SSRG International Journal of Mechanical Engineering
ISSN: 2348-8360/ https://doi.org/10.14445/23488360/IJME-V12I11P105

Volume 12 Issue 11, 48-54, November 2025

Original Article

Sustainable Energy from Biomass Waste: Design and Fabrication of a Screw Briquetting Machine with Calorific Value Assessment

Nagini Yarramsetty[1], Venkata Sushma Chinta[2], Kiran Kumar Amireddy[3], Narasimha Kumar S[4], Varimadugu Sandhya[5], Jyothirmayi Narne[6]

[1,2,3,4,5,6]*Department of Mechanical Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad, Telangana, India.*

[1]*Corresponding Author : ynagini_mech@cbit.ac.in*

Received: 06 September 2025   Revised: 07 October 2025   Accepted: 08 November 2025   Published: 28 November 2025

Abstract - *Biomass briquetting is an effective solution for utilizing agricultural and forest residues as a renewable energy source. This work focuses on designing and fabricating a screw briquetting press that efficiently compresses biomass into high-density briquettes. The machine operates on the screw extrusion principle, where biomass is compressed in a heated die to form cylindrical briquettes. Key design elements include screw and die design, material selection, and heating systems for optimal compaction and energy efficiency. Biomass types like sawdust and cocopeat were tested for density, compression strength, and combustion behavior, and the results were compared with charcoal briquettes. Results show biomass briquettes have comparative mechanical strength and specific calorific value like charcoal briquettes. The system supports rural energy needs by providing a renewable, low-cost fuel alternative and reducing farm waste.*

Keywords - *Biomass Briquettes, Saw Dust, Coco Peat, Fabrication of Briquetting Machine, Calorific Value.*

1. Introduction

By converting industrial, forestry, and agricultural residue into high-density, non-toxic fuel, biomass briquetting provides a sustainable substitute for coal and wood. Using a revolving screw inside a heated barrel, screw briquetting equipment efficiently transforms biomass into dense, long-lasting briquettes, enabling efficient energy recovery, lowering carbon emissions, and promoting rural energy security. In order to activate the natural binders, biomass must be fed, compressed, and heated. The briquettes are then extruded through a die and cooled. Applications include industrial boilers, rural energy solutions, and home heating and cooking, offering a clean alternative to conventional fuels.

Biomass briquetting has emerged as a sustainable method for rural energy production, transforming agro-residues into compact, environmentally friendly fuels. Nonetheless, the majority of prior research has concentrated on piston-type briquetting or singular feedstocks, such as rice husk and bagasse, while insufficient emphasis has been placed on screw-type systems and locally sourced materials, including sawdust, cocopeat, and charcoal. The link between machine design parameters and briquette fuel properties is inadequately investigated. This project aims to design and fabricate a screw briquetting machine and evaluate briquettes generated from sawdust, coconut coir (cocopeat), and charcoal separately. The aim is to create an economical, locally producible technology that can generate high-quality briquettes, thus facilitating trash utilization and offering a sustainable energy solution for rural areas.

Briquetting transforms low-density waste from farming into solid substances with improved combustion rate and decreased fire and pest hazards, according to El-Haggar [1]. Crop residues that have undergone collection, size reduction, air drying, and compaction, such as rice straw and bagasse, constitute good feed stocks.Briquetting is a potential process for turning biomass into usable solid fuel, enhancing handling and energy utility, according to a review by Kpalo et al. [2]. The type of feedstock and operational factors, such as temperature, moisture content, and particle size, affect the quality of the briquettes. A sustainable process for converting urban solid waste (MSW) into premium briquettes with advantageous energy and emission properties is presented in the study by Ganesan et al. [3]. For co-firing applications, MSW briquettes demonstrated a compression strength of 14.52 N/mm² and a calorific value of 22.53 MJ/kg, which is comparable to coal. The study by Tembe et al. [4] assesses energy usage, evaluating the feasibility of producing biomass briquettes in Cameroon over 20 years using coconut shells, sugarcane bagasse, banana peels, and decomposing waste. According to the results, briquettes made from rattan and coconut shells are worthwhile, while bagasse extract and banana peel are not economically feasible without careful planning. Marreiro et al.'s review [5] examines important process variables in the production of biomass briquettes, such as moisture content, pressure, and raw material granulometry, with a focus on how these variables affect the quality of the briquettes. Due to the observed heterogeneity in outcomes, the study supports the use of mathematical simulation and highlights a range of experimental techniques. Francis et al. [6] describe the design and construction of an economical biomass briquetting system that uses only locally sourced resources.

The machine was designed to compress biomass, such as palm fruit shells, rice husks, and sawdust. A hopper, compression container, feed screw extruder, and die are among its components. Compressive strengths ranged from 0.9 to 1.3 kN/m², with palm fruit shell briquettes exhibiting the greatest performance. The equipment worked well for producing briquettes in both neighborhood and industrial settings. The primary goal of Kapadani et al. [7] is to develop a low-cost screw briquetting system that converts crop residue into high-calorific biomass briquettes. With the goal of supporting Indian farmers, who comprise 55% of the labor force, the project highlights the potential for energy generation from unused agricultural waste. It places a strong emphasis on environmental Sustainability, entrepreneurship, and the promotion of renewable energy.

The study also looks at improving the composition of briquettes to increase their calorific value, with room for more advancements employing a variety of raw materials. According to Allan et al. [8], an automatic screw briquetting equipment was developed as an affordable startup option for rural areas in the Philippines. The machine allows for continuous production by incorporating automation components—such as a safety control panel, band heater, PLC, and induction motor controlled by a variable frequency drive—into a manual briquette system. By optimizing screw design, temperature, and speed through simulations and testing, high-quality briquettes were generated at a rate of 10 kg/hr. An economic analysis confirmed the machine's viability for small-scale business ventures. Sundar et al. [9] discuss the development and evaluation of a motorized screw press briquette machine for the production of ecologically friendly biomass fuel. When tested with various biomass combinations of sawdust, rice husk, and cow dung, the machine produced up to 1,020 briquettes per hour at a feed rate of 130 kg/h. Of them, B1 was the most economical, B3 had the maximum compacted density (1.24 g/cm³), and the B2 combination produced the longest briquettes. The study emphasizes how the device could encourage the adoption of renewable energy sources by lowering dependency on standard fuels like wood and charcoal. In order to alleviate the drawbacks of Traditional Briquette Machines (CBM), especially when processing biomass that grows quickly, such as water hyacinth, Okwu et al. [10] present a revolutionary integrated Hopper Briquette Machine (HBM). A feed hopper, barrel, dies, and heating element are among the essential parts of the HBM, which achieves an efficiency of 85% and a production rate of 120 kg/h. It generated 30 billets in 20 minutes during performance tests. The resultant briquettes promoted sustainable solid fuel production by meeting conventional fuel characteristics and being appropriate for usage in bakeries, restaurants, and industrial applications. Sanchez et al. [11] give a thorough rundown of how bio-briquettes are made from agricultural wastes, including bagasse, maize cobs, and rice husks, which are often burned or allowed to rot and harm the environment. The study outlines key procedures, including pretreatment, pyrolysis, size reduction, binder addition, densification, and the utilization of biomass as a readily accessible renewable energy source. It highlights the efficiency of bio-briquettes as wood substitutes for cooking, heating, and energy. The report also covers quality assessment techniques, technological developments, obstacles, and potential paths in the bio-briquetting industry. [12] Shiva Kumar, P. Dinesha, and colleagues (2019) investigate the possibilities of utilizing biomass briquettes as a fuel alternative, emphasizing the effective use of agricultural and industrial waste to enhance rural incomes and conserve energy. It discusses various feedstocks, briquetting techniques, and process variables that affect the quality of briquettes.

Feedstock type, density, moisture content, and binder amount are key variables that influence combustion. A high ash percentage causes corrosion, fouling, and slagging in addition to lowering calorific value. The paper asks for more research on emissions from various briquette forms and finds that briquettes made from biomass are feasible for cooking and heating in rural areas. [13] Sawdust briquetting is being studied by Pushpa Jha et al. (2011) as a sustainable and environmentally beneficial energy source. The density of the briquettes generated is significantly higher (1400 kg/m³) than that of loose sawdust (210 kg/m³), which reduces the costs of handling, storage, and transportation. A 7 kg/hr briquetting machine was built for use in a laboratory. The study assessed how briquette density, utilization of energy, and calorific value were affected by the kind of binder and moisture content. After being tested in a regional stove (chulha), the briquettes showed promise for use in rural energy applications with an energy efficiency of 5%. [14] Briquettes prepared from coffee husk (T1), cocopeat (T2), and the combination thereof (T3) were assessed by Eligio C. Borres Jr. et al. (2022) based on their mechanical and fuel qualities. The most efficient fuel was coffee husk briquettes (T1), which had the highest calorific value (3,919.36 cal/g), the fastest ignition rate, the slowest burning rate, and required the fewest briquettes to boil one liter of water. The mixture (T3) displayed the lowest moisture content, but the cocopeat briquettes (T2) had the maximum strength in mechanical terms and the highest volatile matter content. According to the study's findings, T2 had greater strength and T1 had the finest fuel qualities. [15] The possibility of incinerated briquettes made from sawdust, rice, and coconut husks as a viable cooking fuel in Ghana was assessed by Gilbert Ayine Akolgo et al. in 2021. Using a Multiple-Feed Gasifier Stove (MFGS), the briquettes showed a high calorific value of 24.69 MJ/kg and a combustion efficiency of 34.7%. When compared to charcoal, emissions tests revealed notable drops in CO (80%) and particulate matter (14%).

According to a cost analysis, 40 percent of users said they would be willing to purchase briquettes at Gh¢2.48/kg, which results in a 10% profit. Charred briquettes are a practical and sustainable alternative to traditional fuels as wood and charcoal, according to the study's findings. [16] A study by Samuel Adeyanju (2016) assessed the fuel potential of sawdust-based briquettes and sawdust-paper mixtures for use in home cooking. The sawdust, which came from Triplochiton scleroxylon, was compressed using an automatic press that maintains a constant pressure of 1.77 kN/m². Different substrate-to-binder ratios (50:50%, 60:40%, and 70:30%) and sawdust-to-paper ratios (1:1, 1:2, and 2:1) were examined. The physical and combustion characteristics of the briquettes were assessed, and the mixing ratios had a major impact on both. In comparison to sawdust–paper blends, pure sawdust briquettes exhibited higher volatile matter content (89.67–93.5%) and higher heating values (31,292–32,176 Kcal/kg). On the other hand, the sawdust–paper (2:1) blend had the lowest fixed carbon (2.17–2.33%) and the greatest ash level (8.67–10.33%). The relaxed density and relaxation ratios demonstrated effective compaction. When it came to fuel quality and combustion efficiency, the pure sawdust and 1:1 sawdust–to–paper briquettes were found to be the most effective.

Wu [17] provides a thorough analysis of the integration of biomass briquettes, highlighting the environmental benefits of utilizing densified biomass, including reduced greenhouse gas emissions, improved waste management, and the potential to replace coal and firewood in local energy systems. The study emphasizes that in order to guarantee high-quality briquette manufacturing and improved energy recovery, machine design and operating parameters must be optimized. With an emphasis on new developments and trends, Ngene [18] examined char and biomass briquette techniques. According to the study, screw-type briquetting systems have several advantages over traditional piston or hydraulic presses. These advantages include enhanced binder activation, uniform compaction, and continuous operation, which produce higher-density briquettes with constant calorific values. Ngene also highlights the possibility of using locally accessible leftovers as sustainable feedstocks in decentralized rural energy systems, including sawdust, agricultural husks, and charcoal fines. A systematic analysis and Life Cycle Assessment (LCA) of briquettes and pellets in Latin America by Silva et al. [19] demonstrated that, compared to traditional fossil fuels, biomass densification can significantly reduce environmental impacts. In order to produce low-emission, high-efficiency briquettes appropriate for both small-scale and industrial applications, the study emphasizes the significance of feedstock choice, densification technology, and processing parameters. Experimental studies on the manufacturing of briquettes from coal–biomass blends were conducted by Rath et al. [20], who assessed performance indicators such as combustion efficiency, compressive strength, and calorific value. Their results demonstrate that briquette quality and energy output are significantly impacted by ideal processing parameters, such as moisture content, particle size of particles, and compaction pressure. Particularly for neglected residues such as sawdust, coir pith, and charcoal fines, our experimental evidence highlights the necessity of comprehensive investigations that combine machine design with feedstock-specific characterization.

Using a screw-type briquetting system made from locally accessible materials, the current work combines machine design with briquette performance evaluation in a novel way. This paper examines sawdust, cocopeat, and charcoal separately to ascertain their densification and combustion properties, in contrast to earlier research that looked at single feedstocks or piston-type presses. By guaranteeing consistent heating and ongoing extrusion, the designed method improves the quality of the briquettes and the efficiency of the operation. The study shows a workable, affordable method for turning local waste from biomass into sustainable rural energy by tying feedstock properties to fuel performance. The present effort is distinct from previous studies due to its combined contribution of resource value and technological innovation.

2. Design and Development of Briquetting Machine

Screw briquetting machine design is crucial for efficient biomass compaction, ensuring optimal component selection, durability, and high-quality briquette production. The key components of a screw briquette machine include the screw, hopper, die, and main frame section, each essential for efficient biomass compression and briquette formation.

2.1. Screw

An essential part of the briquetting machine, the screw transports and compresses biomass into homogeneous, compact briquettes. For briquetting purposes, the screw in this design has seven teeth (flights) spaced out over a flighted length of 237 mm. In Figure 1, the helix angle is assessed to be 23.33°, and the screw's mean diameter is determined to be 25 mm. It is discovered that 52.5 Nm of torque is needed to crush the biomass with the screw. It is determined that the motor needs 59.2 kW of power. A 3 HP motor running at 1435 rpm was chosen for the designed machine. A gearbox was added to lower the motor speed and raise the output torque proportionately in order to reach the necessary torque. The equations 1 to 5 are used to calculate screw dimensions.

$$\text{Mean Diameter } (D_m) = (D+d)/2 \tag{1}$$

$$\text{Helix Angle } (\theta): \tan(\theta) = P/(\pi D_m) \tag{2}$$

$$\text{Torque } T = F.D/2 \tag{3}$$

Shear Stress in Shaft

$$\tau = T.r/J \tag{4}$$

Where $J = \pi.D^4/32$

$$\text{Power Requirement: } P = 2\pi NT/60 \tag{5}$$

Fig. 1 Design of the screw

2.2. Hopper

The hopper, whose shape and slope are determined by the bulk density and flow characteristics of the material, guarantees a steady, gravity-fed biomass flow into the screw chamber. To make loading materials easier, the hopper's top entrance is square and is 300 mm by 300 mm. It has a tapered part that ensures smooth material flow and avoids clogging by going from 300 mm x 300 mm to 130 mm × 130 mm. With a final bottom outlet that is 230 mm by 50 mm, material can be discharged into the screw shaft consistently and unhindered. Figure 2 illustrates how the hopper walls are angled between 45° and 60° to accommodate gravity-fed flow. To endure wear, abrasion, and extended operating stress, mild steel or stainless steel is used in the structure's construction. While the design encourages easy cleaning, adequate feeding, and wear resistance, a top flange guarantees structural strength.

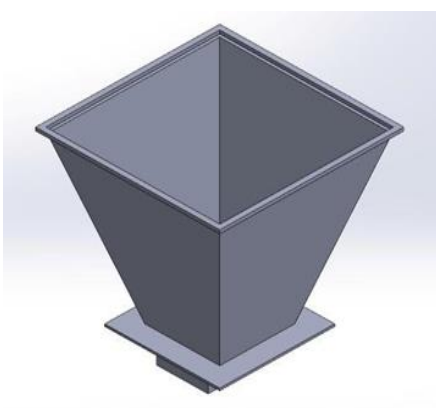

Fig. 2 Design of the hopper

2.3. Die

In order to increase pressure, initiate lignin binding, and facilitate smooth extrusion, the die, which is essential for compressing biomass into cylindrical briquettes, has a tapered interior shape. The die is 100 mm in length. Figure 3 shows that the outer diameter is 50 mm and the inner diameter is 30 mm.

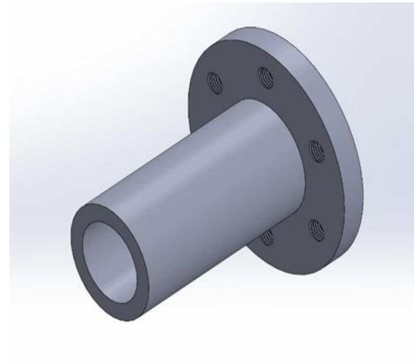

Fig. 3 Design of the Die

2.4. Main Frame

The main frame is constructed from mild steel. It includes cut-outs for the hopper and die, fillets to reduce stress, and flanges for mounting, ensuring strength, accuracy, and ease of assembly, as shown in Figure 4.

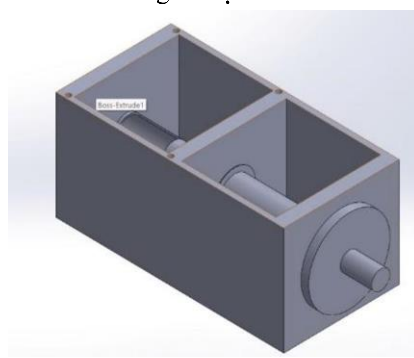

Fig. 4 3D design of the main frame

2.5. Briquetting Machine

The screw briquetting machine was assembled in SolidWorks using precise mate features and subassemblies to ensure accurate alignment, smooth material flow, and ease of maintenance, as shown in Figure 5.

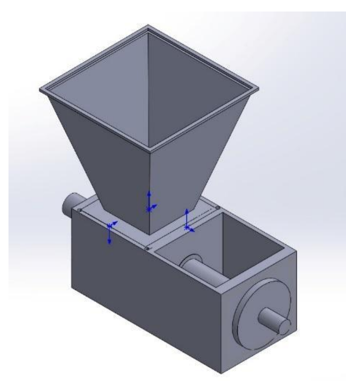

Fig. 5 3D model of the biomass briquetting machine

3. Materials and Fabrication of Briquettes

Figure 6 depicts a briquetting machine that was created at CBIT in accordance with the concept. To heat the feedstock and produce the desired briquette, a heating plate is utilized to encircle the screw. In order to soften the lignin component that is naturally contained in the biomass, the material is compacted by the heating plate, creating briquettes with a central hole. A display device shows the heating plate's temperature. Raw biomass is first fed into the hopper of the screw briquetting machine, where it is gradually forced into a compression chamber by a revolving screw conveyor. The biomass comes into contact with a heated die or heating plate as it moves forward, which causes the temperature to rise. Throughout the compaction process, this softened lignin serves as a binder. The heated biomass is compressed into a dense cylindrical shape by the screw's constant spinning and pressure as it pushes through the die. The majority of briquettes made using this technique include a center hole, which improves airflow and increases combustion efficiency. The screw briquetting machine's design allows for continuous operation, guaranteeing a steady output and making it appropriate for large-scale production of roughly 8 kg/hour.

Fig. 6 Fabricated screw briquette machine

Three materials-sawdust, cocopeat, and coal-were used to create the briquettes. The materials must be clean, dry, and fibrous briquettes of excellent cellulosic biomass grade. To maintain homogeneity and avoid machine clogging, impurities are eliminated. In order to increase briquette strength, avoid steam-induced cracks, and maximize machine efficiency, the moisture content is lowered to 8–12% through sun drying. To guarantee consistent feeding, greater compaction, and enhanced mechanical strength and combustion properties for the briquettes, biomass is ground to less than 5 mm using grinders. The die (50 mm outside, 30 mm inner), heated to 200–350 °C, enabled lignin softening and binderless briquetting, while the tapered 300×300 mm hopper guaranteed smooth feed. The built machine generated dense, consistently formed briquettes with a satisfactory throughput and steady operation when tested with sawdust and coco peat.

Figure 7 depicts sawdust. Briquettes are small, waste-reducing, and energy-efficient fuels made from sawdust and wood particles. They are an energy-efficient source of inspiration and an environmentally friendly substitute for the waste that would result from utilizing conventional firewood. The coconut peat is shown in Figure 8. Briquettes are made from the fibers of coconut husks and are considered green fuels. They are more environmentally friendly than traditional fuels, yet they burn more efficiently. Figure 9 shows the charcoal. Briquettes are solid blocks that burn hotter and longer than ordinary wood, making them a high-energy fuel source.


Fig. 7 Sawdust briquette


Fig. 8 Cocopeat briquette


Fig. 9 Charcoal briquette

4. Results and Discussion

Briquettes were made from three different biomass materials: charcoal, sawdust, and cocopeat, using the screw briquetting equipment that was built. Each material exhibited unique characteristics determined by physical and energy-related parameters:

Figure 10(a) illustrates that charcoal briquettes had the highest density (1328 kg/m³), indicating better compaction and mass per unit volume. Sawdust and cocopeat followed with 947 kg/m³ and 723 kg/m³, respectively. Higher density improves transport and storage efficiency.

Figure 10(b) shows the gross calorific value of briquettes tested as per ASTM E711 standard. Charcoal briquettes exhibited the maximum calorific value (4940 Kcal/kg), making them the best option for thermal energy. Sawdust (4710 Kcal/kg) also showed good potential, while cocopeat (3090 Kcal/kg) was relatively lower due to its fibrous and airy structure.

Figure 10(c) depicts the compressive strength of briquettes tested at U.T.M. The compressive strength is highest for charcoal (1872 Pa), indicating better structural integrity during handling and transportation. Sawdust (1330 Pa) showed moderate strength, and cocopeat (980 Pa) was comparatively weaker due to its loose bonding structure.

Figure 10(d) provides a moisture content of briquettes as per ASTM E871. Charcoal briquettes had the least moisture (3.97%), which is favorable for combustion. Sawdust and cocopeat had slightly higher moisture contents (4.79% and 4.98%), which are in the allowable range for making briquettes.

Charcoal's 4,940 kcalkg^{-1}, sawdust's 4,710 kcalkg^{-1}, and cocopeat's 3,090 kcalkg^{-1} HHV ranking reflects the inherent composition of the feedstock and compaction behavior. Charcoal is preferred for high-energy applications due to its higher fixed-carbon fraction and superior densification, which produce the highest HHV. For both home and small-scale industrial applications, sawdust offers competitive HHV and good mechanical strength. Cocopeat's fibrous structure and probably larger non-combustible portion are responsible for its low HHV and lower compressed strength.

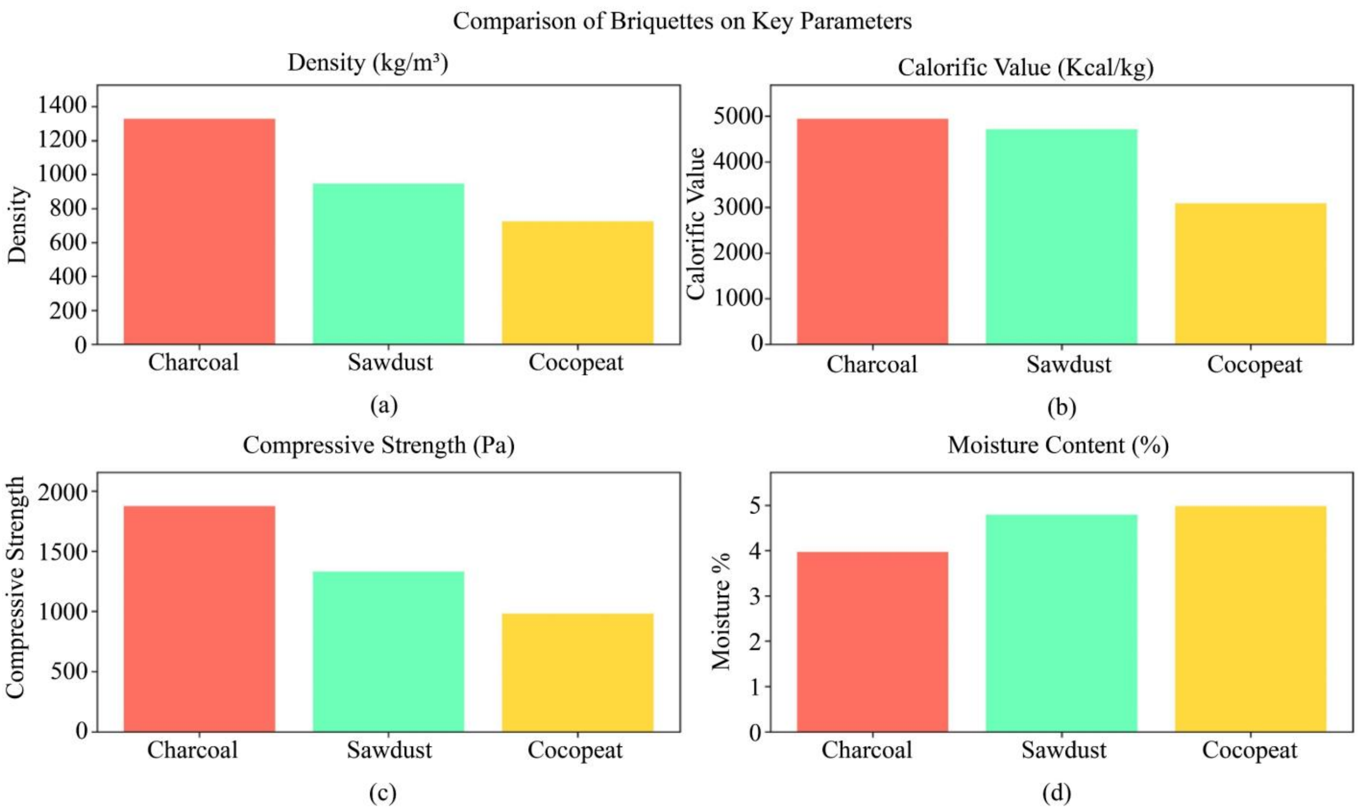

Fig. 10 Comparison of key parameters of briquettes

5. Conclusion

The study successfully addressed a critical research gap by designing a low-cost, efficient screw briquetting machine and conducting a comparative evaluation of three commonly available biomass sources. Unlike prior studies that focused on single materials or expensive hydraulic presses, this work demonstrated the adaptability of screw briquetting across multiple materials. Offered quantitative insights into how material type affects energy value, density, and mechanical strength. Provided a sustainable waste-to-energy pathway for agricultural residues. Encouraged the adoption of custom briquette production based on local material availability. This research thus lays the groundwork for scalable, decentralized energy solutions in both rural and semi-urban areas, while promoting clean energy and circular economy principles.

5.1. Future Scope

Future research can focus on optimizing process parameters such as screw speed, die temperature, and pressure to enhance briquette quality and performance. Investigating hybrid briquettes by blending materials like sawdust and charcoal may help achieve a balance between calorific value, density, and production cost. The use of eco-friendly binders such as starch, molasses, or clay can be explored to improve mechanical strength without harmful emissions. Emission analysis during combustion is essential for environmental compliance. For commercial scalability, semi-automated screw briquetting machines can be designed to increase throughput. Additionally, life cycle and cost-benefit analyses will aid rural entrepreneurs in assessing viability.

Funding Statement

The authors sincerely express their heartfelt gratitude to Chaitanya Bharathi Institute of Technology (CBIT) for the generous funding and continuous support provided under the major research project titled "Design and Fabrication of Biomass Briquetting Machine", as per the sanction order no. CBIT/ PROJ-IH/ I028/ Mech/ D008/ 2024, dated: 26 March 2024.

References

[1] Dr. Salah M. El-Haggar, *Chapter 7 - Sustainability of Agricultural and Rural Waste Management*, Sustainable Industrial Design and Waste Management, Academic Press, pp. 223-260, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[2] Sunday Yusuf Kpalo et al., "A Review of Technical and Economic Aspects of Biomass Briquetting," *Sustainability*, vol. 12, no. 11, pp. 1-20, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[3] Sowndharya Ganesan, and Praveena Vedagiri, "Production and Emission Characterization of Briquette for Sustainable Development: MSW Transformation," *Environmental Science and Pollution Research*, vol. 31, pp. 34340-34354, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[4] E. Tembe, P. Otache, and D. Ekhuemelo, "Density, Shatter Index, and Combustion Properties of Briquettes Produced from Groundnut Shells, Rice Husks and Saw Dust of Daniellia Oliveri," *Journal of Applied Biosciences*, vol. 82, pp. 7372-7379, 2014. [CrossRef] [Google Scholar] [Publisher Link]

[5] Hívila M. P. Marreiro et al., "Empirical Studies on Biomass Briquette Production: A Literature Review," *Energies*, vol. 14, no. 24, pp. 1-40, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[6] Francis Inegbediona, and Tina Ishioma Francis-Akilaki, "Design and Fabrication of a Briquetting Machine," *Journal of Energy Technology and Environment*, vol. 4, no. 1, pp. 11-20, 2022. [Google Scholar] [Publisher Link]

[7] K.R. Kapadani et al., "Design and Manufacturing of Screw Briquetting Machine for Compaction of Biomass," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 9, pp. 1136-1140, 2020. [Google Scholar] [Publisher Link]

[8] Allan Yambot et al., "Automated Screw Type Briquetting Machine as A Small Business Venture," *International Journal of Automation and Smart Technology (auSMT)*, vol. 6, no. 4, pp. 185-189, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[9] Veeravalli John Praneeth Sundar et al., "Development and Evaluation of a Screw Press Briquetting Machine for Biomass Fuel Production," *International Journal of Advanced Biochemistry Research*, vol. 8, no. 11, pp. 259-267, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[10] M.O. Okwo et al., "Development of A Novel Integrated Hopper Briquette Machine for Sustainable Production of Pellet Fuels," *Procedia Computer Science*, vol. 217, pp. 1719-1733, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[11] Philip Donald Cabuga Sanchez, Mia Me T. Aspe, and Kenneth N. Sindol, "An Overview on the Production of Bio-briquettes from Agricultural Wastes: Methods, Processes, and Quality," *Journal of Agricultural and Food Engineering*, vol. 3, no. 1, 2022. [Google Scholar]

[12] P. Dinesha, Shiva Kumar, and Marc A. Rosen, "Biomass Briquettes as an Alternative Fuel: A Comprehensive Review," *Energy Technology*, vol. 7, no. 5, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[13] Pushpa Jha, and Pramod Yadav, "Briquetting of Saw Dust," *Applied Mechanics and Materials*, vol. 110-116, pp. 1758-1761, 2012. [CrossRef] [Google Scholar] [Publisher Link]

[14] Eligio C. Borres, and Lira Virginia B. Mora, "Evaluation and Analysis of Coffee Husk and Coco Peat Briquettes as Biomass Fuel," *European Online Journal of Natural and Social Sciences: Proceedings*, vol. 11, no. 4, pp. 604-617, 2022. [Google Scholar] [Publisher Link]

[15] Gilbert Ayine Akolgo et al., "Assessment of the Potential of Charred Briquettes of Sawdust, Rice and Coconut Husks: Using Water Boiling and User Acceptability Tests," *Scientific African*, vol. 12, pp. 1-8, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[16] Samuel Oluwanisola Adeyanju, "*Evaluation of Sawdust and Sawdust - Paper Briquettes as High Grade Fuel for Domestic Cooking*," Ph.D. Thesis, Federal University of Technology Akure, pp. 1-56, 2016. [Google Scholar]

[17] Mingjun Wu et al., "Advancing Green Sustainability: A Comprehensive Review of Biomass Briquette Integration for Coal-Based Energy Frameworks," *International Journal of Coal Science & Technology*, vol. 12, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[18] Gloria Ifunanya Ngene et al., "A Review on Biochar Briquetting: Common practices and Recommendations to Enhance Mechanical Properties and Environmental Performances," *Journal of Cleaner Production*, vol. 469, pp. 1-16, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[19] D.A.L. Silva et al., "A Systematic Review and Life Cycle Assessment of Biomass Pellets and Briquettes Production in Latin America" *Renewable and Sustainable Energy Reviews*, vol. 157, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[20] Debi Prasad Rath, Abinash Mahapatro, and Binayak Pattanayak "Briquette Production and Performance Evaluation from Coal and Agricultural Waste" *Materials Today Proceedings*, 2023. [CrossRef] [Google Scholar] [Publisher Link]