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Efficiency and Performance Analysis of the Design and Construction of a 30 Kg/Hour Coffee Grinding Machine

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Abstract

This study aims to evaluate the performance of a disk mill coffee grinding machine with a design capacity of 30 kg per hour for small and medium scale coffee processing. The machine was developed as a practical gasoline powered grinder to support coffee processing activities, particularly in areas where access to electricity may be limited. A performance test was conducted using roasted coffee beans with three input loads, namely 500 g, 750 g, and 1000 g. The observed parameters included grinding time, grinding capacity, product yield, residual material, material loss, material conversion efficiency, energy efficiency, and grinding quality based on particle size distribution. The results show that the machine achieved an average grinding capacity of 29.68 kg per hour, which is close to the intended capacity of 30 kg per hour. The average product yield and material conversion efficiency reached 94.55 percent, while the average material loss was 1.11 percent. However, residual material remained at 4.00 percent, indicating that the grinding chamber and discharge system still require improvement. The energy efficiency was reported at 73.8 percent, although the engine power specification needs further clarification. In terms of grinding quality, 70 percent of the particles were within the desired range of 500 to 700 micrometers. These findings indicate that the machine is technically feasible for small scale coffee production, but further refinement is needed to improve material discharge, reduce residual particles, and strengthen particle size consistency.

Introduction

Coffee is one of the most significant agricultural products in Indonesia and it continues to sustain the livelihood of farmers, coffee processors, traders, and small businesses (Irawan, 2025; Ashardiono & Trihartono, 2024; Moordiani et al., 2026). Its value is not only based on the growing and harvesting, but also postharvest processing that turns coffee beans into the product that can be consumed. Grinding, in particular, plays a critical part in the processing of coffee because the roasted coffee beans need to be ground into particles of suitable size prior to being brewed. This process influences the extraction of coffee solids, the release of aroma compounds, taste balance and beverage consistency (Wang et al., 2024). If grinding is done by hand or with a small capacity machine, the grinding process may be time-consuming,

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result in uneven particle sizes and limit the capacity of small coffee processors to produce coffee regularly (Yavari et al., 2026; Etti et al., 2022; Alfaifi et al., 2025).

The requirement for a coffee grinding machine is thus linked to the challenges faced by small and medium scale coffee processors (Khongphinitbunjong et al., 2025; Tikuneh et al., 2023; Warandi et al., 2024). When designing a grinding machine, it is not enough to reduce roasted coffee beans into powder. It should work quickly, have high yield (the amount of coffee powder produced from a given amount of coffee beans), low wastage, and generate coffee powder having the right particle properties for brewing. These criteria are critical because coffee processing involves production efficiency and product quality. A fast grinding process but with a high material loss may decrease economic efficiency, and a grinding process that has a high volume but without particle uniformity may decrease the quality of the coffee product (Hryhorenko et al., 2024)

One of the mechanical systems that can be used in coffee processing is disk mill grinding, which involves breaking down the material with rotating and stationary grinding surfaces (Mandal et al., 2025). This type of mechanism uses roasted coffee beans that enter the grinding chamber to be reduced by pressure, friction, and impact actions until they are smaller particles. This study observed a machine using a disk mill system with several major components, such as a frame, gasoline engine, pulley, V belt, hopper, grinding chamber, disk mill unit, sieve, bearing and outlet. These parts function as a system where roasted coffee beans are fed into the hopper, then pass through the grinding chamber to be broken into smaller particles and then are discharged as ground coffee through the outlet.

The gasoline engine used in this design makes the machine useful for coffee roasting and grinding operations where electricity may not be readily available (Neacsu & Gheorghe, 2026; Delmo, 2025). For small coffee processing units in rural and semi rural environments, it is important that the machines used are not dependent on electricity. As such, the use of a gasoline engine for the grinder may allow for more flexibility in machine operation, particularly for small producers in need of a portable, practical, and field or small workshop based machine. In the original machine design, the grinding machine is powered by a gasoline engine at an average rotational speed of about 4500 rpm, and with the grinding blade rotating at a maximum speed of 4560 rpm. This suggests that the machine is designed to operate in a relatively high speed grinding process for roasted coffee.

While the design and fabrication of a coffee grinding machine is a critical aspect, the usefulness of a machine cannot be assessed simply by looking at the design or construction (Ille et al., 2025). Even if a machine has been successfully assembled, it still requires a test to demonstrate its performance. Testing gives evidence that the machine can achieve the desired throughput, that the capacity is proportional to the throughput, that the losses are minimal, and that the ground coffee produced is of the desired particle size distribution. If this step is not carried out, the machine will be a technical product with unknown effectiveness (Hu et al., 2026; Irjayanti et al., 2025; Jing et al., 2024).

Earlier research on coffee grinding machines has typically centred on grinding mechanism designs, machine part selection, and machine capacity (Kishore et al., 20222; Huang et al., 2025; Abubakar, 2025). Various designs have also adopted disk mill systems for their high capacity in grinding agricultural materials. But a more relevant assessment for small-scale producers should combine capacity, material recovery, material loss, energy consumption and grinding quality in a single assessment. This is because small producers don't only want a machine that can grind fast. They also need to maintain a continuous production, avoid waste, and preserve the physical integrity of the coffee.

The current research assesses the performance of a designed disk mill coffee grinding machine with a capacity of 30 kg per hour. A series of performance tests was conducted using roasted coffee beans with input loads of 500 g, 750 g and 1000 g. These loads were used to determine the machine's performance when the load increased during operation. The parameters that were observed were grinding time, ground coffee yield, residual material (or randemen), material loss, grinding capacity, material conversion efficiency, energy efficiency, and grinding quality. These were chosen because they are the main technical indicators that can be used to describe the suitability of the machine for small and medium scale coffee processing (Bizimungu et al., 2024; Cabral et al., 2022; Zinsli & Villota-Jetzer, 2026).

The novelty of this work is that it tried to extend the assessment of the machine from the mere description of its construction. The study does not address the grinder simply as a mechanical product, but discusses its performance in terms of indicators that are related to its use. The capacity analysis indicates if the machine can achieve the desired production goal. The yield and loss analysis indicates whether the raw material can be used effectively. The energy analysis gives the first impression of the fuel based efficiency, and the particle size analysis provides an indication of the physical characteristics of the ground coffee. This holistic analysis allows the machine to be seen as a processing equipment that relates to the productivity and quality of the product (Zehra et al., 2024; Ramesh et al., 2025; Kumar et al., 2023).

This research will examine the operation of a disk mill coffee grinding machine that has a design capacity of 30 kg per hour. In particular, this study will consider the machine from the perspective of grinding capacity, yield, residual, loss, conversion efficiency, energy efficiency, and quality. This would be helpful for the development of small scale coffee grinding and for assisting coffee farmers who need efficient, practical, and flexible coffee grinding machines.

Methods

Research Design

This research used a practical engineering design approach by designing and testing the performance of a disk mill coffee grinding machine. This study aimed to explore the technical performance of the machine following the manufacturing and assembly process. The purpose of this research was not just to design and fabricate a functional grinding machine, but also to test whether the machine was able to grind roasted coffee beans with an operational capacity as close as possible to the design target.

The approach of the study was in line with machine design and performance evaluation. Performing the evaluation involved observing the workings of the machine during the coffee grinding process, as well as calculating some of the performance indicators from the test results. They were grinding time, grinding capacity, product yield, residual material or randemen, material loss, material conversion efficiency, energy efficiency and grinding quality. Based on the indicators, the study evaluated the machine's suitability in small and medium scale coffee processing.

Research Object

The subject of this research was a disk mill coffee grinding machine with a capacity of around 30 kg per hour. The machine was comprised of several key parts, namely the frame, gasoline engine, pulley, V belt, hopper, disk mill, grinding chamber, sieve, bearing and outlet. The components were interconnected such that the roasted coffee beans went into the hopper and then to the grinding chamber where they were crushed by the rotating disks and then flowed out through the outlet as ground coffee.

The machine was powered by a gasoline engine. According to the machine description, the engine had the capacity of 8 HP with an average engine speed around 4500 rpm. Using a gasoline engine in this machine was important because the objective was to help in the grinding of coffee in a production environment where electricity is not always available. This feature allows the machine to be used by small coffee farmers, especially in semi rural settings.

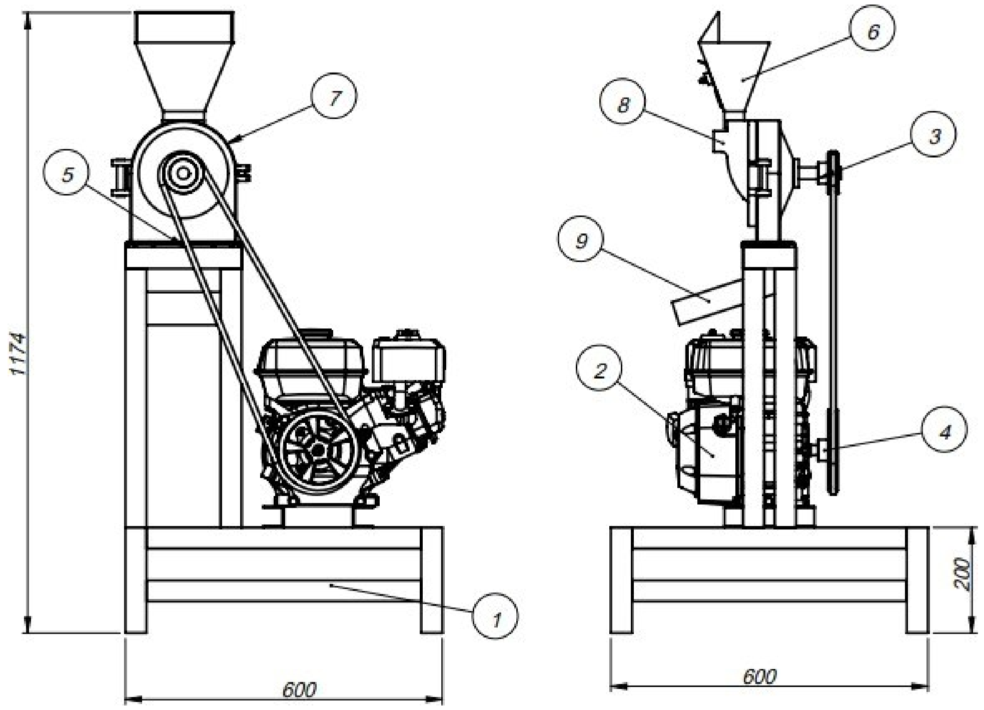

Figure 1. Design of the disk mill coffee grinding machine

Figure 1 presents the design of the disk mill coffee grinding machine examined in this study. The machine consists of several main components, including the frame, gasoline engine, pulley system, V belt, hopper, disk mill unit, grinding chamber, sieve, bearing, and outlet channel. These components are arranged as an integrated mechanical system in which roasted coffee beans are inserted through the hopper, directed into the grinding chamber, reduced into smaller particles by the rotating disk mechanism, and discharged through the outlet as ground coffee. The design illustrates the operational structure of the machine and provides a visual basis for understanding the object evaluated in the performance test.

Materials and Research Instruments

The material used in the performance test was roasted coffee beans. The beans were weighed based on the test load for each test. That the coffee used was roasted coffee was in line with the machine's function, which was to mill roasted coffee to produce coffee powder. The test weight of the load was according to the original test log, which was 500 g, 750 g and 1000 g of roasted coffee beans.

The testing tools used in this research were the disk mill coffee grinding machine that was developed, weighing scale, stopwatch, container, and other workshop tools. The weighing scale was used to record the weight of roasted coffee beans, the weight of the ground coffee, the weight of the remaining residual material after grinding and the loss of material. The stopwatch was used to measure the grinding time from the start of the grinding process until the end of the process. The container was used to collect the ground coffee from the outlet channel.

Machine Design and Fabrication Procedure

The coffee grinding machine was designed to have a frame which holds the gasoline engine, transmission system, hopper, grinding chamber, disk mill unit, and outlet channel. The frame was the main structural component of the machine and was designed to hold the components in place. The gasoline engine was the primary power source, and the pulley and V belt system was used to convey the rotation of the engine to the grinding mechanism.

The hopper was the entry chamber for the roasted coffee beans which entered the grinding chamber. The rotating disk mechanism in the grinding chamber helped to make the coffee beans smaller. The sieve was used to separate the coffee particles to achieve the desired particle size, and the ground coffee was released through the outlet channel. The bearing provided support for the shaft to enable the grinding motion to be smoother

Working Principle of the Machine

The operating mechanism was driven by rotating the grinding shaft via the pulley and V belt from the gasoline engine. The rotation of the gasoline engine made the pulley (attached to the grinding unit) rotate. The shaft rotated the disk mechanism in the grinding chamber. Once roasted coffee beans were inserted into the chamber via the hopper, the coffee beans would be smashed by the disk and broken into finer particles.

Once the coffee beans were crushed, the coffee particles were sieved and then flowed through the outlet. The coffee particles were then collected in a container. This machine operation was based on the original machine design in the source, which fed coffee slowly into the hopper to prevent a pile up at the disk mill.

Performance Testing Procedure

The performance test was conducted to observe the performance of the machine in terms of the amount of coffee that could be ground and the quality of the product. Three input loads of roasted coffee beans were used in the test, i.e. 500 g, 750 g and 1000 g. The use of different loads was to test the machine's capacity to handle various loads and to test whether the machine could maintain its performance when the load increased.

The machine was first switched on and left to run for a few minutes until it was stable. After that, the roasted coffee beans were slowly fed into the hopper. This was to facilitate the entry of the coffee beans into the disk mill and avoid material accumulation at the feeding end of the grinding chamber. The timer was started when the coffee beans started to be ground and stopped at the end of the grinding.

The weight of the coffee after grinding was measured. The residual material in the grinding machine was also weighed, as was the material loss during the grinding. The data were used to determine the percentage of product yield, residual material, material loss, grinding capacity, and material conversion efficiency.

Grinding Capacity Analysis

Grinding capacity was calculated by comparing the initial weight of roasted coffee beans with the time required to complete the grinding process. The calculation was expressed in kg per hour so that the actual performance of the machine could be compared with the intended design capacity. This analysis was important to determine whether the developed machine could approach the target capacity of 30 kg per hour under practical operating conditions.

$$Grinding\ Capacity \frac{Initial\ Material\ Weight\ in\ kg}{\text{Grinding Time in hour}}$$

The grinding capacity obtained from each testing load was then compared to identify whether the machine performance remained stable as the amount of material increased. A machine can be considered technically promising when it maintains a relatively consistent grinding capacity and does not experience a substantial performance decrease under higher input loads.

Product Yield and Material Loss Analysis

Product yield was calculated to determine the percentage of roasted coffee beans successfully converted into ground coffee. This parameter represents the material efficiency of the grinding process because it shows how much of the input material becomes usable product. A high yield indicates that the grinding chamber and outlet system are able to process and discharge the material effectively.

$$\text{Product Yield}\frac{Weight\ of\ Ground\ Coffee}{\text{Initial Material Weight}}\times 100$$

Material loss was calculated to determine the percentage of coffee material that was not recovered as usable ground coffee. Loss may occur because of scattering, fine dust formation, material remaining in the grinding chamber, or material trapped in the outlet section. This parameter is important because even a machine with high capacity may not be economically efficient if it produces excessive material loss.

$$\text{Material Loss}\frac{WWeight\ of\ Lost\ Material}{\text{Initial Material Weight}}\times 100$$

Energy Efficiency Analysis

Energy efficiency was analyzed by comparing the mechanical energy output of the engine with the energy input obtained from fuel consumption. Fuel input was calculated from the volume of gasoline consumed during operation, gasoline density, and the calorific value of the fuel. Output energy was calculated from engine power and operating time. This analysis was included to understand whether the gasoline engine could support the grinding process efficiently in relation to the fuel consumed.

Energy Input= Fuel Volume × Fuel Density × Fuel Calorific Value

Energy Output= Engine Power × O perating Time

$$\text{Energy Efficiency}\frac{Energy\ Output}{\text{Energy Input}}\times 100$$

The energy efficiency calculation was interpreted with caution because the source data contain two different engine power specifications. The machine description states that the gasoline engine has a capacity of 8 HP, while the energy calculation uses 5.5 HP. Therefore, the energy efficiency reported in this study follows the calculation available in the test record, while the inconsistency in engine power specification is acknowledged as a technical limitation that should be clarified in future testing.

Grinding Quality Analysis

Grinding quality was evaluated using the particle size distribution reported in the test record. The analysis focused on the proportion of ground coffee particles within the desired size range of 500 to 700 micrometers, which was associated with V60 brewing. This approach was used to determine whether the ground coffee produced by the machine had an acceptable particle size distribution for brewing purposes.

The grinding quality value was calculated by comparing the mass of particles within the desired size range with the total sample mass reported in the test. This analysis helped show whether the disk mill mechanism could produce not only a sufficient quantity of ground coffee, but also a product with acceptable physical quality. Since the reported particle fractions did not fully reach the stated total sample mass, the result was interpreted carefully as an initial quality indication rather than a final particle size optimization result.

$$\text{Grinding Quality} \frac{\textit{Mass of Particles within the Desired Size Range}}{\text{Total Sample Mass}} \times 100$$

Data Analysis Technique

Data analysis was done through descriptive quantitative analysis. The data were used to calculate the grinding capacity, product yield, residual material percentage, material loss percentage, material conversion efficiency, energy efficiency, and grinding quality. Analysis was done by comparing the calculated values at the three input loads, 500 g, 750 g and 1000 g of roasted coffee beans.

This method of analysis was suitable because the research was aimed at assessing the performance of a coffee grinding machine rather than determining statistical correlations between factors. The comparison of the three different input loads allowed for changes in grinding time, product recovery, material loss, and machine performance to be observed. The calculated data was then used to evaluate whether the machine achieved the desired capacity, recovered most of the input material, had minimal material losses, and produced ground coffee with desired particle quality.

Results and Discussion

This section provides the results of the performance of the designed disk mill coffee grinding machine according to the test procedure outlined in the method section. The experiment was carried out by grinding roasted coffee beans with input loads of 500 g, 750 g and 1000 g. The measured parameters were time, grind coffee output, residual material (randemen), material loss, grinding capacity, material conversion efficiency, energy efficiency and quality. The parameters were used to assess the capacity of the machine to work at near to the stated capacity of 30 kg/hour with reasonable recovery and quality.

The results are displayed in tables with interpretations. The tables present the same data as the original experiment data file, and the interpretation explains the technical implications of the results without altering the study. This format enables the results to be interpreted not only as fabrication results, but also as initial performance testing of a disk mill coffee grinding machine for small and medium scale coffee processing.

Initial Grinding Performance

The initial grinding performance test presents the primary data obtained from the three input loads. This table shows the relationship between input material, grinding time, ground coffee output, residual material, and material loss. These values become the empirical basis for calculating the capacity, yield, loss percentage, and efficiency of the machine.

Table 1. Initial grinding performance test

Parameter	Test 1	Test 2	Test 3
Initial weight in g	500	750	1000
Grinding time in s	62	90	120
Ground coffee weight in g	470	710	950
Residual material or randemen in g	20	30	40
Material loss in g	10	10	10

The findings indicate that the grinding time was longer when more coffee was processed. It took 62 seconds to grind 500 g of roasted coffee beans, 90 seconds to grind 750 g and 120 seconds to grind 1000 g. This is technically sensible because the greater the input weight of the coffee, the longer it will be in contact with the rotating disk mill. More significantly, the time required to process the material was fairly proportional to the input weight, which shows

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that the machine did not experience a significant loss of performance within the loading range of the test.

The results also indicate that the majority of the input material was processed into ground coffee. The machine produced 470 g of ground coffee from 500 g of input material, 710 g from 750 g, and 950 g from 1000 g. The amount of residual material increased from 20 g to 40 g with the increasing input load, while the material loss was consistent at 10 g in all three tests. This indicates that some of the unrecovered material was likely due to the repetition of some characteristics of the grinding process, such as material scattering, formation of fine powder or residual material on the inner surface of the grinding chamber.

Grinding Capacity

Grinding capacity was calculated to determine whether the machine could approach the intended working capacity of 30 kg per hour. The calculation was based on the initial material weight and grinding time in each test. This parameter is important because it directly reflects the productivity of the machine under different input loads.

Table 2. Grinding capacity of the developed coffee grinding machine

Parameter	Test 1	Test 2	Test 3	Average
Initial weight in kg	0.50	0.75	1.00	0.75
Grinding time in s	62	90	120	90
Grinding capacity in kg per hour	29.03	30.00	30.03	29.68

The grinding capacity reached 29.03 kg per hour in the 500 g test, 30.00 kg per hour in the 750 g test, and 30.03 kg per hour in the 1000 g test. The average grinding capacity was 29.68 kg per hour. This shows that the machine has operated almost at its intended capacity of 30 kg per hour. The small gap between the average capacity and the target capacity also indicates that the design of the disk mill system, engine, and transmission system were likely to be able to support the target production scale.

The capacity trend also suggests that the machine worked better with the input loads of 750 g and 1000 g. In fact, the smaller input load of 500 g resulted in a slightly smaller capacity, while the two bigger loads of 750 g and 1000 g resulted in a capacity close to or slightly higher than the intended capacity. This may indicate that the smallest batch size may not be able to represent the true optimal working point of the machine. When used in practice, the machine may have a higher productivity with load sizes closer to the designed working range.

Product Yield and Material Conversion Efficiency

Product yield and material conversion efficiency were analyzed to determine how effectively the roasted coffee beans were converted into usable ground coffee. These two indicators are presented in one table because both are based on the same relationship between the weight of ground coffee output and the initial weight of roasted coffee beans. Product yield shows the proportion of usable coffee powder recovered from the grinding process, while material conversion efficiency confirms the effectiveness of the machine in converting the input material into final product.

Table 3. Product yield and material conversion efficiency

Parameter	Test 1	Test 2	Test 3	Average
Initial weight in g	500	750	1000	750
Ground coffee weight in g	470	710	950	710
Product yield in percent	94.00	94.66	95.00	94.55
Material conversion efficiency in percent	94.00	94.66	95.00	94.55

As shown in Table 3, the product yield increased slightly from 94.00 percent in the 500 g test to 94.66 percent in the 750 g test and 95.00 percent in the 1000 g test. The average product yield reached 94.55 percent, indicating that most of the roasted coffee beans were successfully recovered as ground coffee. The material conversion efficiency showed the same values because it was calculated from the same ratio between ground coffee output and initial material input. This result suggests that the developed machine performed effectively in terms of material recovery, especially at larger input loads within the tested range. However, the remaining unrecovered material still needs to be considered together with residual material and material loss in order to obtain a clearer picture of the overall material balance during grinding.

Residual Material and Material Loss

Residual material and material loss were analyzed to understand the material balance during grinding. Residual material, referred to in the original data as randemen, represents the coffee particles that remained in the machine after grinding. Material loss represents the portion of coffee that was not recovered as usable ground coffee.

Table 4. Residual material and material loss

Parameter	Test 1	Test 2	Test 3	Average
Initial weight in g	500	750	1000	750
Residual material or randemen in g	20	30	40	30
Residual material or randemen in percent	4.00	4.00	4.00	4.00
Material loss in g	10	10	10	10
Material loss in percent	2.00	1.33	1.00	1.11

As shown in Table 4, the residual material remained constant at 4.00 percent across the three tests, although its weight increased from 20 g in the 500 g test to 30 g in the 750 g test and 40 g in the 1000 g test. This pattern indicates that the amount of material retained in the machine increased proportionally with the input load. In contrast, material loss remained constant at 10 g in all tests, but its percentage decreased from 2.00 percent in the 500 g test to 1.33 percent in the 750 g test and 1.00 percent in the 1000 g test. This suggests that larger input loads reduced the relative impact of material loss on the overall grinding process. However, the presence of residual material and loss still indicates that the grinding chamber, outlet channel, and material discharge mechanism require further refinement to improve product recovery and reduce unrecovered coffee particles.

Energy Efficiency

Energy efficiency was analyzed to evaluate how effectively the gasoline engine converted fuel energy into mechanical energy for the grinding process. The energy calculation in the original file used a gasoline powered disk mill with 5.5 HP engine power, fuel consumption of 0.6 liter per hour, gasoline density of 0.74 kg per liter, and gasoline calorific value of 44,400 kJ per kg. The calculation produced an energy efficiency value of 73.8 percent.

Table 5. Energy efficiency of the gasoline powered disk mill machine

Energy Parameter	Value
Machine type	Gasoline powered disk mill
Engine power used in energy calculation	5.5 HP
Grinding capacity	30 kg per hour
Fuel consumption	0.6 L per hour
Gasoline density	0.74 kg per L

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Gasoline calorific value	44,400 kJ per kg
Energy efficiency	73.8 percent

Grinding Quality Based on Particle Size Distribution

Grinding quality was evaluated based on particle size distribution because the usefulness of a coffee grinder is determined not only by capacity and yield, but also by the physical suitability of the ground coffee. The original file identifies 500 to 700 micrometers as the desired particle size range for V60 brewing, and the quality value is calculated from the proportion of particles within the desired range.

Table 6. Grinding quality based on particle size distribution

Particle size range	Mass in g	Percentage	Interpretation
Below 500 micrometers	10	10 percent	Fine particles
500 to 700 micrometers	70	70 percent	Desired range for V60 brewing
Above 700 micrometers	15	15 percent	Coarse particles
Total recorded mass	95	95 percent	Requires clarification
Grinding quality value	70	70 percent	Based on particles within the desired range

Grinding quality was assessed based on the particle size distribution of the ground coffee produced by the disk mill machine. As shown in Table 6, the largest proportion of the sample was found in the 500 to 700 micrometer range, which represented 70 percent of the recorded particles and was identified as the desired range for V60 brewing. Meanwhile, 10 percent of the particles were below 500 micrometers and were categorized as fine particles, while 15 percent were above 700 micrometers and were categorized as coarse particles. These results indicate that the machine was able to produce a dominant particle fraction within the expected brewing range, although the recorded mass balance still requires clarification because the total recorded particle mass reached only 95 percent. Therefore, the grinding quality result should be interpreted as an initial indication of particle size suitability rather than a final optimization result.

The result obtained from the disk mill coffee grinding machine suggests that the prototype has the feasibility for small to medium scale coffee processing. The average grinding capacity, which was close to the target of 30 kg per hour, indicates that the design of the disk mill, engine, and transmission were sufficient to support the target production. This aspect is important in recent developments of small capacity coffee grinders, where the feasibility of a grinding machine is increasingly determined not only by successful fabrication, but also by combined consideration of capacity, yield consistency and suitability for small producers (Han et al., 2026; Onyegirim et al., 2025; Geberehiet et al., 2026). In this sense, the current machine has a higher productivity than some recent small capacity coffee grinders, but the machine must undergo further testing to ensure efficient and stable operation over extended periods of use.

The output yield and material loss demonstrate that the machine was not only fast to grind coffee, but also capable of producing the maximum amount of coffee as a product. This is significant as production rate in postharvest equipment is not only affected by machine capacity. A coffee mill that can grind a large amount of coffee but with a high residual or spillage would be less economical to use every day. The consistent residual pattern observed in this study indicates that the residual may be related to chamber shape, outlet pathway, particle sticking, and feeding. Recent grinding optimization studies also suggest that grinding

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performance can be evaluated using several indicators, such as mass output, grinding time, uniformity, motor temperature and mean particle size (Guo et al., 2026; Zhao et al., 2026; Hu et al., 2026). Thus, the residual and losses in this study are a design suggestion to enhance the outlet pathway and chamber surface rather than a machine malfunction.

It is important to understand the difference between the material conversion efficiency and energy efficiency. The 94.55 percent value is the coffee conversion efficiency, while the energy efficiency value, 73.8 percent is the ratio between fuel energy and mechanical energy. These two values should not be combined because they represent different aspects of performance. Recent research on grinding optimisation highlights that energy efficiency is related to engine power, stability of rotational speed, motor temperature and load (Huang, 2025; Abubakar, 2025). Due to this, the energy efficiency result of the current study is still valuable, but it should be taken with caution since the manuscript still has an error between the 5.5 HP used for energy calculation and the 8 HP mentioned in the machine description. This should be corrected before the manuscript is submitted because the power of the engine used is a critical parameter in calculating efficiency.

The grinding quality result is also significant because coffee grinding is related to coffee brewing. The result that 70 percent of the particle sample had a size of 500-700 micrometers indicates that the machine was capable of producing a dominant particle size fraction that is suitable for filter brewing. Recent coffee research indicates that particle size distribution plays a key role in extraction, flavor consistency, acidity, bitterness, total dissolved solids, and sensory quality (Nguyen et al., 2025; Septiana et al., 2025; Ahmed et al., 2025). This suggests that particle size should not be considered as a secondary variable. It is part of the machine's quality performance. But the particle size results still need to be adjusted because the sieving fractions only add up to 95 g instead of the 100 g sample. The 5 g should be accounted for by repeating the sieving and reporting the mass balance.

Conclusion

This study concludes that the developed disk mill coffee grinding machine is technically feasible for small and medium scale coffee processing. The machine achieved an average grinding capacity of 29.68 kg per hour, which is close to the intended design capacity of 30 kg per hour. The average product yield and material conversion efficiency reached 94.55 percent, while the average material loss was only 1.11 percent. These results indicate that the machine can process roasted coffee beans efficiently with relatively low material loss. However, the presence of 4.00 percent residual material in the grinding chamber shows that the discharge system and internal chamber design still require improvement. The energy efficiency value of 73.8 percent also suggests that the gasoline powered system can support the grinding process, although the engine power specification must be clarified because the manuscript mentions both 8 HP and 5.5 HP. In terms of grinding quality, 70 percent of the particles were within the desired 500 to 700 micrometer range, indicating acceptable initial suitability for V60 brewing. Overall, the machine shows promising performance, but further refinement is needed in the outlet mechanism, residual reduction, engine specification consistency, and particle size mass balance before wider practical application.

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