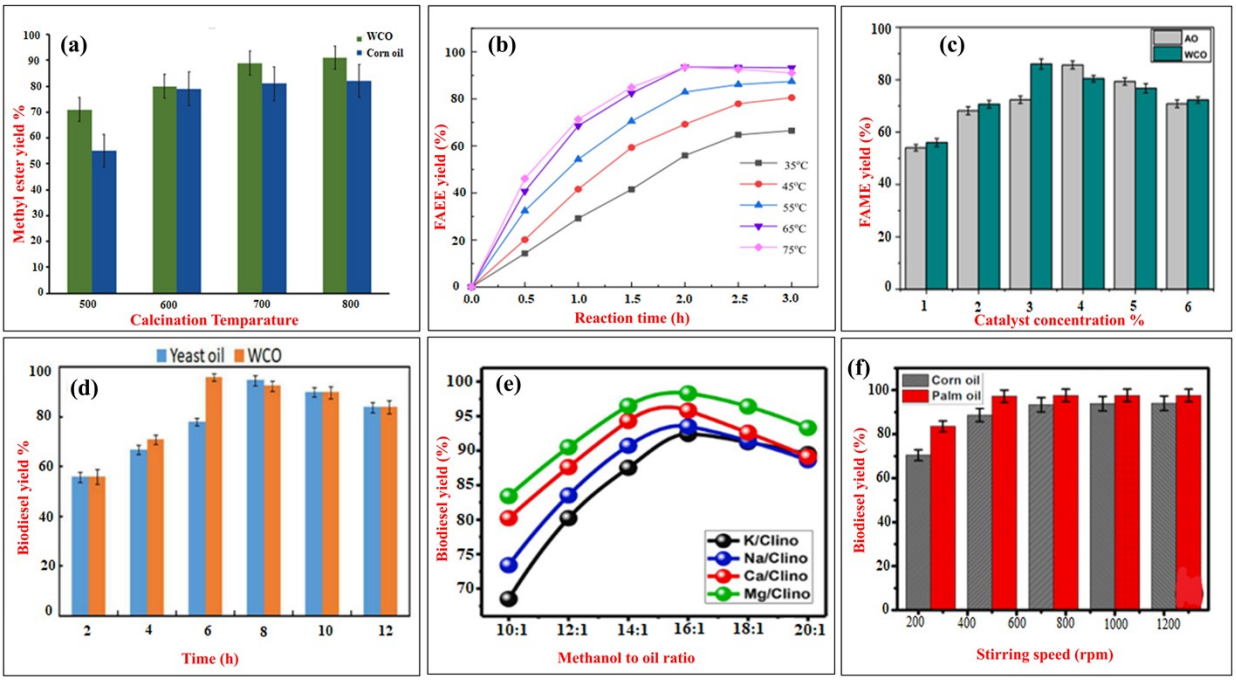

Fig. S7. Effect of (a) calcination temperature [183], (b) reaction temperature [180], (c) catalyst concentration [185], (d) reaction time [190], (e) methanol to oil ratio [195], (f) stirring speed [196]on biodiesel production.

Table S1 Characteristics of Waste cooking oil used in the production of biodiesel

Feedstock	Viscosity (mm^2/s) at 40 °C	Density (g/ml)	Acid value (mg KOH/g oil)	Kinematic viscosity at 40°C (mm^2/s)	Free fatty acid value %	Saponification value (mg KOH/g oil)	Flash point (°C)	Ref
Waste cooking oil	68.21	0.9062	1.53	-	-	204.6	-	[330]
Waste cooking oil	-	0.916	35.4	-	18	234.71	-	[347]
Waste palm oil	29.92 ± 0.62	900 ± 2.21	1.88 ± 0.45	-	1.10 ± 0.056	188 ± 0.62	-	[348]
Waste sunflower oil	-	0.920	-	41.34	0.06	193	-	[177]
Waste cooking oil	4.76	0.82	35.9	-	17.95	147.2	-	[178]
Waste cooking oil	4.54	0.91	3.75	-	-	194.4	-	[191]
Waste cooking oil	-	0.920	-	33	17.5	173	-	[349]
Waste frying oil	35.06	0.896	1.948	-	0.974	-	-	[200]
Waste frying oil	32.6	0.9258	5.78	-	2.9	-	-	[201]
Waste cooking oil	-	0.905	0.7-0.8	31	3	-	240	[350]
Waste cooking oil	-	0.944	1.41	18	-	200.33	-	[153]
Waste date seed oil	23.56	0.92	20	-	-	236	-	[164]
Waste palm oil	32	0.902	1.9	-	1	201.5	-	[351]

Waste cooking oil	88.6	0.92	1.25	-	-	197	-	[215]
Waste cooking oil	58.31	0.920	3.08	63.38	1.54	-	-	[37]
Waste animal tallow	-	0.95	9.38	46	4.3	-	235	[219]
Waste cooking oil	4.54	0.91	3.75	-	-	194.4	-	[191]
Waste cooking oil	31.524 (± 0.012)	0.908 (± 0.002)		35.023 (± 0.011)	1.269 (± 0.16)			[352]
Mixture of WCO and *Calophyllum inophyllum* oil	49.27	0.912	19.75	54.12	-	-	-	[353]
Waste Cooking Oil	6.22	0.981	5	-	-	186.45	-	[161]
Beef tallow animal fat	-	0.943	4.82	24.6	2.41	261.65	168	[245]
Beef tallow blend with waste used vegetable oil	22.3	0.902	0.249	-	0.1745	180	-	[163]
Composite oil of *Pongamia pinnata*, animal fat and waste cooking oil	44	0.927	11	-	1.692	-	245	[354]
Waste Soybean Oil	-	0.865	0.72	-	0.36	196.6	-	[355]
Waste palm oil	-	0.970	10.3	24.1	5.2	-	300	[356]
Waste Cooking Oil	-	0.91	3.6	4.2	-	207	-	[265]
Waste chicken fat	13.2	1.473	5.33	-	2.68	109.4	-	[339]