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Comparative Analysis of E5-E15 Fuel Blends and 10-14 g CVT Roller Mass on the Power-Torque Curves of a 110 cc Automatic Motorcycle

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Muhammad Vendy Hermawan[1*], Deni Andriyansyah[1], and Muhammad Ilyas Safarudin[1]

[1]Department of Mechanical Engineering, Sekolah Tinggi Teknologi "Warga" Surakarta, Indonesia

Corresponding author:
Muhammad Vendy Hermawan
Sekolah Tinggi Teknologi "Warga" Surakarta, Indonesia
Email: vendyhermawan2@gmail.com

Abstract

This study aims to evaluate the combined effects of low-level ethanol blending and CVT roller mass variation on the power and torque characteristics of a 110 cc automatic motorcycle. Experiments were conducted using two Pertalite-ethanol fuel blends, E5 and E15, in combination with CVT roller masses ranging from 10 g to 14 g. Engine performance was evaluated using a dynotest, enabling direct measurement of the power-rpm and torque-rpm characteristics for each fuel-roller configuration. The results indicate that increasing the ethanol content from 5% to 15% leads to a consistent improvement in engine performance across the tested range. Compared with E5, the E15 blend produces higher peak power and torque while maintaining the performance peak within the mid-range engine speed region that is favorable for CVT operation. Among the tested configurations, the combination of E15 fuel with an 11 g roller delivers the best overall performance, achieving a maximum power of 8.94 hp at approximately 7,200 rpm and a peak torque of 9.21 Nm at around 7,000 rpm. In contrast, heavier rollers tend to reduce peak torque and shift the effective power band toward higher engine speeds, which is less beneficial for daily riding conditions. These findings demonstrate the interaction between fuel blending and CVT roller mass in shaping the power-torque characteristics of automatic motorcycles and provide practical guidance for optimizing performance under everyday operating conditions.

Keywords: *Pertalite-ethanol, CVT roller, dynotest, power, torque.*

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INTRODUCTION

The dominance of motorcycles as the primary mode of transportation in Indonesia and Southeast Asia leads to a high dependence on fossil fuels, while petroleum reserves continue to decline year by year due to their non-renewable nature. This condition drives the need to develop more sustainable energy sources that can be produced from biological resources [1], [2], [3]. In this context, ethanol, a biofuel derived from the fermentation of biomass such as sugars, starches, and agricultural residues, is a strong candidate to be used as a gasoline additive because of its wide availability, relatively simple production process, and renewable characteristics [4].

Beyond its advantages as a renewable fuel, ethanol has a high research octane number that can increase resistance to detonation and stabilize combustion in spark-ignition gasoline engines [5]. Multiple studies have found that adding ethanol to gasoline at low to medium fractions (E5-E20) can improve combustion quality through oxygenation and latent heat cooling effects, allowing engines to operate more efficiently without major modifications to conventional engine hardware [6], [7]. In various SI engine studies, gasoline-ethanol blends are commonly reported to increase torque and power and to lower CO and HC, with the consequence of higher specific fuel consumption due to the lower heating value of ethanol, the magnitude of which depends on engine configuration and control strategy [8], [9], [10]. Earlier studies also show that ethanol exhibits high octane rating [11], a charge-cooling effect [12], and higher laminar flame speed [13], thereby improving combustion efficiency, torque, and cycle-to-cycle stability across different spark-ignition engine configurations.

For motorcycles in the 110-150 cc class, chassis dynamometer experiments indicate that gasoline-ethanol blends within E5-E20 can increase power and torque outputs and thermal efficiency at certain load and speed points while simultaneously reducing CO and HC [14]. Ox may increase under certain conditions because of higher peak combustion temperatures, or it may decrease when vaporization and charge-cooling effects are more dominant [15], [16]. Studies in Indonesia on small engines report similar trends. E5-E15 tends to be optimal for daily performance, while higher fractions often require calibration adjustments so that the octane benefit compensates for the lower heating value per liter [3]. Specifically for Pertalite fuel with RON 90, which is widely used in Indonesia, several experimental studies report that blending ethanol at E5-E20 improves performance and or efficiency and reduces emissions compared with neat Pertalite. For example, in tests on a four-stroke gasoline engine, E15-E20 often shows gains in power and efficiency and reductions in CO and HC relative to neat Pertalite, while CO^2 tends to increase as an indicator of more complete combustion. Other experiments with bioethanol-Pertalite also confirm that E10-E20 can provide the best trade-off between fuel economy and emissions for part-load and low-speed conditions that are common in daily motorcycle use [17], [18].

On the CVT side, a hallmark of automatic scooters, roller mass is a key tuning parameter that governs ratio shift dynamics and the engine speed profile throughout acceleration [19]. Experimental literature shows that lighter rollers raise the operating RPM so launch response and low-to-midrange torque improve, whereas heavier rollers tend to upshift sooner and support power stability in the mid-to-high speed range. Both trends influence the peak power achieved on the chassis dynamometer curves [20] [21]. Similar findings are reported in CVT studies on the Honda Beat and other 110-125 cc scooters, where variations in roller mass and CVT springs produce clear differences in peak power and torque and in their distribution over the tested speed range [22].

Although the body of knowledge on gasoline-ethanol blends and on CVT tuning is substantial, they are generally investigated separately. Studies on Pertalite-ethanol for motorcycles focus on performance, efficiency, and emissions without varying roller mass, while CVT studies evaluate the effects of rollers and springs without changing fuel quality that shapes combustion characteristics and torque curves in small SI engines. In fact, the interaction between combustion character influenced by ethanol content and CVT ratio-shift strategy influenced by roller mass can determine the location and magnitude of power and torque peaks and the post-peak decay gradient on a chassis dynamometer. To date, publications that systematically combine these two variables on a 110 cc carbureted scooter remain scarce.

Addressing this gap, the present study experimentally investigates the effects of two ethanol levels in Pertalite, E5 and E15, representative of daily splash blending, together with five CVT roller masses, 10, 11, 12, 13, and 14 g, on a carbureted Honda Beat 110 cc from 2012. Power-rpm and torque-rpm curves were measured using a chassis dynamometer. The results show that E15 increases peak power and peak torque compared with E5, and that there are distinct differences between 10 g rollers, which favor peak torque in the low-to-midrange, and 11 g rollers, which favor peak power and stability in the mid-range to high-range at the same blend. The best combination is E15 with 11 g rollers for power of 8.94 hp at approximately 7.200 rpm and for torque of 9.21 Nm at approximately 7.000 rpm.

Phenomenologically, these findings are consistent with the octane and oxygenation effects of ethanol that accelerate combustion and delay knock [18], and they are consistent with the centrifugal force mechanism of the rollers that determines the CVT shift schedule. The objectives of this study are to compare the effects of E5 versus E15 on the full power and torque curves of a 110 cc engine, to evaluate the effects of 10 g versus 11 g rollers on the peak locations, magnitudes, and performance spread, and to identify the fuel-roller pairing that is most advantageous for peak-power and peak-torque requirements in a carbureted automatic scooter without ECU modification. The emphasis is on the full curves rather than peak values alone so that practical implications for daily commuting and tuning can be drawn clearly.

Previous work on Pertalite-ethanol blends generally does not combine roller-mass variation, while CVT studies that vary roller mass tend to keep fuel quality constant. The novelty of this study lies in the integrated experimental evaluation of Pertalite-ethanol blend variation (E5-E15) and CVT roller mass tuning on the complete power-rpm and torque-rpm characteristics of a 110 cc carbureted automatic motorcycle, highlighting their interaction under real operating conditions. Moreover, full power-torque curves for fuel by roller combinations on 110 cc carbureted scooters are still limited, and the interaction between octane increases from ethanol and CVT shift character is rarely analyzed. Because combustion quality determines engine output magnitude and roller mass governs how engine speed is held near the power peak region, testing both factors simultaneously is required to capture realistic performance effects. This study combines ethanol variation E5 and E15 and roller mass 10 g and 11 g on a carbureted Honda Beat 110 cc through chassis dynamometer testing, yielding power-rpm and torque-rpm curves for all combinations, demonstrating the configurations that best support different performance targets, and providing an empirical basis linking fuel physicochemical properties with CVT mechanical dynamics under real-world use conditions.

METHODS AND ANALYSIS

This experimental study analyzes the effects of ethanol-Pertalite blend composition and CVT roller mass on the performance of an automatic (CVT) motorcycle engine, represented by power (hp) and torque (Nm) as functions of engine speed. The test vehicle was a Honda Beat 110 cc, with specifications listed in Table 1. All tests were carried out on a chassis dynamometer (dynotest) to obtain direct and accurate engine performance data.

A carbureted motorcycle was deliberately selected to minimize control-system confounders arising from the fuel supply system. In a carburetor, air-fuel mixing occurs mechanically, so the mixture entering the combustion chamber is not influenced by electronic sensors, the ECU, or automatic correction strategies such as closed-loop fuel control in port-fuel-injection systems. This configuration allows the effects of Pertalite-ethanol composition changes to be observed more directly, without enrichment or fuel-saving algorithms intervening. Carburetion also facilitates rapid changes of hardware such as CVT rollers and provides unencumbered test access without sensor-induced engine faults, making it well suited to experiments focused on performance responses to fuel and mechanical variations.

Table 2 presents typical fuel properties of Pertalite (RON 90) and ethanol adopted from the literature as a general reference to support the discussion [23] [24] . Pertalite is a gasoline fuel with a research octane number of approximately 90 and negligible inherent oxygen content, while ethanol is an oxygenated fuel characterized by a high oxygen mass fraction of about 34-35 wt.% and a substantially higher research octane number (RON > 108). These intrinsic differences explain the discussion in this study regarding the role of ethanol in increasing the effective octane rating and oxygen availability of the fuel blend, which promotes improved combustion stability and mid-range torque.

The fuels consisted of Pertalite as the base gasoline and 96% ethanol as an oxygenating additive. The 96% ethanol used in this study was produced by fermenting sugar-rich biomass or cassava starch hydrolysate with Saccharomyces cerevisiae, followed by distillation to the 96% azeotrope. This follows common practice in gasoline-bioethanol blending studies for SI engines. Detailed ethanol-production steps are beyond the scope of this manuscript and will be presented elsewhere. Two fuel blend compositions were prepared: E5 (95% Pertalite + 5% ethanol) and E15 (85% Pertalite + 15% ethanol).

Ethanol was selected for its high octane rating and oxygen content, both of which can enhance combustion efficiency. The Pertalite-ethanol blends were prepared volume-

Table 1. Motorcycle specifications

Parameter	Specification
Engine type	4-stroke, OHC, air-cooled
Engine displacement	108 cc (110 cc)
Bore × Stroke	50 × 52 mm
Compression ratio	9.0 : 1
Maximum power	8.22 hp @ 8000 rpm
Maximum torque	0.85 Nm @ 5500 rpm
Cooling system	Air-cooled
Ignition system	CDI-DC
Battery	MF 12 V - 3.5 Ah

Table 2. Typical fuel properties of Pertalite (RON 90) and ethanol

Property	Pertalite (RON 90)	Ethanol
Research Octane Number (RON)	90	108-109 (pure ethanol)
Oxygen content	0%	34-35%
Lower heating value (LHV)	42-44 MJ/kg	26.8-27 MJ/kg
Density at 25 °C	720-760 kg/m^3	785 kg/m^3
Stoichiometric air-fuel ratio	14.5-14.7	9
Latent heat of vaporization	350 kJ/kg	840 kJ/kg
Fuel type	Hydrocarbon gasoline	Oxygenated biofuel

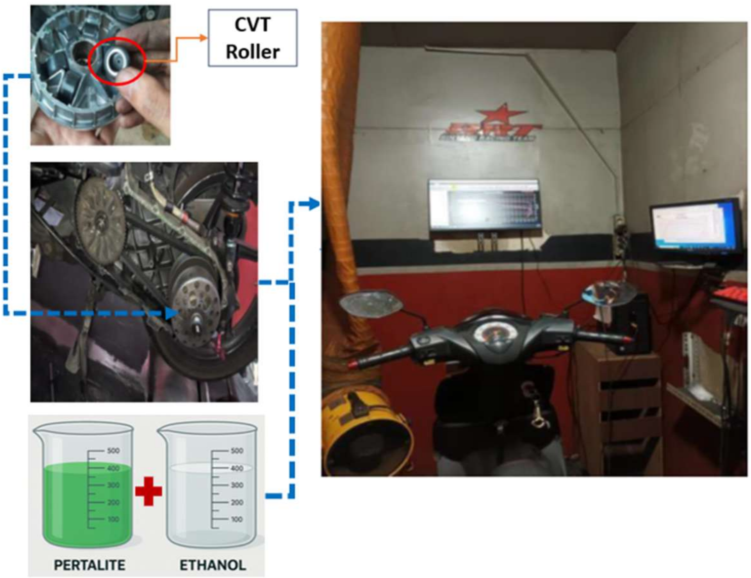

Figure 1. CVT rollers and dynotest setup

Table 3. Dynotest specifications

Parameter	Specification
Maximum power capacity	200 HP
Maximum torque capacity	100 ft-lbs
Channels	2-channel AFR sensor
Maximum speed measurement	200 KPH
Drum speed accuracy	1/100 MPH
Drum diameter	305 mm
Total weight	350 kg
Adjustability	Adjustable front wheel bracket
Software	BRT control & interface software

rically using graduated cylinders, then mixed until homogeneous. The fuel tank was filled only after the previous fuel volume had reached a very low level, preventing residual mixing that could alter the intended blend composition. After filling, the engine was run to a stable idle before testing commenced.

Two CVT roller masses were investigated, 10 g and 11 g, to assess the centrifugal-force effect on the automatic ratio change of the CVT. Engine performance (power and torque) was then measured on the dynotest. Figure 1 shows the CVT rollers and the dynotest procedure. Dynotest specifications are provided in Table 3. For each combination of fuel blend and CVT roller mass, the dynotest measurement was conducted once after the engine reached stable operating conditions. Power-rpm and torque-rpm data were then recorded continuously during each test run and used for subsequent analysis.

The dynotest employed a drum-speed resolution of 1/100 mph to maintain consistent power and torque estimation across the full rpm range. Prior to each test, the bench was calibrated by zeroing the drum, verifying vehicle alignment on the roller, checking tire pressure to the specified value, and validating sensor installation. These steps were taken to minimize reading errors from potential sources such as tire slip on the drum at high rpm, engine temperature rise that may influence output, and misalignment or improper installation of CVT components.

RESULTS AND DISCUSSIONS

Engine power data are presented in Table 4, and engine torque data are presented in Table 5. The power and torque analysis begins at around 6200 rpm because, at this speed, the CVT reaches a stable ratio, the centrifugal clutch is fully engaged, and the engine enters its effective torque band, ensuring that dynotest readings are more accurate and free from low-rpm slip or shifting-phase disturbances. The results show that changes in roller mass and differences in ethanol composition in the fuel blend exert consistent effects on the rise and fall patterns of power and torque across the engine-speed range. . For the 5% ethanol blend, the power curves with 10-14 g rollers tend to increase up to a peak within 7,000-7,600 rpm. The 10 g roller produces a peak power of about 8.70 hp at 7,400 rpm, whereas the 11 g roller reaches the highest value of 8.80 hp at around 7,000 rpm. Heavier rollers (12-14 g) exhibit peak power at higher rpm, indicating that the greater centrifugal force causes the CVT ratio change to occur at higher engine speeds, shifting the power curve to the right.

For E15, the power increase follows a similar trend, but peak values tend to be slightly higher than for E5. The 10 g roller produces a maximum power of 8.80 hp at 7,400 rpm, whereas the 11 g roller reaches the highest power of 8.94 hp at around 7,200 rpm. This is consistent with ethanol's characteristics of a higher octane number and greater oxygen content, which stabilize combustion and enable higher effective power at mid to high-engine speeds. Heavier rollers with E15 show a shift of the power peak toward higher engine speeds, which is consistent with the CVT ratio-change mechanism driven by the rollers' centrifugal force.

Table 4. Engine power versus engine speed for roller mass variation (10-14 g) using E5 and E15 fuel blends

Engine speed (x1000rpm)	**Ethanol 5% (E5)**					**Ethanol 15% (E15)**				
	Engine power (Hp)									
	10 gr	**11 gr**	**12 gr**	**13 gr**	**14 gr**	**10 gr**	**11 gr**	**12 gr**	**13 gr**	**14 gr**
6.20	2.10	2.50				2.50	2.80			
6.40	3.50	4.90				3.80	4.10			
6.60	5.40	6.90	2.51			5.70	6.00	2.49		
6.80	6.80	7.70	3.72			7.10	7.40	3.78	2.47	
7.00	7.80	8.80	5.93			8.20	8.50	5.67	3.76	2.46
7.20	8.50	8.60	7.34	2.47		8.60	8.94	7.06	5.64	3.74
7.40	8.70	8.20	8.30	4.84		8.80	8.88	8.15	7.02	5.60
7.60	8.30	7.70	8.75	6.82	2.49	8.40	8.56	8.55	8.11	6.98
7.80	7.80	7.40	8.45	7.61	3.68	8.10	8.50	8.75	8.50	8.06
8.00	7.70	7.30	8.00	8.70	5.87	7.90	8.20	8.35	8.70	8.45
8.20	7.60	7.10	7.59	8.50	7.26	7.90	8.20	8.05	8.31	8.65
8.40	7.40	7.10	7.39	8.11	8.20	7.70	8.00	7.86	8.01	8.26
8.60	7.20	6.90	7.24	7.61	8.65	7.50	7.80	7.86	7.81	7.96
8.80	7.10	6.70	7.14	7.32	8.35	7.40	7.70	7.66	7.81	7.77
9.00	7.10	6.60	7.04	7.22	7.90	7.50	7.80	7.46	7.61	7.77
9.20	7.20	6.60	6.84	7.02	7.51	7.60	7.90	7.36	7.42	7.57
9.40	7.30	6.80	6.69	7.02	7.31	7.50	7.80	7.46	7.32	7.37
9.60	7.30	6.50	6.64	6.82	7.16	7.60	7.90	7.56	7.42	7.27
9.80	6.90	6.20	6.74	6.62	7.06	7.90	7.20	7.46	7.51	7.37
9.90	6.20	5.80	6.69	6.53	6.96	7.50	6.70	7.56	7.42	7.47
10.00	3.50	3.20	5.96	5.76	6.11	5.70	5.98	6.32	6.23	6.12

Table 5. Engine torque versus engine speed for roller mass variation (10-14 g) using E5 and E15 fuel blends

Engine speed (x1000rpm)	**Ethanol 5% (E5)**					**Ethanol 15% (E15)**				
	Torque (Nm)									
	10 gr	**11 gr**	**12 gr**	**13 gr**	**14 gr**	**10 gr**	**11 gr**	**12 gr**	**13 gr**	**14 gr**
6.20	3.10	3.20				2.70	3.12			
6.40	4.56	5.80	3.16			4.20	4.62	3.16	2.52	
6.60	6.20	6.90	5.74	3.13		6.10	6.52	5.74	3.23	2.45
6.80	7.34	8.10	6.82	5.67	3.09	7.90	8.32	6.82	4.82	3.81
7.00	8.32	8.90	8.01	6.75	5.60	8.70	9.21	8.01	6.54	5.53
7.20	8.88	8.90	8.80	7.92	6.67	9.00	9.10	8.80	7.57	7.16
7.40	8.30	7.80	8.80	8.70	7.83	8.40	8.82	8.80	7.85	7.52
7.60	7.70	7.20	7.71	8.70	8.60	7.70	8.12	7.71	7.90	7.70
7.80	7.20	6.70	7.12	7.63	8.60	7.40	7.82	7.12	7.53	7.61
8.00	6.80	6.40	6.63	7.04	7.54	7.10	7.52	6.63	7.06	6.98
8.20	6.60	6.20	6.33	6.55	6.96	6.80	7.22	6.33	6.78	6.70
8.40	6.40	5.90	6.13	6.26	6.47	6.50	6.92	6.13	6.50	6.43
8.60	5.90	5.70	5.83	6.06	6.18	6.20	6.62	5.83	6.22	6.16
8.80	5.70	5.90	5.64	5.77	5.99	6.00	6.42	5.64	5.94	5.89
9.00	5.60	5.80	5.83	5.57	5.70	5.90	6.32	5.83	5.70	5.62
9.20	5.50	5.60	5.74	5.77	5.51	5.80	6.22	5.74	5.56	5.44
9.40	5.40	5.70	5.54	5.67	5.70	5.70	6.12	5.54	5.47	5.35
9.60	5.30	4.80	5.64	5.47	5.60	5.60	6.02	5.64	5.38	5.25
9.80	5.00	4.50	4.75	5.57	5.41	5.70	6.12	4.75	5.28	5.16
9.90	4.40	4.10	2.27	4.69	5.51	5.50	5.92	2.27	5.08	5.07
10.00	2.50	2.30			4.42	4.10	4.52		4.66	4.71

The torque analysis in Table 5 shows a pattern that is nearly identical to the power curves, but with the peaks occurring at slightly lower engine speeds. For E5, the 10 g roller achieves a peak torque of about 8.40 Nm at 7,200 rpm, while the 11 g roller delivers the highest torque of 8.90 Nm at 7,000 rpm. Heavier rollers exhibit a reduction in peak torque and a shift of the torque peak to higher rpm, indicating a weaker CVT response in the low-speed range when roller mass is larger. For E15, peak torque improves overall, marked by a highest torque of 9.21 Nm with the 11 g roller. This indicates that the 15% ethanol content can raise combustion efficiency and thus increase torque in the mid-speed range.

Several cells in the tables appear blank, especially for 12 g, 13 g, and 14 g rollers at low engine speeds. These gaps typically arise because the dynotest did not record or failed to output data at certain speeds. Potential causes include sensor fluctuations, temporary engine instability during testing, or CVT transition conditions that prevent the system from capturing power or torque accurately at specific points. Low-rpm data are also more susceptible to vibration noise, tire slip on the dynotest drum, and sensor response lag, which can prevent the instrument from generating stable readings. These gaps do not affect the integrity of the main analysis because peak power and torque are well captured within the performance-relevant rpm range.

The relatively small increase in power observed in this study is consistent with the characteristics of low-ethanol blends applied to a carbureted engine operating under standard configuration. In such conditions, the improvement in combustion quality primarily enhances combustion stability and efficiency rather than producing a substantial increase in effective engine output. In addition, the CVT roller mass plays a

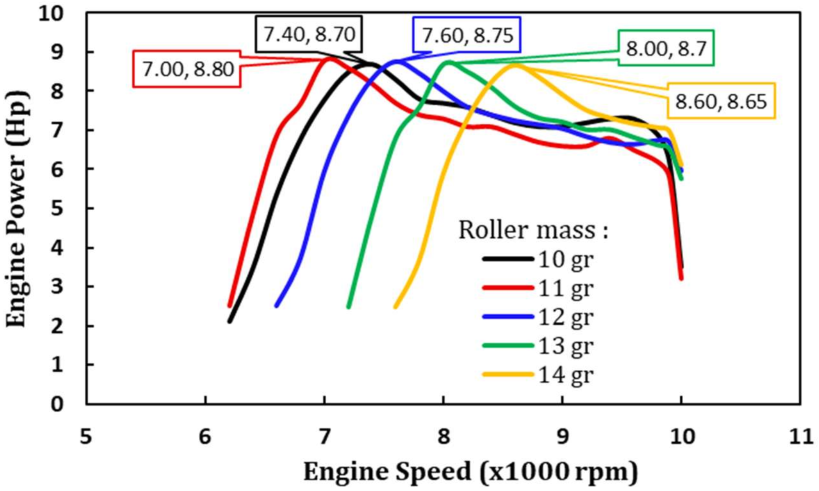

Figure 2. Power-rpm graph for ethanol 5% - Pertalite 95% with varying roller masses

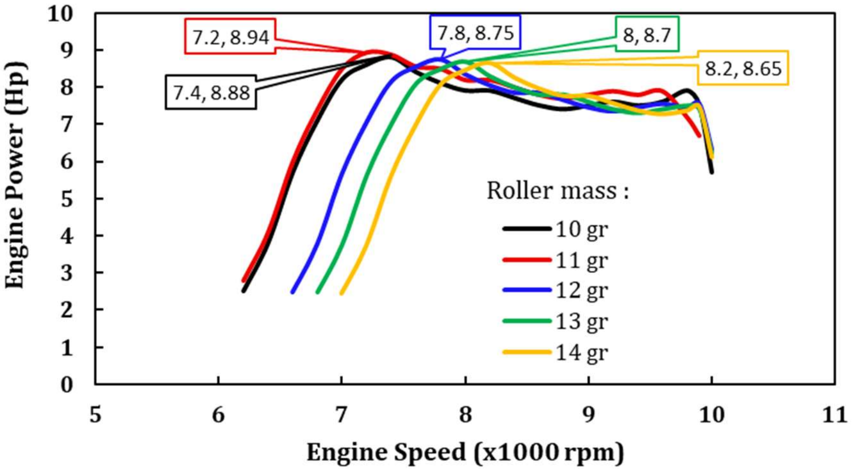

Figure 3. Power-rpm graph for ethanol 15% - Pertalite 85% with varying roller masses

more dominant role in governing engine speed behavior and redistributing power across the operating range. As a result, mechanical CVT tuning has a greater influence on the power profile than the incremental energy contribution from ethanol combustion alone.

Figure 2 shows power versus engine speed for ethanol 5% - Pertalite 95% with 10-14 g roller masses. The curves rise together through the mid-speed range and then decline above 9,000 rpm. The best peak power is achieved by the 11 g roller at 8.80 hp at 7,000 rpm, followed by 10 g at 8.70 hp at 7,400 rpm. The 12 g variant reaches 8.75 hp at 7,600 rpm, while 13 g and 14 g reach 8.70 hp at 8,000 rpm and 8.65 hp at 8,600 rpm, respectively. This trend shows that increasing roller mass from 10 g to 11 g raises peak power while lowering the rpm at which the peak occurs, making the mid-range performance band easier to exploit. Further increases to 12-14 g push the power peak to higher rpm without proportional gains in peak power, which is less favorable for typical CVT acceleration.

Figure 3 presents power versus engine speed (rpm) for ethanol 15% - Pertalite 85% with 10-14 g rollers. Across the mid-speed range, all curves tend to sit above the E5 curves, indicating a positive effect of 15% ethanol on effective power. The highest peak power is delivered by the 11 g roller at 8.94 hp at 7,200 rpm. The 10 g roller follows closely at 8.88 hp at 7,400 rpm. The 12 g variant reaches 8.75 hp at 7,800 rpm, while 13 g and 14 g achieve 8.70 hp at 8,800 rpm and 8.65 hp at 8,200 rpm, respectively. Compared with E5, the E15-11 g combination not only yields the highest peak value but also shifts the power peak to a slightly lower engine speed than E15-10 g, resulting in a thicker mid-range performance band. Meanwhile, 12-14 g again show a shift of the peak to higher rpm with reduced practical benefit for acceleration.

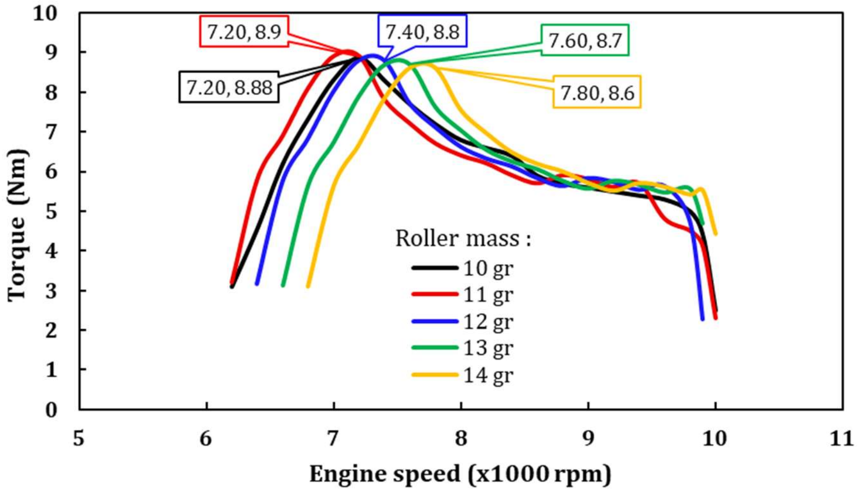

Figure 4. Torque-rpm graph for ethanol 5% - Pertalite 95% with varying roller masses

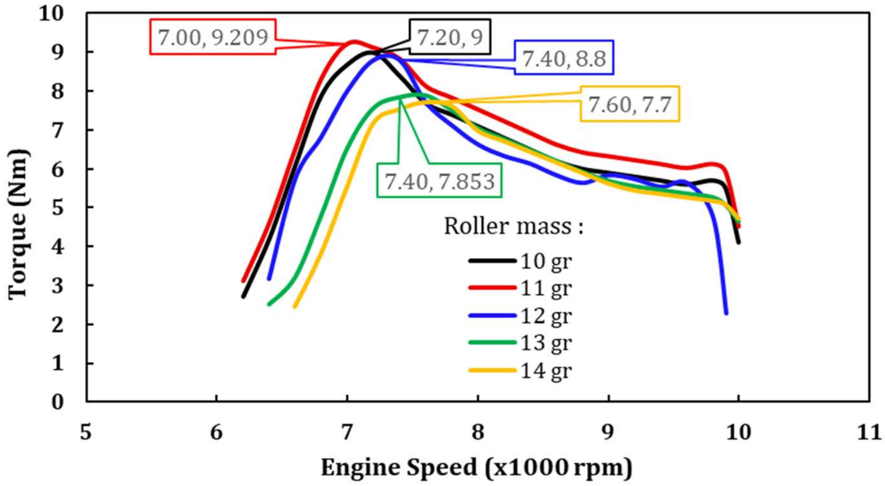

Figure 5. Torque-rpm graph for ethanol 15% - Pertalite 85% with varying roller masses

Figure 4 shows torque versus engine speed (rpm) for ethanol 5% - Pertalite 95% with 10-14 g rollers. All curves reach their torque peaks within 7,000-7,600 rpm, then decrease gradually. The best peak torque is delivered by the 11 g roller at 8.90 Nm at 7,200 rpm, with the 10 g roller very close at 8.88 Nm at 7,200 rpm. The 12 g variant yields 8.80 Nm at 7,400 rpm, whereas 13 g and 14 g produce 8.70 Nm at 7,600 rpm and 8.60 Nm at 7,800 rpm, respectively. This tendency confirms that 11 g produces the strongest mid-range torque at a slightly lower rpm, improving practical acceleration response. Increasing mass to 13-14 g reduces the torque peak and shifts it to higher rpm, which is less ideal for low-to-midrange pull in CVT applications.

Figure 5 shows torque versus engine speed (rpm) for ethanol 15% - Pertalite 85% with 10-14 g rollers. The highest peak torque is obtained with the 11 g roller at 9.209 Nm at 7,000 rpm, while the 10 g roller reaches 9.0 Nm at 7,200 rpm. The 12 g variant records 8.80 Nm at 7,400 rpm, the 13 g drops further to 7.70 Nm at 7,600 rpm, and the 14 g is lower again at 7.853 Nm at 7,400 rpm. These results indicate that with E15, the 11 g roller not only maximizes peak torque but also lowers the rpm at which the peak occurs, creating a very strong mid-range torque band. Conversely, 13-14 g reduce peak torque and require higher rpm to reach the peak, which in practical terms diminishes driveability.

Effect of E5 vs E15 on Power and Torque

Compared with E5, E15 consistently increases peak power by about 0.10-0.14 hp and increases peak torque by about 0.10 Nm for the 10 g roller and 0.31-0.71 Nm for the

11 g roller, with peak locations remaining around 7,000-7,400 rpm. In E15-11 g, the peak occurs at a slightly lower rpm than in E15-10 g, indicating a thicker mid-range torque band that is easier for the CVT to exploit. Mechanistically, ethanol's higher octane number and oxygen content enhance combustion stability and efficiency at medium loads, suppress knock tendency, and increase effective torque without forcing the engine to chase higher rpm to reach the peak. Thus, E15 not only raises the peak values but also improves the quality of the curve in the operating region most frequently used by CVTs.

Effect of Roller Mass Variation Across Both Fuels

Switching roller mass from 10 g to 11 g generally increases peak torque and lowers the peak rpm, so the peak arrives slightly earlier and the curve becomes thicker within 7,000-7,500 rpm, the most relevant band for CVT operation. Increasing mass to 12 g is still acceptable on E5 as peak torque remains relatively competitive. However, with 13-14 g, peak torque tends to drop and the power peak shifts to higher rpm, which is less favorable for practical acceleration. In principle there is a balance point for roller mass. If it is too light, the engine tends to stay at high rpm without adequate torque surplus. If it is too heavy, ratio upshift is accelerated at the expense of mid-range torque. In the present data, 11 g is the best compromise for both E5 and E15, with E15-11 g standing out because it delivers the highest peak power, the highest peak torque, and a peak that occurs at a slightly lower rpm, thereby improving driveability.

The improvement in mid-range torque shape with E15 is consistent with findings that the presence or direct injection of ethanol increases mixture homogeneity and accelerates flame propagation, thereby reducing CO and HC and improving combustion stability [25]. These implications support the observation here that the higher-ethanol configuration (E15) provides a stronger mid-range performance band in CVT operation [26], [27].

CONCLUSION

Based on the experimental results and analysis, the following conclusions can be drawn.

1. Increasing the ethanol content in Pertalite fuel from E5 to E15 consistently improves engine performance. Peak power increases by approximately 0.10-0.14 hp and peak torque increases by about 0.10-0.71 Nm, while the peak operating engine speed remains within the range of 7,000-7,400 rpm.
2. CVT roller mass has a significant influence on the shape and position of the power-rpm and torque-rpm curves. Lighter rollers tend to enhance torque in the low-to-mid engine speed range, whereas slightly heavier rollers provide more stable power delivery at higher engine speeds.
3. Among the tested configurations, the combination of E15 fuel and an 11 g CVT roller provides the most balanced overall performance. This configuration yields the highest peak power and peak torque while shifting the peak to a slightly lower engine speed, resulting in a stronger mid-range performance and improved driveability.
4. Heavier CVT rollers in the range of 12-14 g generally reduce peak torque and shift the power peak toward higher engine speeds, making them less favorable for practical acceleration in automatic motorcycles.
5. The main contribution of this study is the integrated experimental evaluation of fuel combustion characteristics and CVT mechanical tuning on the complete power-rpm and torque-rpm curves of a 110 cc carbureted automatic motorcycle, providing practical guidance for optimizing fuel-roller combinations for daily use.

Future research is recommended to include repeated testing to improve statistical reliability, measurements of fuel consumption and exhaust emissions, and investigations involving fuel-injected engines, CVT spring variations, as well as ignition and air-fuel ratio adjustments. While E15 demonstrated superior performance compared to E5 in this study, higher ethanol contents (>15%) or the use of pure ethanol may not necessarily result in improved engine performance. Further studies are required to evaluate the performance characteristics and potential limitations of higher ethanol blends.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare the absence of any potential conflicts of interest concerning the study, its writing, or its publication.

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