Biodiesel is produced from grape seed oil and mango seed oil by using two different methods, one method is transesterification process and the other one is catalytic cracking process. In the catalytic cracking process, three different catalysts used are alumina($\text{Al}_2\text{O}_3$), zeolite(ZSM-5) and zirconia ($\text{ZrO}_2$).

Experimental work has been carried out to investigate performance, combustion and emission characteristics of diesel engine starting with grape seed biodiesel blends with diesel and the second phase of tests with blends of mango seed biodiesel with diesel at different loads.

Series of tests are conducted using each of the fuel blends in a direct injection single cylinder diesel engine working at a constant speed of 1500 rpm at different loads. In each test, engine characteristics like brake thermal efficiency, specific fuel consumption, peak cylinder pressure, heat release rate and exhaust emissions are computed. It is found that B25 blend is performing better with the following results compared to other grape seed biodiesel blends.

6.1 Methyl Esters of Grape Seed Oil (Transesterification Process)

- The brake thermal efficiency value for B25 (25% biodiesel and 75% diesel) methyl esters of grape seed oil(MEGSO) is 26.25% at 80% load on engine.
- The specific fuel consumption value for B25 MEGSO is 0.3165 kg/kWh at 80% engine load.
- The peak cylinder pressure value for B25 MEGSO is 59.01 bar at 80% load on engine.
- Heat release rate value for B25 MEGSO is 120.36 kJ/ m$^3$ deg at 80% load on engine.
- The nitrogen oxide ($\text{NO}_x$) emissions at 80% engine load for B25 MEGSO is 1074 ppm.
• The hydrocarbon (HC) emissions for B25 MEGSO is 79.4 ppm at 80% load on engine.
• The carbon monoxide (CO) emissions in percentage of volume for B25 MEGSO is 0.15 % at 80% engine load.
• The smoke emissions for B25 MEGSO is 64.5 HSU at 80% load on engine.

6.2 Grape Seed Biodiesel (Catalytic Cracked Grape Seed Oil with Alumina As Catalyst)

• The brake thermal efficiency value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 26.54% at 80% load on engine.
• The specific fuel consumption value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 0.3001 kg/kW-h at 80% engine load.
• The peak cylinder pressure value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 62.56 bar at 80% load on engine.
• Heat release rate value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 124.40 kJ/ m³ deg at 80% load on engine.
• The nitrogen oxide (NO\textsubscript{x}) emissions at 80% engine load for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 1183 ppm.
• The hydrocarbon (HC) emissions for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 71.6 ppm at 80% load on engine.
• The carbon monoxide (CO) emissions in percentage of volume for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 0.13 % at 80% load on engine.
• The smoke emissions for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with alumina as catalyst is 59.4 HSU at 80% load on engine.

6.3 Grape Seed Biodiesel (Catalytic Cracked Grape Seed Oil with Zeolite As Catalyst)

• The brake thermal efficiency value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 26.38% at 80% load on engine.
• The specific fuel consumption value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 0.3105 kg/kW-h at 80% load on engine.
• The peak cylinder pressure value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 61.34 bar at 80% load on engine.
• Heat release rate value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 123.10 kJ/m³ deg at 80% load on engine.
• The nitrogen oxide (NOₓ) emissions at 80% load on engine for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 1189 ppm.
• The hydrocarbon (HC) emissions for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 73.2 ppm at 80% engine load on engine.
• The carbon monoxide (CO) emissions in percentage of volume for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 0.15 % at 80% load on engine.
• The smoke emissions for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zeolite as catalyst is 60.9 HSU at 80% load on engine.
6.4 Grape Seed Biodiesel (Catalytic Cracked Grape Seed Oil with Zirconia as Catalyst)

- The brake thermal efficiency value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 26.34% at 80% load on engine.
- The specific fuel consumption value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 0.3138 kg/kW-h at 80% load on engine.
- The peak cylinder pressure value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 59.69 bar at 80% load on engine.
- Heat release rate value for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 121.58 kJ/ m³ deg at 80% load on engine.
- The nitrogen oxide (NOx) emissions at 80% load on engine for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 1192 ppm.
- The hydrocarbon (HC) emissions for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 73.4 ppm at 80% load on engine.
- The carbon monoxide (CO) emissions in percentage of volume for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 0.13 % at 80% load on engine.
- The smoke emissions for B25 grape seed biodiesel obtained by catalytic cracking of grape seed oil with zirconia as catalyst is 61.1 HSU at 80% load on engine.

Methyl esters of mango seed oil (MEMSO) produced by transesterification process and mango seed biodiesel produced by catalytic cracking using three catalysts are blended with diesel in different ratios is fuelled to diesel engine to test the engine
characteristics. On analysis of test results B25 blend of MEMSO and mango seed biodiesel performed well compared to other blends. So engine characteristics values fuelled with B25 blend biodiesel produced by two production process are reported.

6.5 Methyl Esters of Mango Seed Oil (Transesterification Process)

- The brake thermal efficiency value for B25 (25% biodiesel and 75% diesel) MEMSO is 25.25% at 80% load on engine.
- The specific fuel consumption value for B25 MEMSO is 0.3518 kg/kW-h at 80% load on engine.
- The peak cylinder pressure value for B25 MEMSO is 55.85 bar at 80% load on engine.
- Heat release rate value for B25 MEMSO is 112.58 kJ/ m$^3$ deg at 80% load on engine.
- The nitrogen oxide (NO$_x$) emissions at 80% load on of engine for B25 MEMSO is 1065 ppm.
- The hydrocarbon (HC) emissions for B25 MEMSO is 80 ppm at 80% load on engine.
- The carbon monoxide (CO) emissions in percentage of volume for B25 MEMSO is 0.14 % at 80% load on engine.
- The smoke emissions for B25 MEMSO is 65.3 HSU at 80% load on engine.

6.6 Mango Seed Biodiesel (Catalytic Cracked Mango Seed Oil with Alumina as Catalyst)

- The brake thermal efficiency value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 25.61% at 80% load on engine.
• The specific fuel consumption value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 0.3284 kg/kW-h for 80% load on engine.

• The peak cylinder pressure value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 58.67 bar at 80% load on engine.

• Heat release rate value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 118.28 kJ/ m³ deg at 80% load on engine.

• The nitrogen oxide (NOₓ) emissions at 80% load on engine for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 1200 ppm.

• The hydrocarbon (HC) emissions for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 73.8 ppm for 80% load on engine.

• The carbon monoxide (CO) emissions in percentage of volume for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 0.14 % at 80% load on engine.

• The smoke emissions for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with alumina as catalyst is 61.5 HSU for 80% load on engine.

6.7 Mango Seed Biodiesel (Catalytic Cracked Mango Seed Oil with Zeolite as Catalyst)

• The brake thermal efficiency value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 25.51% at 80% load on engine.

• The specific fuel consumption value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 0.3315 kg/kW-h at 80% load on engine.
- The peak cylinder pressure value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 57.35 bar at 80% load on engine.

- Heat release rate value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 114.28 kJ/ m³ deg at 80% load on engine.

- The nitrogen oxide (NOₓ) emissions at 80% load on engine for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 1212 ppm.

- The hydrocarbon (HC) emissions for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 74.2 ppm at 80% load on engine.

- The carbon monoxide (CO) emissions in percentage of volume for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 0.15 % at 80% load on engine.

- The smoke emissions for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zeolite as catalyst is 61.8 HSU at 80% load on engine.

6.8 Mango Seed Biodiesel (Catalytic Cracked Mango Seed Oil with Zirconia as Catalyst)

- The brake thermal efficiency value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 25.43% at 80% load on engine.

- The specific fuel consumption value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 0.3418 kg/kW-h at 80% load on engine.

- The peak cylinder pressure value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 56.28 bar at 80% load on engine.
• Heat release rate value for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 113.62 kJ/ m³ deg at 80% load on engine.

• The nitrogen oxide (NO_x) emissions at 80% load on engine for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 1220 ppm.

• The hydrocarbon (HC) emissions for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 75.6 ppm at 80% load on engine.

• The carbon monoxide (CO) emissions in percentage of volume for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 0.15 % at 80% load on engine.

• The smoke emissions for B25 mango seed biodiesel obtained by catalytic cracking of mango seed oil with zirconia as catalyst is 61.9 HSU at 80% load on engine.

Biodiesel produced by transesterification and catalytic cracking process from fruit seed vegetable oils can be a potential source of alternate fuel for diesel engines that can be used to partially substitute conventional fuel as there is a little drop in engine performance with reduced HC, CO and Smoke emissions when compared to that of diesel fuel. Catalytic cracking process is faster process of producing biodiesel eliminates water washing process and helps in saving a lot of water, moreover when fuelled to diesel engine a slight improvement in engine brake thermal efficiency and lesser specific fuel consumption is noticed compared to biodiesel from transesterification process.
SCOPE FOR FUTURE WORK

- Experiments can be conducted using produced biodiesels by implementing NO\textsubscript{x} emission reduction techniques such as addition of cetane improvers, retarding injection timing and also by exhaust gas recirculation.

- Catalytic cracking process can be experimented with cheaper and abundantly available catalysts for economical production of biodiesel from variety of feed stocks.

- Experiments can be conducted at different injection pressures for better fuel atomization to decrease emissions.