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Fuel Consumption in an Organic Fertilizer Processing Machine

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ABSTRACT

The demand for organic fertilizer is crucial for small-scale farming businesses, particularly when compared to chemical fertilizers, which are expensive and negatively affect long-term soil fertility. This study aims to determine the specific fuel consumption requirements for gasoline engines used in organic fertilizer processing machines based on the workload applied to the engine. The research compares the actual specific fuel consumption and fuel consumption times for three types of gasoline, RON 90, RON 92, and RON 98, under an engine operating load of 3 kg. The results show that for a 3 kg load, the specific fuel consumption is 10 milliliters for RON 90, 35 milliliters for RON 90, and 25 milliliters for RON 92. The time savings for operating under a 3 kg load are 2.91 minutes with RON 90, 1.99 minutes with RON 92, and the lowest time savings of 0.92 minutes with RON 98.

Keywords: Fuel, gasoline, Organic fertilizer, processing machine.

Introduction

Indonesia is a developing country, with most of its population living in rural areas. People in these regions depend heavily on agriculture as their primary source of livelihood. Therefore, developing modern techniques for processing agricultural products is essential to increase productivity. Implementing modern technology requires consideration of several factors, such as providing agricultural equipment to farmers at affordable prices. This research designs machines and tests fuel consumption for producing organic fertilizer, which can replace chemical fertilizers that have a long-term negative impact on soil fertility.

This organic fertilizer is expected to improve plant productivity and quality compared to conventional methods, which can pose risks to human health, the environment, and agricultural land. In response to these issues, we propose analyzing gasoline engines' specific fuel consumption and operating duration related to the workload in designing organic fertilizer processing machines. The goal is to enhance the agricultural production process. Currently, most farmers still use chemical fertilizers to achieve immediate crop fertility, but these fertilizers reduce plant productivity and soil fertility over time, and their costs are rising. Consequently, traditional methods are no longer adequate and satisfactory for today's agricultural needs.

Several key problems can be identified to address this situation, and various ideas or concepts have been developed that can be adopted. The main problems include: reduced space for the necessary organic farming; the

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high cost of machinery for producing organic fertilizer, making it unaffordable for farmers; and machines that tend to waste fuel and have high power consumption, which indirectly increases production costs. Procuring sufficient quantities of organic fertilizer to meet the needs of food crops is challenging but crucial for achieving optimal food production levels. Types of organic fertilizers include compost, manure, harvest residues such as straw, coconut husks, and corn cobs, as well as livestock waste, industrial waste that uses agricultural materials, and city waste. The quality of organic fertilizer varies significantly depending on its ingredients. This quality is determined by nutrient content, the presence of toxic materials, pathogens, weed seeds, and the level of maturity of the organic material [1].

The most widely used type of organic fertilizer is compost, which is the result of the decomposition of plant waste such as straw, coconut husks, reeds, leaves, and corn cobs, as well as animal waste. This decomposition process occurs thanks to the activity of decomposing microorganisms such as fungi, actinomycetes, and earthworms. Along with the growth of the livestock industry, farmers' interest in using manure is also increasing.

Manure is a type of organic fertilizer that decomposes quickly and produces higher levels of organic carbon (C-organic) and nitrogen (N-total) than rice straw, corn forage, and Flemingia [2]. The nutrient content in organic fertilizer found in manure varies depending on the type of livestock, the food consumed, the age, and the health condition of the animals. Another type of organic fertilizer is green manure, which can come from crop residues; plants are intentionally grown to produce green manure or wild plants that grow on the edges of fields, roadsides, or irrigation channels [3]. The moisture content of goat manure is relatively lower than that of cow manure and slightly higher than that of chicken manure, with a value of 64%. It contains 31% organic matter, 0.7% nitrogen (N), 0.4% phosphorus pentoxide (P_2O_5), 0.25% potassium oxide (K_2O), 0.4% carbon dioxide (C_2O), and a C/N ratio of 20-25%, according to research sources [4].

Gasoline is a refined petroleum product comprising a mixture of hydrocarbons, additives, and other blending agents. The gasoline composition varies widely, depending on the crude oil used during refining. The typical hydrocarbon composition of gasoline by volume includes 4-8% alkanes, 2-5% alkenes, 25-40% isoalkanes, 3-7% cycloalkanes, 1-4% cycloalkenes, and 20-50% total aromatics (0.5-2.5% benzene) [5], The properties of gasoline have changed significantly since 1908, when automobiles became the primary consumers of gasoline. The history of these changes includes the content of lead anti-knock additives, anti-knock index, volatility, sulfur content, hydrocarbon composition, use of oxygenates, and current gasoline additives. Over time, gasoline has evolved into a high-octane, low-sulfur product that now has restrictions on maximum vapor pressure [6].

These chemical compounds include anti-knock agents, antioxidants, metal deactivators, lead scavengers, corrosion inhibitors, anti-icing agents, upper cylinder lubricants, detergents, and dyes. The final gasoline product typically contains more than 150 separate components, with 1,000 compounds identified in various mixtures [7]. Gasoline contains many hazardous and carcinogenic chemicals such as benzene, butadiene, toluene, ethylbenzene, xylene, trimethylpentane, methyl tert-butyl ether (MTBE), and many others. Approximately 140 billion gallons of gasoline were consumed in the U.S. alone in 1989. An increase in gasoline prices by just ten cents per gallon resulted in an additional profit of 14 billion dollars per year for the oil industry cartel [8].

This study aims to analyze the specific fuel consumption requirements relative to the workload of organic fertilizer processing machines. Observations are conducted through testing using experimental analysis after the organic fertilizer processing machine is tested, and data generated by the instruments will be analyzed.

Methods

Tools and Materials

The equipment used in this research included a unit of organic fertilizer processing machine, a tachometer, a fuel measuring cup, scales, a stopwatch, and a modified fuel tank. The research materials include gasoline base RON 90, RON 92, and RON 98, as well as organic fertilizer (goat manure).

Research flow diagram
The research flow diagram can be presented in **Figure 1**.

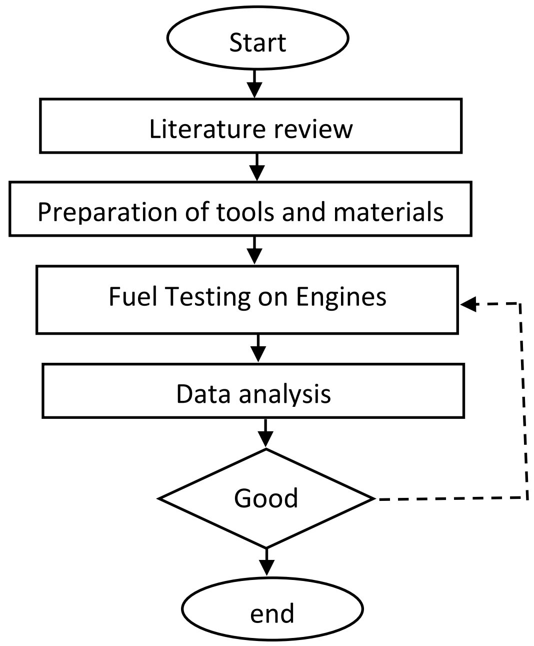

Figure 1. Research flow chart diagram

Results and Discussions
Gasoline engine
The gasoline engine used in this research has the following specifications: Torque 1.1 kg-m/2500 Rpm, power 5.5 HP, displacement 163 cc, fuel tank capacity 3.6 liters, oil capacity 0.61 liters, maximum engine speed 3,600 Rpm.

Test Data
The test results of the organic fertilizer processing machine, tested with loads of 1, 2, and 3 kg at an engine speed of 2000 Rpm, can be presented in the following table. **Table 1** Machine Testing at 1500 Rpm.

Table 1. Machine test data at 2000 Rpm

Gasoline fuel	Testing	Loas (Kg)	Rpm engine	Fuel consumption (ml)	Machine operation (minutes)
	1	1		25	2.08
RON 90	2	2	2000	40	3.56
	3	3		65	5.15
	4	1		15	1.44
RON 92	5	2	2000	30	2.56
	6	3		55	3.16
	7	1		10	1.14
RON 98	8	2	2000	20	1.61
	9	3		30	2.24

Organic Fertilizer Processing Machine.
The image of the organic fertilizer processing machine can be presented in **Figure 2**.

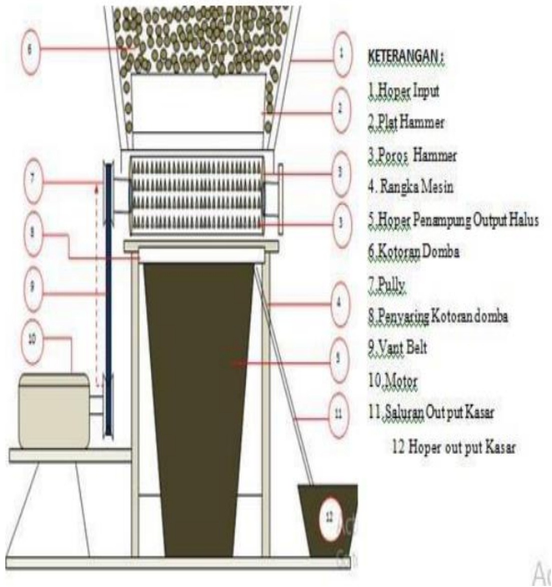

Figure 2. Organic Fertilizer Processing Machine

Fuel Consumption Analysis
The fuel consumption analysis of the organic fertilizer processing machine can be presented in **Figure 3**. The graph below shows the specific fuel consumption for the organic fertilizer processing machine using RON 90, RON 92, and RON 98. **Figure 3** illustrates that the highest fuel consumption is observed with RON 90 for loads of 1, 2, and 3 kg, while the lowest fuel consumption is with RON 98 for the same loads. This study is consistent with previous research on RON 90 and RON 92, which investigated the impact of fuel octane ratings on gasoline engines [9][10]. This study aims to compare fuel consumption in the organic fertilizer processing machine to achieve economic efficiency in the community.

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This observation has been previously conducted by researchers who analyzed the impact of octane ratings on fuel savings and engine performance [11]. The impact of octane rating affects the engine's fuel consumption, but this economic value influences the machine's operation in organic fertilizer production. Previous research on the octane ratings of RON 90, RON 92, and RON 98 has also been conducted, concluding that higher octane ratings lead to increased power and torque produced by the vehicle [12]. Fuel used in the organic fertilizer processing machine needs further investigation into the effects of other factors influencing fuel compatibility and the ignition system. In reality, fuel consumption depends on the engine size and type. This has been previously studied by researchers examining the impact of fuel on gasoline engines [13].

Analysis of the Relationship between Workload and Time Speed

The analysis of the relationship between workload and time speed in the organic fertilizer processing machine can be presented in **Figure 3 - 4**. The graph below shows the relationship between workload and machine time speed.

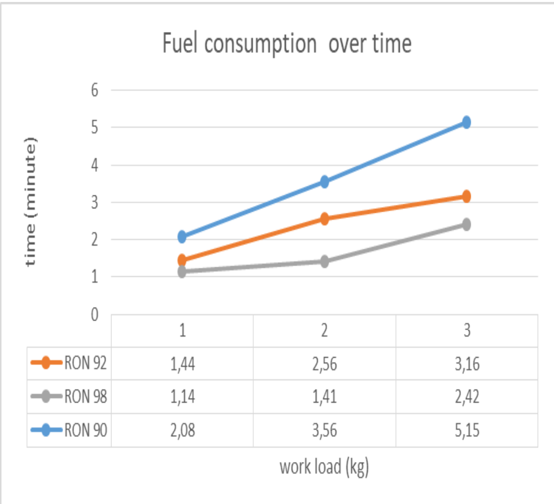

Figure 3. Fuel consumption over time

Based on **Figure 4**, the most effective time savings are achieved with RON 90 and RON 98 fuels, resulting in a work time reduction of approximately 2.91 minutes.

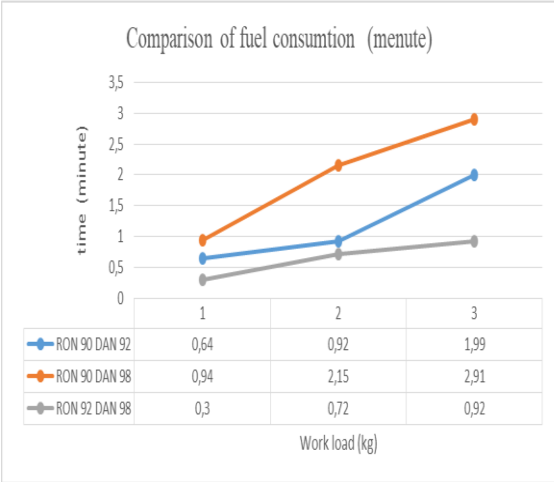

Figure 4. Fuel comparison over time

The graph in **Figure 3 and 4**, shows the relationship between load and time speed for 1, 2, and 3 kg. It indicates that the fastest working time is achieved with RON 98 fuel, while the slowest working time occurs with RON 90 fuel for all loads. This suggests that using higher-octane gasoline (98 RON) can save working time and lead to greater fuel savings. Previous research has used drive cycle simulations to estimate the reduction in fuel consumption associated with using higher-octane gasoline in various vehicles [14].

The analysis of optimizing machine speed and fuel used considers these parameters as inputs. Observations show that low-octane fuel is preferred for engines with lower compression ratios, The use of high-octane fuel can impact engine power, torque, and fuel consumption. The lack of references regarding market fuel usage affects engine performance. This research aims to evaluate the effects of using Pertalite (RON 90), Pertamax (RON 92), and Pertamax Turbo (RON 98) fuels on organic fertilizer processing machines. Gasoline with RON 90 and RON 98 achieves a fuel efficiency comparison value of 84%, while RON 92 and RON 98 achieve a fuel efficiency comparison value of 46%. In contrast, the fuel efficiency ratio for RON 90 and RON 92 is 30%. Other scholars have previously researched this study regarding optimizing engine speed with gasoline fuel [15]. The findings of this research indicate that higher octane ratings can lead to fuel savings. This study aligns with previous research examining the performance of gasoline engines using different octane ratings (RON 91, 93, 95, 97, and 98). It shows that using an octane rating higher than what the engine requires not only reduces brake thermal efficiency (BTE) but also increases specific fuel consumption [16].

Analyzing the time differences in fuel usage reveals the time savings for various fuels. The time savings analysis for RON 90 and RON 98, RON 92 and RON 98, and RON 90 and RON 92 can be presented in the following graph. The efficiency analysis of fuel consumption reduction and operating time is shown in Figure 4. The time savings graph indicates that for loads of 1, 2, and 3 kg, RON 90 and RON 98 fuels achieve the most significant time savings.

RON 90 and RON 92 fuels rank second for 1 kg loads, followed by RON 92 and RON 98. However, for a 3 kg load, the lowest time savings are observed at 0.92 minutes. Research on reducing gasoline consumption impacts economic value, fuel savings, and increased fuel efficiency in agricultural machines. This, in turn, affects gasoline subsidies and can boost income in the community. This study is also conducted in developing countries, analyzing gasoline prices, gasoline consumption, and fuel savings, as previously investigated by other researchers [17].

Fuel Consumption Analysis

Based on the **Figure 5 and 6**, fuel consumption savings per liter per minute for RON 90 and RON 98, RON 92 and RON 98, and RON 90 and RON 92, can be illustrated in **Figure 5**. The highest fuel consumption at 3 kg is observed with RON 90 gasoline. The analysis shows a fuel savings of 10 milliliters for RON 90 and RON 92, 35 milliliters for RON 90 and RON 98, and 25 milliliters for RON 92 and RON 98. The analysis of fuel consumption savings and operating time demonstrates that using high-octane fuels can reduce fuel consumption in gasoline engines. This study, tested across various RON ratings, confirms that higher octane levels can lead to fuel savings. The findings are [18, 16].

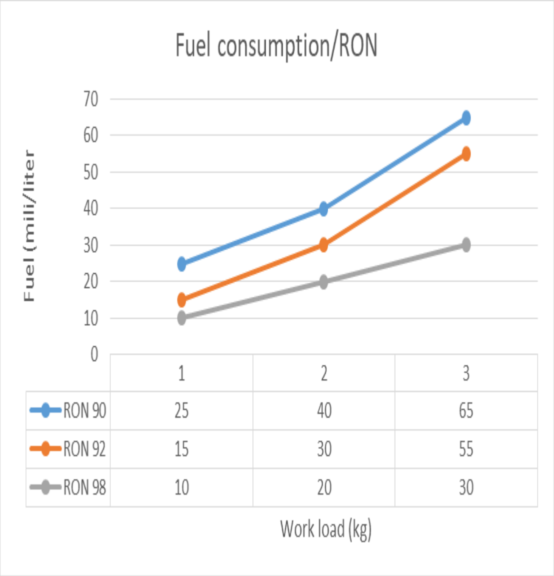

Figure 5. Fuel consumption/RON

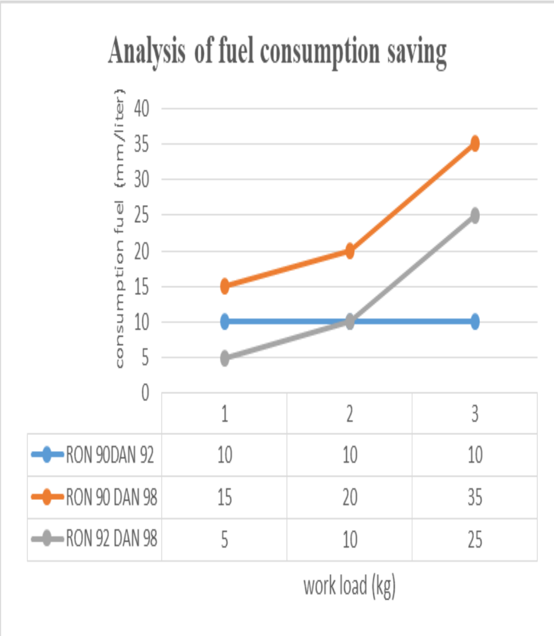

Figure 6. Analysis of fuel consumption saving

Figure 5 and 6 show the engine's fuel consumption and specific fuel consumption comparison, with RON 90 and RON 98 bases increasing at 1, 2, and 3 kg. The lowest fuel consumption is achieved with RON 98 gasoline, at 3 milliliters with a 3 kg load, while the highest is with RON 90 gasoline, at 60 milliliters with a 3 kg load.

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The most considerable consumption difference at 3 kg is 35 milliliters, followed by RON 92 and RON 98 fuels, with a fuel consumption difference of 25 milliliters at 3 kg. Meanwhile, the savings between RON 90 and RON 92 from 1-3 kg remain constant, with a consumption difference of 10 milliliters. Comparing fuel consumption is crucial for analyzing the economic needs of machine operations. Previous researchers have conducted similar analyses by comparing the performance of engines using various gasoline brands [19].

The analysis of the quality of automatic fuel ignition and its implications for fuel requirements is influenced by the fuel's octane level, which in turn affects the fuel consumption volume between RON 90, 92, and 98. This study aligns with previous research on the impact of fuel ignition quality on fuel requirements in engines [20, 21].

Conclusions

1. Fuel consumption results for a 3 kg load show that the lowest consumption is with RON 98 fuel, at 30 milliliters, while the highest is with RON 90 fuel, at 65 milliliters. The fuel consumption for RON 92 at 3 kg is 55 milliliters.
2. The comparison results for time efficiency indicate that for loads of 1, 2, and 3 kg, the most significant time saving of 2.91 minutes is achieved with RON 90 and RON 98 fuel. RON 90 and RON 92 fuel rank second for time-saving, followed by RON 92 and RON 98 fuel, which has the lowest time saving of 0.92 minutes for loads of 1 to 3 kg.

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Author Contributions

HA, YC, YE: Conceptualization, method, writing, analyses, supervision, review, DF: editing review, HA, YC, IBR: methodology, methodology, analyses, HA: drafting, DF: experiment, data experiment.

Conflicts of Interest

The authors declare no conflict of interest in this paper.

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