The aim of this work is to investigate the effect of fuel injection pressure (FIP) on in-cylinder spray and combustion characteristics of biodiesels in a single cylinder CRDI optical engine at 1200 rpm. Biodiesel from waste cooking oil and Karanja oil and baseline mineral diesel were used as test fuels. Mie-scattering technique was used for spray characterization. The spray characteristics were studied by analysing the spray tip penetration and spray cone angle. The direct imaging of spray indicated relatively longer injection delay for biodiesel (B100). Biodiesel (B100) also exhibited longer liquid jet penetration length and narrower spray cone angle than baseline mineral diesel. Waste cooking oil-based biodiesel (WCOB) showed lower flame luminosity with shorter visible flame duration at higher injection pressures. Experiments were performed to investigate combustion, performance, emissions and particulate characteristics of biodiesels derived from waste cooking oil and Karanja oil and their blends (B20) in a metal engine at constant engine speed (1500 rpm). A partial flow dilution tunnel was used to collect and measure the mass of primary particulate from biodiesel (B100) and blends (B20) vis-a-vis baseline mineral diesel. The collected particulate matter (PM) was subjected to chemical analyses for assessing the trace metals using inductively coupled plasma-optical emission spectrometer (ICP-OES). In addition, measurement of elemental carbon (EC) and organic carbon (OC) was also carried out for the engine exhaust.