







# Vibration analysis using wavelet transformation technique and performance characteristics of a diesel engine fueled with tamarind biodiesel-diesel blends and diverse additives

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## Highlights

- Effects of diverse additives in tamarind biodiesel combustion were investigated.
- BHT showed better BTE (3.8%) and BSFC (4.1%) improvement compared to DEE in B20.
- Better NO<sub>x</sub> trade-off on both BHT (16%) and DEE (9%) in B20 blend.
- Vibration analysis of the engine was evaluated using DWT and DWPT algorithms.
- Feature extraction was precisely done using the 2D-DWT.

## Abstract

This study investigates the combustion, performance characteristics, and emission levels of diesel and tamarind biodiesel mixtures (B20, B30, B40, and B100) in a single-cylinder, four-stroke, direct injection (DI) diesel engine. Further, two fuel additives, namely Butylated Hydroxytoluene (BHT) (an antioxidant) and Diethyl ether (DEE) (a cetane improver), were separately added to B20 to enhance the engine characteristics. In addition, Wavelet Transform and Wavelet Packet algorithms were used to investigate the vibration behaviour of the tested fuels. The results demonstrate that the B20 blend improved the performance and generated less emission than the other blends. Moreover, the brake thermal efficiency (BTE) and brake-specific fuel consumption (BSFC) for B20+BHT were 3.8% higher and 4.1% less than B20, respectively. B20+DEE combustion showed lower CO and smoke pollutants by 51% and 19% compared to B20, respectively. The NO<sub>x</sub> emissions for the blends containing BHT and DEE were decreased by 16% and 9%, respectively. The engine vibration analysis showed almost the same frequency with fuel blends B20 and B30, which were similar to the diesel fuel values. The results concluded the tamarind biodiesel/diesel mixtures with BHT and DEE improved the performance and emissions behaviors of DI diesel engine and could be considered a potential alternative biofuel for such engines. Wavelet analysis of the engine was accurately employed to extract the prominent features of the vibrations.