

Comparison between citronella oil and clove oil additives on fuel consumption, power and torque of motorcycle

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Abstract

The use of essential oil additives in petrol has been widely recognised to improve fuel quality because it can increase the oxygen content, which improves combustion performance in the combustion chamber. This study aims to analyse the effect of adding citronella oil and clove oil as essential oil additives into petrol fuel on fuel consumption, power and torque of motorcycles. This research was conducted through an experimental study by varying the composition of additives added to petrol fuel. Citronella and clove oil were added to petrol fuel of RON 90 in ratios of 5%, 10%, and 15%. The results confirmed that adding citronella oil could improve combustion performance better than adding clove oil. Among these ratios, the addition of 10% citronella oil gave the most significant improvement to the combustion performance of the motorcycle in all criteria: fuel consumption, power and torque.

Keywords

Essential oil, Citronella oil, Clove Oil, Fuel Consumption, Power

Introduction

The world demand of fossil fuel increases every year. One of the reasons is the increase of the number of vehicles as impact of economic and population growths [1-3]. In automotive field, many countries face challenges of limited fossil fuel, especially petrol, as well as reducing its effect to climate change [4]. The need for petrol is increasing day by day and the search for alternative solutions is intensifying. The advancement of science and technology has led to the exploration of many possibilities to reduce the consumption of petrol fuel but increase combustion performance at the same time [5]. There are many research arise to increase the possibility to replace fossil fuel with biofuel such as bioethanol or biodiesel [6-10], or to improve the quality of fossil fuel by combining with additive properties [4, 11-13].

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In the recent years, many additives has been explored to improve the quality of petrol in term of consumption, power, and torque [14]. The addition of ethanol [15], octane booster [16], and some essential oils [17-19] have been studied, to name but a few. The latter one is considered to hit the trend of the research, since it can develop the agricultural sector and increase the utilization of fuel quality at the same time. The effort to improve fuel efficiency and reduce pollution is to reformulate fuels with additives that increase the oxygen content of the fuel. These additives improve the engine's combustion performance or enhance its combustion, which produces more power and reduces the volume of fuel used [20].

Many types of plants have been proven to produce essential oils, such as lemongrass oil, citronella oil, clove oil, and tea tree oil. The selection can be referred to potential agriculture in the particular area. In this research, the essential oil additives used are citronella oil and clove oil. Citronella oil contains geraniol while clove oil contains eugenol which can improve combustion performance by increasing oxygen concentration in petrol [21, 22]. By adding oxygen atoms to the fuel, these atoms will act to oxidise soot and carbon monoxide (CO) gas in the combustion chamber [23].

Many research have been proven that citronella oil and clove oil can improve combustion performance of vehicle at many factors, which are fuel consumption, power, and torque [17, 19, 21, 24]. However, the research were conducted separately on different type of vehicles. So far it is not known whether there is a significant difference in the addition of citronella oil and clove oil to petrol. Therefore, this study aims to compare the effect of adding citronella oil and clove oil to petrol on consumption, power and torques on a particular type of motorcycle.

Method

Motorcycle specification

Motorcycle of Honda Beat FI 2019 is used in this study. Table 1 details the specifications of this motorcycle described by the manufacturer.

Table 1. Specifications of Beat FI 2019

Item	Specification
Engine Type	: 4-Stroke, SOHC with Air Cooling, Esp.
Transmission	: Automatic, v-matic
Diameter x Stroke	: 50 x 55.1 mm
Step Volume	: 108,2 cc
Compression Comparison	: 9.5 : 1
Maximum Power	: 6.38 kw (8.68 PS) / 7,500 rpm
Maximum Torque	: 9.01 N.m (0.92 kgf.m) / 6,500 rpm
Kopling	: Automatic, Centrifugal, Dry Type

Experimental design

The engine performance indicators measured on this study are fuel consumption, power and torque. The measures are conducted on pure Pertalite as the control variable, and

addition of citronella oil and clove oil on Pertalite with ratios of 5%, 10% and 15%, respectively. Each measure is repeated three times to obtain accurate data. The optimised mileage to measure fuel consumption in this study is 6 km with an average speed of 40-70 km/hour. Power and torque measures were carried out using a dynamometer test equipment.

To find out the comparative results of fuel consumption, power, torque on the motorcycle, a different analysis was carried out with the t test [26].

$$t = \frac{\bar{x} - \bar{y}(\mu x - \mu y)}{\sqrt{\frac{(nx-1)s_x^2 + (ny-1)s_y^2}{nx+ny-2} \sqrt{\frac{1}{nx} + \frac{1}{ny}}}} \quad (1)$$

Result and Discussion

Data analysis on fuel consumption

The data is collected three times on each measure of fuel consumption. The data of fuel consumption measure is shown in Table 2 and the trend is illustrated in Figure 1.

Table 2. Fuel consumption test results

Fuel Composition	Fuel Consumption (km/litre)			Average (km/litre)
	P1	P2	P3	
Pure Pertalite	40.00	40.54	39.74	40.09
Pertalite + Citronella Oil 5%	46.15	42.55	42.25	43.65
Pertalite + Citronella Oil 10%	46.51	44.44	43.80	44.91
Pertalite + Citronella Oil 15%	42.86	41.96	41.67	42.16
Pertalite + Clove Oil 5%	41.67	43.48	42.55	42.56
Pertalite + Clove Oil 10%	42.25	41.38	42.86	42.16
Pertalite + Clove Oil 15%	42.55	41.96	43.17	42.56

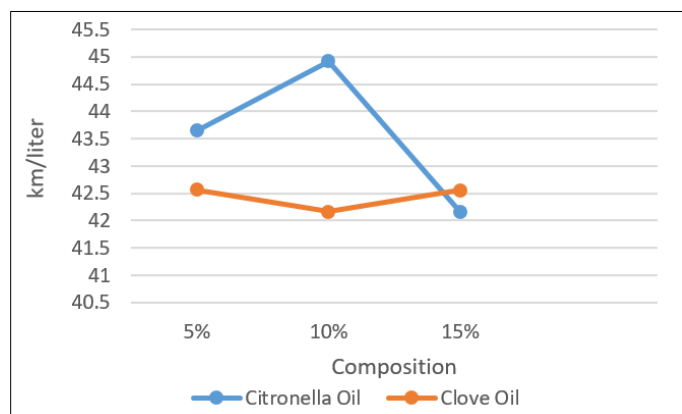


Figure 1. Fuel consumption test comparison

Table 2 proves that both essential oils improve fuel consumption performance indicated by the distance mileage coverage. Figure 1 shows the different pattern of fuel consumptions on addition of these two essential oils to Pertalite on three ratios, 5%, 10%, 15%, respectively. The lowest fuel consumption obtained on the addition of 15% citronella oil, but these two essential oils has different trends. By using t-test at significant level of 5%, the results confirm that the difference of fuel consumption between citronella oil

and clove oil is significant on the addition of 10% citronella oil and 10% clove oil, as shown in Table 3.

Table 3. T-test calculation results

Compositions	Calculation Results	Remarks
5%	T count = 0.798 < t table 2.776	Not Significant
10%	T count = 2.981 > t table 2.776	Significant
15%	T count = -0.793 < t table 2.776	Not Significant

Data analysis on power

The data is collected three times on each measure of power. The data of power measure is shown in Table 4 and the trend is illustrated in Figure 2.

Table 4. Power test results

Test	Pure Peralite	Addition of Citronella Oil (kW)			Addition of Clove Oil (kW)		
		5%	10%	15%	5%	10%	15%
1	4.59	5.27	5.38	5.39	5.23	5.18	5.28
2	4.89	5.32	5.43	5.33	5.28	4.68	5.34
3	5.03	4.74	5.42	5.43	5.33	5.33	5.41
Average	4.84	5.11	5.41	5.38	5.28	5.06	5.34

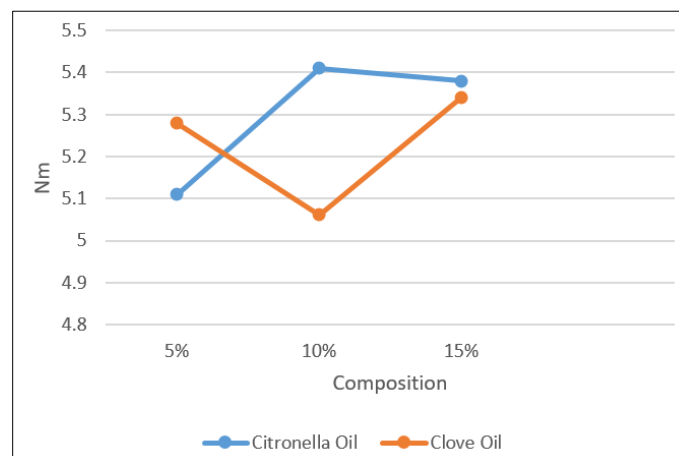


Figure 2. Power test comparison

Table 4 proves that both essential oils improve power performance indicated by the increase of power obtained. Figure 2 shows the different pattern of power on addition of these two essential oils to Peralite on three ratios, 5%, 10%, 15%, respectively. The highest power obtained on the addition of 10% citronella oil, but these two essential oils has different trends. However, by using t-test at significant level of 5%, the results confirm that there is no significance difference between the addition of citronella oil and clove oil to Peralite, as shown in Table 5.

Table 5. T-test calculation results on power

Compositions	Calculation Results	Significant/Not Significant
5%	T count = -0.905 < t table 2.776	Not Significant
10%	T count = 1.759 < t table 2.776	Not Significant
15%	T count = 0.842 < t table 2.776	Not Significant

Data analysis on torque

The data is collected three times on each measure of torque. The data of torque measure is shown in Table 6 and the trend is illustrated in Figure 3.

Table 6. Torque test results

Test	Pure Peralite	Addition of Citronella Oil (kW)			Addition of Clove Oil (kW)		
		5%	10%	15%	5%	10%	15%
1	7.27	8.43	8.56	8.47	8.31	8.27	8.32
2	8.07	8.58	8.67	8.51	8.47	6.80	8.47
3	8.01	7.59	8.63	8.62	8.50	8.49	8.55
Average	7.78	8.20	8.62	8.53	8.42	7.85	8.45

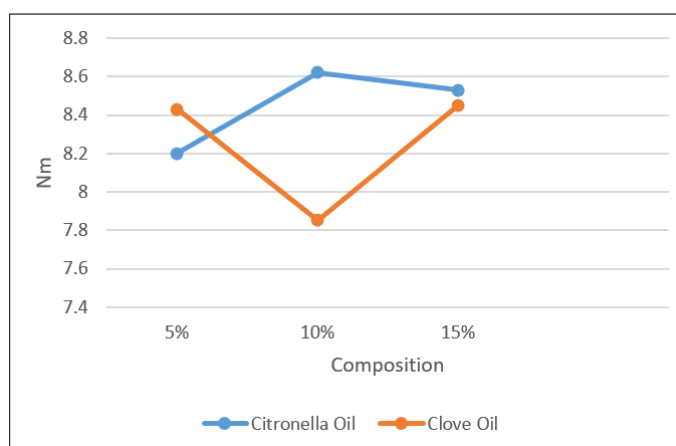


Figure 3. Torque test comparison

Table 6 proves that both essential oils improve torque performance indicated by the increase of torque obtained. Figure 3 shows the different pattern of torque on addition of these two essential oils to Peralite on three ratios, 5%, 10%, 15%, respectively. The highest torque obtained on the addition of 10% citronella oil, but these two essential oils has different trends. However, by using t-test at significant level of 5%, the results confirm that there is no significance difference between the addition of citronella oil and clove oil to Peralite, as shown in Table 7.

Table 7. T-test calculation results on torque

Compositions	Calculation Results	Significant/Not Significant
5%	T count = -0.723 < t table 2.776	Not Significant
10%	T count = 1.443 < t table 2.776	Not Significant
15%	T count = 1.070 < t table 2.776	Not Significant

Conclusion

This study confirm that the addition of both citronella and clove oils can improve the combustion engine performance in term of fuel consumption, power, and torque compared to pure Peralite. On fuel consumption performance, it is found that the addition of 10% citronella oil is the most economical, where the average is 44.91 km/liter. The addition of 10% citronella oil has a significant difference compared to 10% clove oil. On power performance, it is found that power obtained from the addition of 10% citronella oil is highest, with the average of 5.41 kW. However, the addition of citronella

oil does not have a significant difference compared to the addition of clove oil at any ratio. On torque performance, it is found that the torque obtained from the addition of citronella oil 10% is highest, with the average of 8.62 Nm. However, the addition of citronella oil does not have a significant difference compared to clove oil at any ratio.

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