Table 2.1 Various feedstocks used for biodiesel production

	Examples	**Advantages**	**Disadvantages**	**References**
First generation feedstock	Soyabean Palm, Sunflower, rapeseed,etc.	• Synthesis of biodiesel.	• Crises in food market. • Rise in cost of edible oil as well as biodiesel. • Land requirements for cultivation of plant are in large proportion.	[Celikten et al., 2010; Sumathi et al., 2008; Siler-Marinkovic et al., 1998]
Second generation feedstock	Karanja, Jatropha, Jojoba, Waste frying oil, Animal fat,etc.	• Decrease dependency on first generation feedstocks which are edible oil since alternative source of biodiesel. • Wastelands can be used which are not preferred for food crop.	• Not liberal to restitute our total transportation. • Impecunious performance in the frosty temperature.	[Pramanik, 2003; Canoira et al., 2006; Canakci, 2007; Singh and Singh, 2010]
Third generation feedstock	Microalgae of different species such as Botryococcus Braunii, Chlorella species, Nanochloro-psis species,etc.	• Superior over first and second generation feedstock. • Due to its expeditive reproduction, cultivation is facile, extensive productivity and oil yield. • Does not require specific land for production. It can be grown in salt water, fresh water and in bioreactor which is inappropriate for above two feedstocks.	• Cost for processing is expensive. • There are chances of contamination from bacteria so proper sterile conditions required. • Most algal lipid has lower fuel value than diesel fuel and biodiesel with many poly-unsaturates.	[Mata et al., 2010; Chisti, 2007]

Table 2.2 Various Homogeneous and heterogeneous catalyst for biodiesel production

Catalyst	Feedstock	Catalyst wt%	Oil: alcohol molar ratio	Reaction temperature	Time (min)	Conversion	References
Homogeneous Acid catalyst							
H_2SO_4	Sunflower oil and Soybean oil	2.5	1:6	60	60	96.6	[Farag et al., 2011]
HCl	Sunflower oil and Soybean oil	2.5	1:6	60	120	87.9	[Farag et al., 2011]
$AlCl_3$	Sunflower oil and Soybean oil	2.5	1:6	60	120	87.98	[Farag et al., 2011]
CH_3SO_3H	Palm fatty acid	0.1	1:3	130	60	91	[Aranda et al., 2007]
H_3PO_4	Palm fatty acid	0.1	1:3	130	60	50	[Aranda et al., 2007]
CH_3SO_3H	Palm fatty acid	0.1	1:3	130	60	80	[Aranda et al., 2007]
$C_2HF_3O_2$	Soybean oil	2.0	1:20	80	360	98.40	[Miao et al., 2009]
PTSA	Corn oil	4.0	1:10	80	120	97.10	[Guan et al., 2009]
BSA	Corn oil	4.0	1:10	60	480	82	[Guan et al., 2009]
Homogeneous Base catalyst							
NaOH	*Pongamia pinnata*	0.5	1:9	60	45	89.5	[Sharma and Singh,

							2008]
NaOH	Waste frying oil	0.8	1:6	60	60	95	[Dias et al., 2008]
$NaOCH_3$	Duck tallow	1.0	1:6	65	180	83.60	[Chung et al., 2009]
KOH	Sunflower oil	1.0	1:6	60	60	95	[Dias et al., 2008]
TMAH	Cotton seed oil	2.0	1:6	65	120	98	[Karavalakis et al., 2010]
TMG	Waste frying oil	3	1:12	65	90	93.80	[Karavalakis et al., 2011]
TEA	Cotton seed oil	6	1:9	190	180	55.3	[Yao et al., 2010]
Heterogeneous Acid catalyst							
Propyl-SO_3H-SBA-15	Palm oil	6	1:20	140	120	72	[Melero et al., 2010]
Amberlyst-36	Palm oil	6	1:20	140	120	32	[Melero et al., 2010]
Sulfated zirconia	Oleic acid	0.50 gm	1:40	60	720	90	[Patel et al., 2013]
Chlorosulfonic zirconia	Oleic acid	3	1:8	100	720	100	[Zhang et al., 2014]
30%$WO_3/AlPO_4$	Soybean oil	5	1:30	180	300	72.5	[Xie et al., 2012]
Ce/HUSY zeolite	Soybean oil	0.001 mol	1:30	200	1440	99.80	[Borges et al., 2013]
$Fe(HSO_4)_3$	Waste oil	1	1:15	205	240	94.5	[Alhassan et al., 2013]
30%Tungstosicicacid/ zeoliteHβ	Oleic acid	100 mg	1:20	60	600	86	[Narkhede and Patel, 2013]

Heterogeneous Base catalyst							
CaO	Rapeseed oil	1	1:26	60	180	90	[Kawashima et al., 2009]
MgO	Canola oil	3	3:20	190	120	82.8	[Jeon et al., 2013]
SrO	Olive oil	5	1:6	65	15	82	[Chen et al., 2012]
K_3PO_4	Fried oil	5	1:6	65	180	78	[Viola et al., 2012]
Li/CaO	Karanja oil	5	1:6	65	60	99	[Kaur and Ali, 2011]
Na/Al_2O_3	Soybean oil	1	1:32	120	360	97.1	[Tonetto and Marchetti, 2010]
Cs/SiO_2	Canola oil	100 mg	1:40	135	300	25.35	[Kazemian et al., 2013]
MgAlFe hydrotalcite	Soybean oil	3	1:21	65	240	81	[Wang et al., 2012]
β - $Ca_3(PO_4)_2$	Soybean oil	1.01	1:6.27	70	300	97.73	[Chakraborty et al., 2011]
Enzyme catalyst							
Immobilized lipase on crystalline PVA	Soybean oil	4	1:6	37	-	66.3	[Bergamasco et al., 2013]