Comparative Chemical Analysis of Plant-Based vs. Animal-Based Biodiesel: Impacts on Engine Performance and Emissions

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First-generation biofuel crops, like corn and peanuts, are effective for biodiesel production, but compete with food crops and require arable land use. Third-generation biofuels, such as beef tallow and chicken fat, utilize waste materials without such drawbacks. Biodiesel was synthesized from both sources, comparing the products to commercial and farm diesel. Effects of different saturation levels in biodiesel blends were analyzed. Environmental sustainability of the blends was determined, with unsaturated blends emitting less carbon dioxide compared to saturated blends. To evaluate biodiesel performance and properties, four methods of chemical analysis were conducted, along with an engine performance test. Transmittance percentages determined clarity of fuel samples. Flashpoint and pour point tests assessed temperature resilience. Each sample was tested in a diesel engine for a set time, recording carbon dioxide emissions and engine temperature. Corn biodiesel had the highest yield (89%) and 5% beef blend was the clearest at the standard wavelength of 680 nm, while peanut 12.5% blend was the clearest at 500 nm. All blends, except chicken, were clearer than the control pure diesel at 900 nm. For performance, unsaturated biodiesel consistently had the lowest pour point temperatures, while the highest flashpoints were consistently 20% blends, with the highest being chicken biodiesel. Results were consistent with fatty acid compositions of saturated and unsaturated materials. After comprehensive analysis, plant-based blends outperformed animal-based blends with comparatively lower carbon dioxide emissions, higher transmittance percentages, yields, and lower pour point temperatures, while saturated blends endured more complete combustion from hydrocarbons.

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