
| RESEARCH ARTICLE

Advances in Charcoal Briquetting Machines: A Comprehensive Review of Technologies, Performance, and Sustainable Applications

Swift N. K. Onyegirim¹, Emmanuel I. Nwankwo² ✉ Kennedy C. Owuama³ and Hipolite A. Madukasi⁴

¹²³⁴*Department of Mechanical Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli – Nigeria*

Corresponding Author: Emmanuel I. Nwankwo, **E-mail:** ei.nwankwo@coou.edu.ng

| ABSTRACT

This review meticulously investigates the technological framework surrounding charcoal briquetting machines, accentuating their operational mechanisms, efficiency metrics, and diverse applications. Employing a systematic literature review methodology, a total of 26 peer-reviewed articles were meticulously curated from the Scopus and Google Scholar databases, encompassing the years 2000 to 2025, predicated on established performance, design, and application parameters. The analysis delineates briquetting machines into four principal classifications: manual, hydraulic piston, screw extruder, and roller press machines. Significant findings indicate that manual machines provide cost-effectiveness and suitability for rural contexts, albeit at the expense of lower production throughput. Hydraulic piston presses improve the durability and consistency of briquettes, while screw extruders facilitate the continuous manufacture of high-calorific briquettes, though they are associated with elevated wear rates. Roller press machines demonstrate exceptional performance at the industrial scale with reduced binder requirements. Notwithstanding their advantages, all machine types present inherent trade-offs regarding energy efficiency, cost implications, and operational intricacy. Contemporary trends underscore the significance of automation and the Internet of Things (IoT) in enhancing overall performance. The investigation proposes the formulation of hybrid systems that amalgamate the straightforwardness of manual designs with the operational efficacy of automated presses. Furthermore, it endorses customized deployment strategies: low-maintenance units for rural environments and sophisticated systems intended for industrial applications. These findings aspire to guide forthcoming design innovations and policy advocacy for sustainable biomass energy initiatives.

| KEYWORDS

Charcoal briquetting machine, biomass energy, screw extruder, hydraulic piston press, roller press, manual briquetting.

| ARTICLE INFORMATION

ACCEPTED: 05 May 2025

PUBLISHED: 07 June 2025

DOI: 10.61424/ijans.v3.i2.325

1. Introduction

The escalating international demand for sustainable and renewable energy alternatives has engendered considerable scholarly interest in biomass briquettes as a substitute for conventional fossil fuels (Karekezi, 2002). Charcoal briquettes, derived from agricultural byproducts, forestry refuse, and various biomass constituents, present an environmentally sustainable solution by mitigating deforestation and reducing greenhouse gas emissions (Mwampamba et al., 2013a). The efficacy and quality of charcoal briquettes are primarily determined by the type of briquetting apparatus used, making the selection of appropriate technology crucial for achieving optimal production outcomes (Mwampamba et al., 2013a). This manuscript offers a thorough examination of the various types of charcoal briquetting machines, their operational mechanisms, efficiencies, and applications, providing

Copyright: © 2025 the Author(s). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) 4.0 license (<https://creativecommons.org/licenses/by/4.0/>). Published by Bluemark Publishers.

insights into the advancements and challenges prevalent in this domain (Ezechukwu et al., 2025; Ikebudu et al., 2012; Ikebudu et al., 2015; Iweka et al., 2019; Iweka & Owuama, 2020; Iweka et al., 2021a). Charcoal briquetting machines facilitate the compression of biomass materials under elevated pressure, with or without the addition of binders, to yield dense and uniform briquettes suitable for combustion purposes (Kpalo et al., 2020). The principal machines utilized in briquette fabrication encompass screw extruders, piston presses (both hydraulic and mechanical), and roller presses, each characterized by unique operational mechanisms and performance attributes (Bello et al., 2024; Dohm, 2013). Screw extruders implement continuous compression through a rotating screw mechanism (Anaemeje et al., 2022; Idogho et al., 2025; Chinedu, 2021; Chukwudi et al., 2024), resulting in the production of high-density cylindrical briquettes, whereas piston presses employ a reciprocating motion to compact biomass into solid blocks (Miah, 2017). Conversely, roller presses operate by employing two counter-rotating rollers to generate briquettes, frequently necessitating binders to ensure cohesion (Ngene et al., 2024). The selection of machinery is contingent upon several factors, including the properties of the raw materials, the desired quality of the briquettes, the scale of production, and economic considerations (Ngene et al., 2024; Obi et al., 2022).

Briquetting machine efficiency is measured by a number of factors, including energy consumption, production capacity, briquette durability, and combustion performance (Dinesha et al., 2019). According to research, screw extruders frequently produce higher-quality briquettes but have high wear and maintenance costs (Dikeogu et al., 2014; Ekpechi et al., 2023; Ekpechi et al., 2025; Erebugha et al., 2024; Eze et al., 2021; Ezeaku et al., 2024), while piston presses are more durable but may require more energy (Tumuluru et al., 2011). Additionally, the addition of binders like starch, clay, or molasses affects the calorific value and strength of briquettes, with varying outcomes depending on the type of machine (Lubwama et al., 2022; Obi et al., 2022). Recent advancements in automation and Internet of Things-based monitoring systems have further increased the efficiency and dependability of briquetting machines by enabling real-time adjustments for optimal performance (Zhang et al., 2021). The applications of charcoal briquettes span household cooking, industrial heating, and power generation, particularly in developing regions where access to clean energy remains limited (Mwampamba et al., 2013). In rural Africa and Asia, small-scale briquetting machines have empowered local communities by converting agricultural waste into valuable fuel (Jugu et al., 2025; Ikebudu et al., 2021; O. D. K. et al., 2024; Nwankwo et al., 2012; Nwankwo et al., 2011; Vivian et al., 2025), reducing reliance on firewood and charcoal (Mwampamba et al., 2013b). Meanwhile, industrial-scale briquetting plants contribute to sustainable waste management and carbon-neutral energy production in developed economies (Divyabharathi et al., 2024).

Despite their benefits, challenges such as high initial investment costs, machine wear, and inconsistent briquette quality persist, necessitating further research into material optimization and machine design (Mwampamba et al., 2013c). This review synthesizes existing literature on charcoal briquetting machines, comparing their mechanisms, efficiency, and applications while identifying gaps for future research (Onyenanu et al., 2024; Owuama & Owuama, 2021; Swift et al., 2012; Onyenanu et al., 2015; Ubani & Onyenanu, 2024; Ukwu et al., 2024; Utu et al., 2024). By evaluating technological advancements and economic feasibility, this study aims to guide engineers, manufacturers, and researchers in optimizing briquetting processes for sustainable energy solutions (Madukasi et al., 2025; Mulani et al., 2022; Nnaji et al., 2024; Offodum et al., 2025; Okonkwo et al., 2012; Onyenanu & Nwigbo, 2021).

2. Literature

Research about charcoal briquetting machinery encompasses a variety of models, each tailored to distinct operational contexts. Manual briquetting machines, such as those innovated by Ninawe et al. (2024) and Osarenmwinda and Ihenyen (2012), are lauded for their cost-effectiveness and suitability within rural environments. Hydraulic piston presses have been examined by Segun et al. (2023) and Agidi et al. (2017), who document substantial compaction efficiency alongside robust briquette longevity. Screw extruder machines, analyzed by Arowosafe (2021) and Puspa et al. (2023), facilitate continuous operation and enhanced combustion characteristics; however, they often necessitate meticulous maintenance. Roller press machines, as explored by Bembenek et al. (2025) and Gaikwad et al. (2023), demonstrate efficacy in the high-volume production of uniform briquettes, particularly within industrial applications. Across the spectrum of machine types, scholars highlight energy consumption, mechanical integrity, and the role of binders as pivotal factors that significantly affect briquette

quality and operational efficiency. The existing body of literature signifies persistent endeavors to enhance design efficacy and advocate for sustainable biomass usage.

3. Methodology

To ensure a rigorous and comprehensive literature base, the Scopus and Google Scholar databases were selected for data retrieval due to their extensive indexing of peer-reviewed publications in renewable energy technologies, mechanical engineering, and sustainable biomass utilization (Aromataris & Riitano, 2014; Bramer et al., 2017). The following Boolean search query was used to capture a broad range of research outputs:

- "Charcoal briquetting machine" OR "biomass briquette press"
- AND ("manual" OR "screw extruder" OR "hydraulic piston" OR "roller press")
- AND ("design" OR "performance" OR "efficiency" OR "fabrication" OR "application")

The search covered the years 2000 to 2025, to encompass both foundational studies and recent innovations in machine design, energy performance, and application. This initial query returned 729 records. After applying exclusion criteria such as lack of experimental data, non-English language, or duplication, and performing quality appraisal based on methodological rigor, 26 studies were shortlisted and used in the full-text review. The review focused on publications that involved performance evaluations, field testing, or comparative analysis of briquetting machine types.

3.1 Publication of Journals by Ranking

As illustrated in Figure 2, the publication trend over the last two decades shows a marked increase in research focused on charcoal briquetting machine technology, particularly between 2015 and 2025. This surge aligns with global and regional efforts to promote sustainable solid biofuels, especially in Sub-Saharan Africa and South Asia, where dependence on traditional wood fuel remains high. High-ranking journals in renewable energy, agricultural engineering, and environmental technology featured prominently in the publication landscape. The increase in scholarly output reflects a broader shift toward green engineering solutions, circular economy integration, and the decarbonization of cooking fuels in line with the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action).

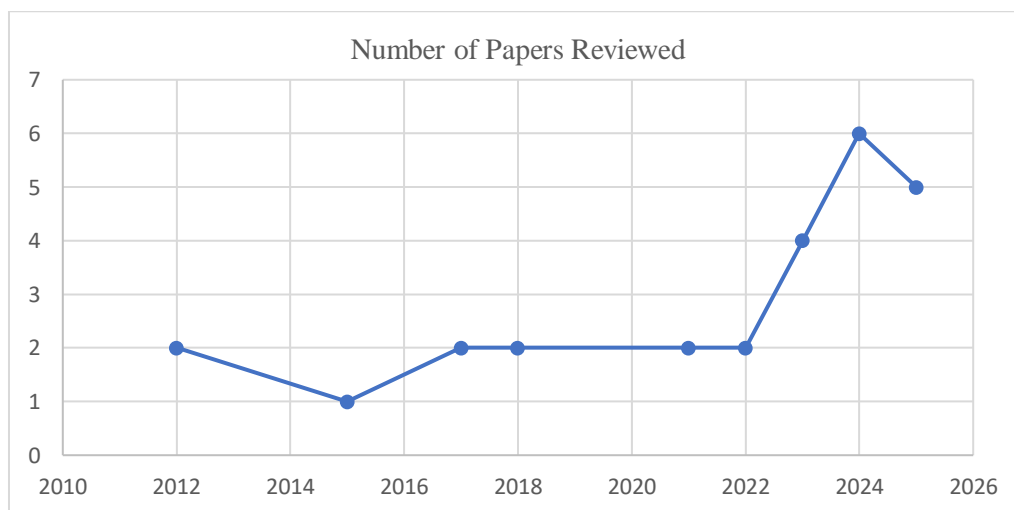


Figure 1: Graph of Journal Article by Year of Publication (Osobajo et al., 2017)

4. Review

A comparison analysis was carried out to highlight operational differences and performance indicators among several charcoal briquetting machine types. Table 1 compiles data from several studies to compare manual, hydraulic piston, screw extruder, and roller press machines based on key criteria such as production capacity, energy efficiency, briquette quality, and mechanical layout. This comparison clearly demonstrates the trade-offs

between simplicity, productivity, and technological sophistication. Manual machines provide low-cost options appropriate for rural deployment, but they produce lower throughput.

Table 1: Summary of Reviewed Studies on Manual (Lever-Based) Charcoal Briquetting Machines

S/N	Title	Machine Description	Key Findings	Citations
1	<i>Performance Evaluation of a Hand-Operated Compression-Type Briquetting Machine</i>	"A manual briquetting machine was developed to address rural unemployment. The machine uses a piston press mechanism for briquetting and a swing and lever component to convert human force into piston pressure."	"The machine achieved an average production capacity of 122.928 kg/hr, demonstrating its efficiency. Practical implications include producing 5 to 8 kg of briquettes per day, meeting the daily cooking fuel needs of a family of four."	(Ninawe, Ingale, et al., 2024)
2	<i>The Preliminary Design and Fabrication of a Manually Operated Briquetting Machine</i>	The machine's principal parts are the frame, compaction chamber, and base plate. The compaction chamber contains twenty (20) moulding dies, each having transmission rod, piston, and ejector."	"The machine can produce twenty (20) briquettes at a time of about 50mm length and 28mm diameter. The compaction pressure and force were determined to be 17.5 KN/m ² and 215.3N, respectively. It is hoped that the machine will be very useful for small and medium-scale briquette manufacturers."	(Osarenmwinda & Ihenyen, 2012)
3	<i>The Production of Briquette from Sawdust and Waste Paper Using a Manual Briquetting Machine</i>	"The briquettes were produced using a manual briquetting machine using three sawdust and waste paper mixing ratios of 50:50, 80:20, and 20:80. Combustion reactions investigated were burning time, ignition time, moisture content, density, volatile matter, fixed carbon, ash content, and calorific values."	"The percentage free carbon of the briquettes ranged from 18- 25%; the calorific value ranged from 3418-3689cal/g. The results attained show that sawdust and waste paper mixture have good combustion characteristics, which qualify them as an alternative to firewood for domestic, industrial, and commercial energy."	(Onwugbuta et al., 2023)
4	<i>Design, Development, and Performance Evaluation of a Manually Operated Briquette Machine for Sustainable Energy Production from Agricultural Waste</i>	"A 5-ton hydraulic jack is used to manually run the machine and provide the pressure required for compaction. The briquette machine has two mould boxes positioned vertically, one on top and the other at the bottom. Each mould box has 16 sets of	"It was developed and effectively employed in the production of sawdust-based biomass briquettes. It can produce 32 briquettes. The physical properties of the briquettes produced were determined at varying biomass-binder ratios of 100:15 and 100:25 by weight using cassava starch as the binding agent. The biomass briquette machine is designed for small-scale biomass briquette manufacture."	(Larbi et al., 2024)

5	<i>Design and Implementation of a Low-Pressure Briquetting Machine for Pinus spp. Wood Residues: An Approach to Appropriate Rural Technology</i>	<p>pistons, which aid in the compaction process.”</p> <p>“The design integrates the following components: structure, shaft for compaction, device to activate manual compaction, and mold to generate solid biofuel (briquette).”</p>	<p>“The proposed briquette molding unit can produce 4 cylindrical pieces in one pressing. Each briquette has an approximate diameter of 7.2 cm with a length of 9 to 10 cm. The machine operator generates, on average, 94 briquettes in a 6-hour workday, with a maximum operating pressure of 2.40 MPa. Carbon dioxide equivalent emissions of 77 g CO₂e/kg are presented as a viable and balanced alternative among traditional fuels. The machine is suitable for the local production of briquettes.”</p>	(Morales-Máximo et al., 2025)
---	--	---	---	-------------------------------

Table 2 summarises major data from the chosen research, including compaction force, briquette strength, binder ratio, and thermal efficiency. The research examined shows that hydraulic presses produce consistent output quality, with compression ratios and briquette densities varying according to biomass source and binder content.

Table 2: Hydraulic piston press Briquetting Machines

S/N	Title	Machine Description	Key Findings	Citations
1	<i>Development of a Multiple-Piston Hydraulic Briquetting Press HBP and Characterization of Newsprint Briquettes Produced</i>	"Sorted Gmelina arborea sawdust was mixed with pulped newsprint fibers in 5 ratios, 10, 20, 30, 40, and 50%, respectively, to produce briquettes."	"The machine output capacity was 96 briquettes/hour, with low production cost. The briquettes produced are structurally stable with dimensions: 15.00 mm internal hole, 80.00 mm external diameter, and 60.00 mm height. Low binder briquettes (90:10% wt/wt) are fragile and brittle, while higher binder briquettes are strong and durable. Binder concentration positively improves the combustion characteristics, while the time spent cooking 1kg of yam is not significantly different from rice. The briquettes' thermal efficiency in the stove was significantly affected by binder concentration and stove characteristics."	(Segun et al., 2023)
2	<i>Development and Performance Evaluation of a Hydraulic Operated Double Mould Briquette Machine</i>	"A 2-ton-sized hydraulic jack is used to provide two equal but opposite pressures for the production of briquettes from two sets of mould boxes. The developed briquette machine consists of two mould boxes positioned vertically opposite to each other at the top and the bottom."	"Each mould box has 16 sets of pistons which aid in the compaction process, giving the machine the capacity to produce 32 briquettes at a time. The shatter index and water resistance capacity of the produced briquettes were determined to be 98.6 % and 95.75 %, respectively, and were attained at an optimum biomass-binder ratio of 100:25. The analysis or tests performed on the briquette from sawdust demonstrate that the machine's performance is good. The biomass briquetting machine is designed for small-scale biomass briquette manufacturing."	(Osei et al., 2022)
3	<i>Design and fabrication of a hydraulically operated machine for making briquettes from agricultural waste</i>	"Its major parts include hydraulic jack, frame, pistons, and compression cylinders. The results of testing the equipment revealed that the highest binder concentration ratios of 30% and 40% produced the best briquettes. The compression ratios of the machine for the different materials are of appreciable levels, ranging from 1:2.5 to 1, 3.2, with rice husk having the least and saw dust the highest."	"The bulk densities of the briquettes produced also varied widely, with rice husk recording the lowest value of 2.5 kg/m ³ and sawdust the highest value of 5.2 kg/m ³ . In addition, the compressive strength of the bagasse produced with saw dust was higher, with the value of 1.8 KN/m ² and that of rice husk was lower, with the value of 0.26 KN/m ² ."	(Agidi et al., 2017)
4	<i>Development and Performance</i>	"The machine consisted of the 40-bar hydraulic-	"The machine has a capacity of 120 briquettes per hour. The compressed	(Dairo et al.,

	<i>Evaluation of a Low-Cost Hydraulic-Operated Biomass Briquetting Machine</i>	operated piston, control, press, power, ejection, and frame sections, and adopted the binder-less technology. Sawdust and rice husk were used as sample biomass materials."	biomass obtained from the developed machine in the form of briquettes had a mean diameter and height of 30 mm \pm 0.02 and 16 mm \pm 0.01, respectively. The heating values obtained for SB and RHB were 51.0 Kcal/g and 39.4 Kcal/g, respectively. The output efficiency of the machine was 88%, indicating a satisfactory performance of the machine."	2018)
5	<i>Performance Evaluation of a Piston Press for Sawdust Briquetting as Solid Fuel.</i>	"Operated with an electric motor (1HP), driver/driven pulleys, v-belt, cylinder (barrel), and extrusion die."	"It was observed that the output briquettes from the piston press have an average calorific value (HHV) or a mass energy density of 19244 KJ/kg, while the raw sawdust had an average calorific value of 18682 KJ/kg."	(Tanimu, 2021)
6	<i>Design and Fabrication of Briquetting Machine for Solid Waste</i>	The charcoal briquette machine consists of several components, including a hopper, motor, grinder blades, stand, sieve box, sieve plate, blade, sprocket, and bearing, mixing blades, pushing plate, chain to drive the sprocket, cylinder, and piston.	"The results indicated that the briquettes made from sawdust, dry leaves, and a very small amount of wheat flour (binding agent) are compact, dry, and have greater calorific value when compared to the briquettes made from sawdust, dry leaves, and coffee husk (binding agent) are not strongly bonded and possesses slightly lower calorific value."	(Manjunath et al., 2018)

The capacity of screw extruder briquetting machines to operate continuously and their combustion efficiency were evaluated in-depth. The structural design, production rate, fuel qualities, and operating parameters of a few chosen screw-type briquetting machines are compared in Table 3.

Table 3: Screw Extruder Briquetting Machines

S/N	Title	Machine Description	Key Findings	Citations
1	<i>Design And Fabrication of a Screw Press Briquetting Machine</i>	“The essential component parts of the machine are the hopper, screw barrel, the die, and screw conveyor. The machine has a screw diameter of 50 mm and runs on a 415/15HP/3phase electric motor with a pulley diameter of 10mm/550mm. The belt designation for is machine is B68.”	“From the test carried out, the machine is capable of producing briquettes in continuous operation, which gives it an edge over the manually operated hydraulic press. It can be adapted to curb agro residues' indiscriminate disposal and burning in their production or consumption centres, thereby protecting the environment from air pollution and invariably turning waste to wealth.”	(Arowosafe, 2021)
2	<i>Performance Analysis of Bio-Briquetting Machine With Screw Extruder Type Based on Quality of Bio-Briquettes</i>	“The machine had production capacity of 30 kg/hour, equipped with a motor of 1 HP, which transmitted to the machine through a pulley and a belt, and also has a cutter, which rotates continuously.”	“With a feed of 5 kg, the machine produced 50 pieces of bio-briquette. The machine could produce good bio-briquettes, such as calorific value of 6,511.3 cal/g, inherent moisture of 1.97%, ash content of 5.88%, volatile matter of 27.71%, fixed carbon content of 64.99%, and compressive strength was 16.98 kg/cm2.”	(Puspa et al., 2023)
3	<i>Design and Manufacturing of Screw-Extruder Based Briquetting Machine for Agricultural Residues</i>	The manufactured briquetting machine consisted of two major parts. The first part is a cutting and crushing unit that receives raw materials from a hopper located above the unit and works based on a rotating disc carrying six sets of rectangular blades. The second part is a pressing and extrusion system, which was fixed down the cutting and crushing unit on a metal base with has rectangular frame of 1600 x 950 mm. Cut and crushed material is being transferred by delivering the cone to the pressing and extruder system through a conical opening with a net having a specific diameter of mesh to pass only desired particle sizes. An electrical motor with a reduction unit is	“Results showed that briquettes produced by a screw-press based briquetting machine are hard enough to be transported when treated at a moisture content of 30% and 35 %. More shattered pieces were observed at a lower moisture content of 25%. In addition, in both residue types, adding more benders led to higher impact resistance (IRI). A sufficient production rate of briquettes has been obtained at 30% moisture content, where, production rates were 120.33, 128.67, 132.67 kg/h for rice straw mixed with 2, 4, and 6 percent of bending material respectively, and for cotton stalks, the production rates were 119.00, 123.33, and 131.33 kg/h with 2, 4 and 6 percent of bending material respectively. However, higher moisture contents of 35 and 40 % lead to lower production rates.”	(El-Sheikha, 2015)

		used to provide the machine with the required power."		
4	<i>Design and Fabrication of a Briquetting Machine</i>	"The machine comprised of a hopper, compaction chamber, die/barrel, feed screw extruder, feed screw housing, bearings power transmission shaft, and the frame. The developed machine was tested by using it to produce briquette samples from sawdust, rice husk, and palm fruit shell under the same conditions of binder concentration."	"Results showed that the compressive strength of the briquette samples ranged from 0.9kN/m ² to 1.3kN/m ² with palm fruit shell having the highest compressive strength of 1.3kN/m ² . The machine was found suitable to be used in producing briquettes from sawdust, rice husk, and palm fruit shell for both local and industrial uses."	(Francis-Akilaki, 2022)
5	<i>Design, Fabrication, And Performance Evaluation of Motor-Operated Screw Type Briquetting Machine</i>	"The machine was made up of metal sheets and plates and other locally available materials."	"Results showed that the machine performed the highest briquetting time and briquetting rate of 9.63 minutes and 6.20 kg/hr. Or 0.70 min/pc, respectively, when carbonized corn cobs were used as briquette material. While sawdust has the highest Impact on the Resistance Index and Moisture Content of 156.2525 and 27.38 % w.b., respectively. Moreover, the highest recorded Specific Fuel Consumption and Burning Rate were in the carbonized corn cob and charcoal powder briquettes with SFC of 1.44 and 1.62 g of briquette/gram of water, and burning rate of 11.02 and 15.05 g/minute, respectively."	(Panuelos, 2017)
6	<i>Performance Optimization of a Locally Developed Charcoal Briquette Machine Using Response Surface Methodology</i>	"The charcoal briquette machine is powered by an electric motor rated at 3 horsepower (2.2 kW) and operates on either 220V or 380V, depending on the configuration. The briquettes produced measure 50 mm in diameter and 100 mm in length, shaped under a compression force of 1500 N."	"It has a production capacity ranging from 40 to 50 kilograms per hour, with an optimized 235.77 kg/hr throughput and an operational efficiency of 84.75%. Optimal operating conditions were identified at 79.46 RPM machine speed."	(Okpala et al., 2025)

Critical results from research assessing variables such as material flow, compaction regularity, and production volume are summarised in Table 4. In order to create consistently formed briquettes at high throughput, biomass is compressed between two counter-rotating rollers that are fitted with dies.

Table 4: Roller Press Briquetting Machines

S/N	Title	Machine Description	Key Findings	Citations
1	<i>Fabrication of Briquette Press Machine – An Approach</i>	“The design specifications of these machines vary, with components like vertical support, pusher lever, and base plate contributing to their functionality. Briquettes produced through this process undergo proximate and ultimate analyses to determine their elemental composition, aiding in understanding combustion requirements and gas volume during burning.”	“Studies have shown that the calorific value of briquettes surpasses that of traditional coal, with enhancements like anode dust enrichment agents and binders further boosting their heating value.”	(Ninawe, Ingle, et al., 2024)
2	<i>Impact of the Roller Press Briquetting Process on the Morphological and Mechanical Properties of Apatite Ore</i>	“...the authors investigated the briquetting of hydroxyapatite and fluorapatite rock material and evaluated the properties of briquettes prepared in a roller press.”	“The briquettes exhibited relatively large Ra values (mean 9.67 μm). The highest hardness was registered at the specimen center (61 HV5), whereas the lowest was at the edge (25 HV5). A high density of 2.51 g/cm ³ was achieved in the process. It was possible to obtain saddle-shaped briquettes with reproducible properties, high density (porosity of 21%), and durability without using a binder additive. The study demonstrated that roller press briquetting can be successfully utilized as a method for compacting phosphate-bearing materials for storage, transportation, and further processing.”	(Bembenek et al., 2025)
3	<i>“Briquetting Roller Press Machine For the Pharmaceutical Industry”</i>	“The working principle is simple: raw materials are fed between two counter-rotating rollers, which are furnished with synchronized moulds that define the product shape. The material to be briquetted is introduced into the nip between the two rollers by means of a feeder system. On passing through the roller gap, the material is compacted and formed	“The main USP of our project is that it can produce relatively more tablets depending on the size and speed of the roller, and it is beneficial to the company as it will achieve a substantial result by producing more than 50,000 tablets for which the current machine is designed.”	(Gaikwad et al., 2023)

	into briquettes of uniform size and shape, enabling its inherent resources to be utilized in subsequent production cycles.”	
4	<i>A Novel Approach to the Screw Feeder Design to Improve the Reliability of Briquetting Process in the Roller Press</i>	—
		“In experiments, using the proposed design, the compaction ratio of the peat increases by 22-27%, and hydrolyzed lignin by 14-17%. The proposed approach allows for preventing drive overloading and ensures the reliable operation of pre-compaction devices for the roller presses.”
		(Baiul et al., 2023)

5. Discussion

This review conducts a critical analysis of the operational efficacy, design attributes, and appropriateness of four principal types of charcoal briquetting machinery: manual, hydraulic piston, screw extruder, and roller press machines. The results indicate that each category of machinery addresses distinct facets of briquette production efficiency, contingent upon context-specific requirements such as scale, financial constraints, and access to energy resources.

Manual briquetting machines, exemplified by the works of Ninawe et al. (2024) and Osarenmwinda and Ihenyen (2012), maintain significant popularity within low-income and rural contexts due to their minimal capital investment and straightforward design. Nevertheless, their restricted production capacity, high physical labor demands, and variable briquette quality inhibit scalability. Conversely, hydraulic piston presses, as scrutinized by Segun et al. (2023) and Osei et al. (2022), deliver enhanced compaction and durability through the application of regulated hydraulic pressure. In comparison to manual machines, they produce briquettes of greater density and thermal efficiency, albeit with moderate energy expenditures and maintenance requirements due to their reliance on fluid systems. Screw extruder machines, investigated by Arowosafe (2021) and Puspa et al. (2023), facilitate continuous production and are particularly adept at generating hollow briquettes with superior combustion properties. They outperform both manual and hydraulic machines regarding output volume and the energy value of the briquettes, though they are more susceptible to wear resulting from friction within the screw-barrel mechanism. In contrast to piston-type systems, screw extruders necessitate tighter control over feedstock moisture and increased technical maintenance, rendering them less suitable for environments characterized by a lack of skilled labor. Roller press machines, analyzed by Bembenek et al. (2025) and Gaikwad et al. (2023), are distinguished in industrial-scale applications due to their capacity to process substantial volumes of biomass into uniform, high-density briquettes with minimal binder requirements. When assessed against screw extruders, they achieve comparable output while exhibiting greater uniformity and structural integrity. However, their elevated initial investment and dependence on precision-engineered components restrict their accessibility in resource-limited regions.

A definite performance hierarchy is revealed overall: manual < hydraulic < screw extruder < roller press; however, this needs to be contextualised by factors like user competence, price, and simplicity of maintenance. While industrial operations benefit from the scale and automation of screw and roller systems, manual and hydraulic options are still viable for small-scale rural customers. Future developments that blend the output efficiency of cutting-edge technologies with the mechanical simplicity of manual systems, combined with initiatives to lower machine prices and enhance user training, are necessary to close these gaps.

6. Conclusion

The main performance distinctions between the various types of charcoal briquetting machines were determined by this review. Manual machines that produced 5–8 kg per day, as those by Ninawe et al. (2024), were appropriate for domestic usage but had limited scalability. Up to 32 briquettes with a shatter index of 98.6% and water resistance of 95.75% were generated per cycle by hydraulic piston presses, such as the one examined by Osei et al. (2022). Higher calorific values (up to 6,511.3 cal/g) and production rates ranging from 30 to 132 kg/h were demonstrated by screw

extruder machines (Puspa et al., 2023; El-Sheikha, 2015). With densities of 2.51 g/cm³ (Bembenek et al., 2025) and over 50,000 units produced in pharmaceutical settings (Gaikwad et al., 2023), roller press machines achieved industrial-scale outputs.

A number of suggestions are made in light of these results in order to improve the scalability, efficiency, and adoption of charcoal briquetting methods in various production situations. The development of hybrid machines should balance output, cost, and user-friendliness. Low-maintenance solutions should be given priority in rural installations, whereas high-throughput, automated systems should be purchased in industrial setups to optimise efficiency.

References

- [1] Agidi, G., Onatola, T., & Gana, I. M. (2017). Design and fabrication of a hydraulically operated machine for making briquettes from agricultural waste. *Direct Research Journal of Agriculture and Food Science*, 5 (3), pp. 121-129. <http://directresearchpublisher.org/aboutjournal/drjafs>
- [2] Anaemeje J. C., Owuama K. C., Okafor O. C., Madu K. E. (2022). Determination of a suitable retrofit of R-134A using refrigerant blends of R290 and R600, aided by an optimization technique. *Journal of Engineering Sciences*, Vol. 9(1), pp. G1-G7, doi: 10.21272/jes.2022.9(1).g1
- [3] Baiul, K., Vashchenko, S., Khudyakov, O., Bembenek, M., Zinchenko, A., Krot, P. V., & Solodka, N. (2023). A Novel Approach to the Screw Feeder Design to Improve the Reliability of Briquetting Process in the Roller Press. *Eksplotacja i Niezawodność*, 25(3). DOI 10.17531/ein/167967
- [4] Believe O Idogho, Ifeanyichukwu U Onyenanu, Kennedy C Owuama, Ashimedua C Ndubisi, Chukwunwendu E Ilochonwu (2025) Optimization of a Sustainable Virgin Coconut Oil Extraction Machine for Rural Communities. *Journal of Food Technology & Nutrition Sciences*. SRC/JFTNS-275. DOI: doi.org/10.47363/JFTNS/2025(7)215
- [5] Bello, R. S., Olorunnisola, A. O., Omoniyi, T. E., & Onilude, M. A. (2024). Technoeconomic Review of Briquette Production in a Screw Press [SP] and Hydraulic Piston Press [HPP]. DOI: 10.5772/intechopen.1007809
- [6] Bembenek, M., Dmytriv, V., Kowalski, Ł., Turniak, K., Frocisz, Ł., Niyazbekova, R., & Krawczyk, J. (2025). Impact of the Roller Press Briquetting Process on the Morphological and Mechanical Properties of Apatite Ore. *Materials*, 18(7), Article 7. <https://doi.org/10.3390/ma18071442>
- [7] Chinedu, Owuama Kennedy, Performance Characteristics Response of Palm Kernel Oil Plants to Increasing Number of Processing Machines, in Imo State. *International Journal of Innovation and Sustainability*, 3, 1 - 7, Available at SSRN: <https://ssrn.com/abstract=3353640>
- [8] Chukwudi, B. C., Ademusuru, P. O., Amaefule, C. O., & Swift, O. N. K. (n.d.). Investigation of the Thermal Conductivity of Ceramic Tiles Processed from Steel Slag (SS).
- [9] Chukwuka Placid, Egbuna Ikechukwu and Chinedu, Owuama Kennedy and Nweto, Linda, A Systematic Study and Design of Production Process of Itakpe Iron Ore for a Production Capacity of 1.5mt. *Equatorial Journal of Engineering*, 71 -77, Available at SSRN: <https://ssrn.com/abstract=3353638>
- [10] D. K., O., R., U., O. C., N., O.O., O., E. I., N., & D.A., E. (2024). Deployment of Lean Manufacturing in Palm Oil Mill for Maximum Yield: A Case Study of Leading Palm Oil Producer in Nigeria. *Asian Journal of Current Research*, 9(3), 1–17. HAL Id: hal-05074331
- [11] Dairo, O. U., Adeleke, A. E., Shittu, T., Ibrahim, N. A., Adeosun, O. J., & Iyerimah, R. B. (2018). Development and performance evaluation of a low-cost hydraulic-operated biomass briquetting machine. *FUOYE Journal of Engineering and Technology*, 3(1).
- [12] Dikeogu, T. C., Onyewudiala, J. I., Ezeabasili, A. C. C., & Swift, O. (2014). Self-purification potential of the tropical urban stream: A case study of the New Calabar River in Port Harcourt, Nigeria. *Global Advanced Research Journal of Engineering, Technology, and Innovation*, 3(1), 7–15. Available online <http://garj.org/garjeti/index.htm>
- [13] Dinesha, P., Kumar, S., & Rosen, M. A. (2019). Biomass Briquettes as an Alternative Fuel: A Comprehensive Review. *Energy Technology*, 7(5), 1801011. <https://doi.org/10.1002/ente.201801011>
- [14] Divyabharathi, R., Kalidasan, B., JS, S. S. R., & Chinnasamy, S. (2024). Recent advances in sustainable agro residue utilisation, barriers and remediation for environmental management: Present insights and future challenges. *Industrial Crops and Products*, 216, 118790. <https://doi.org/10.1016/j.indcrop.2024.118790>
- [15] Dohm, E. D. (2013). Production and Characterization of Coal-Biomass Briquettes [PhD Thesis, Virginia Polytechnic Institute and State University].
- [16] Ekpechi, D. A., Obiukwu, O. O., Nwankwo, E. I., & Okpalaku-Nath, V. C. (2023). Experimental study of the thermal and mechanical properties of epoxy-reinforced composites. *Journal of Applied Physical Science International*, 15(1), 6–16. DOI: 10.56557/JAPSI/2023/v15i18192

- [17] Ekpechi, D. A., Obiukwu, O. O., Opara, U. V., Emeziem, V. C., Nwankwo, E. I., Ezeaku, N. I., Ozuruoha, E. N., Oluwadare, O. E., Ayo-Akano, H. O., & Opkalaku-nath, V. C. (2025). Evaluation of Key Performance Factors and Recommendation of Optimization Strategies of a Power Generation Company. *Engineering Science & Technology*, 52–68. <https://doi.org/10.37256/est.6120255523>
- [18] Ekpechi, D. A., Opkalaku-nath, V. C., Opara, U. V., Ezeaku, N. I., Nwankwo, E. I., Nwankwo, C. A., Hassan, A., Osasona, C. O., & Jackson, D. O. (2025). Modeling and Comparative Analysis of the Compressive Strength of Concretes of Varying Sand Zones Using Scheffe's Theory. *Engineering Science & Technology*, 177–201. <https://doi.org/10.37256/est.6220255525>
- [19] El-Sheikha, A. M. (2015). DESIGN AND MANUFACTURING OF SCREW-EXTRUDER BASED BRIQUETTING MACHINE FOR AGRICULTURAL RESIDUES. *Misr Journal of Agricultural Engineering*, 32(4), 1375–1396. DOI: 10.21608/mjae.2015.97587
- [20] Erebugha, A. Y., Ezechukwu, V. C., & Owuama, K. C. (2024). Green Plants Extracts Corrosion Inhibition of Aluminum—A Review. *Iconic Research and Engineering Journals*, 7(6), 8–15. Available at <https://www.irejournals.com/formatedpaper/1705261.pdf>
- [21] Eze, C. O., Owuama, K. C., & Okafor, O. C. (2021). Performance evaluation of castor oil and neem oil as cutting fluids applied in drilling operations of mild steel. *World Journal of Engineering Research and Technology*, 7(4), 90–111.
- [22] Ezeaku, N. I., Ekpechi, D. A., Chiabuotu, C. C., Nwankwo, E. I., Olum, R. I., & Jerome, F. N. (2024). Application of Quantitative Models for Enhancing Supply Chain Efficiency and Mitigating Risks in the Water Tank Manufacturing Industry in Nigeria. *Engineering Science & Technology*, 389–404. <https://doi.org/10.37256/est.5220244554>
- [23] Ezechukwu, V. C., Braide, T. K., Onyenanu, I. U., Ayadinuno, G., Agwaziam, J. O., & Ojinekeya, C. O. (2025). Structural Simulation Analysis of the Developed Hybrid of Aluminum Composites and Carbon Nanotube Brake Disc. *International Journal of Applied and Natural Sciences*, 3(1), 18–28. <https://doi.org/10.61424/ijans.v3i1.195>
- [24] Ezechukwu, V. C., Oghenekaro, P. O., Onyenanu, I. U., Ayadinuno, G., & Agwaziam, J. O. (2025). Mathematical Modeling and Optimization of Plantain Chip Drying: A Parametric Study on Air Frying Conditions. *IPS Journal of Engineering and Technology*, 1(1). <https://doi.org/10.54117/ijet.v1i1.13>
- [25] Ezechukwu, V. C., Onyenanu, I. U., Ayadinuno, G., Agwaziam, J. O., & Ojinekeya, C. O. (2025). Corrosion Resistance of Developed Bolted Flange Made of Momordica Angustisepala Fiber (MAF) and Breadfruit Seed-Shell Particles (BFSAP). *IPS Journal of Engineering and Technology*, 1(1), 34–37. <https://doi.org/10.54117/ijet.v1i1.4>
- [26] Francis-Akilaki, F. I. and T. I. (2022). Design and Fabrication of a Briquetting Machine. *Journal of Energy Technology and Environment*, 4(1), Article 1. <https://doi.org/10.37933/nipes.e/4.1.2022.2>
- [27] Gaikwad, D. L., Nagarajan, B., Mirji, V., Patel, P., & Jagdale, A. (2023). BRIQUETTING ROLLER PRESS MACHINE FOR PHARMACEUTICAL INDUSTRY. *Journal of Emerging Technologies and Innovative Research*, 10(4). 213-216. Available: <http://www.jetir.org/papers/JETIR2304C23.pdf>
- [28] Ibrahim, E. T. G. (n2021). PERFORMANCE EVALUATION OF A PISTON PRESS FOR SAWDUST BRIQUETTING AS SOLID FUEL. Retrieved May 24, 2025, from https://www.academia.edu/26954493/PERFORMANCE_EVALUATION_OF_A_PISTON_PRESS_FOR_SAWDUST_BRIQUETTING_A_S_SOLID_FUEL
- [29] Ikebudu, K. O., Chukwumanya, E. O., & Swift, O. N. K. (2012). Correlation of Compressive Strength of Coal Pellets with Wet Weight of Coal Powder Agglomerates. In *Proceedings of the International MultiConference of Engineers and Computer Scientists* (Vol. 2).
- [30] Ikebudu, K. O., Chukwumanya, E. O., Swift, O. N. K., & Too-chukwu, N. (2015). Design of Pelletizing Machine (Balling Disc). *International Journal of Materials, Mechanics and Manufacturing*, 3(1), 9–12. <https://doi.org/10.7763/IJMMM.2015.V3.156>
- [31] Iweka, C. S., Owuama, K. C., & Swift, O. N. K. (2019). Influence of different inoculum concentrations on anaerobic digestion of corn chaff for energy production. *International Conference on Engineering Adaptation and Policy Reforms*, 1(1), 128–136.
- [32] Iweka, S. C., & Owuama, K. C. (2020). Biogas Yielding Potential of Maize Chaff Inoculated with Cow Rumen and Its Characterization. *Journal of Energy Research and Reviews*, 34–50. <https://doi.org/10.9734/jenrr/2020/v6i330171>
- [33] Iweka, S. C., Owuama, K. C., Chukwunneke, J. L., & Falowo, O. A. (2021a). Optimization of biogas yield from anaerobic co-digestion of corn-chaff and cow dung digestate: RSM and Python approach. *Heliyon*, 7(11). <https://doi.org/10.1016/j.heliyon.2021.e08255>
- [34] Jugu, E. B., Onyenanu, I. U., & Nwobi-Okoye, C. C. (2025). Finite Element Analysis and Factorial Optimization of Heat Treatment Flaws in CNG Pressure Vessels: Implications for Structural Integrity and Safety. *Scientific Journal of Engineering and Technology*, 2(1). <https://doi.org/10.69739/sjet.v2i1.487>
- [35] Karekezi, S. (2002). Renewables in Africa—Meeting the energy needs of the poor. *Energy Policy*, 30(11–12), 1059–1069. [https://doi.org/10.1016/S0301-4215\(02\)00058-7](https://doi.org/10.1016/S0301-4215(02)00058-7)
- [36] Kingsley Okechukwu Ikebudu, Swift Kenneth Onyegirim, & Philip Ifchukwu Udeorah. (2021). Effect of green sand mixture with dextrin additives on mechanical properties of aluminum 6351. *Global Journal of Engineering and Technology Advances*, 6(2), 131–141. <https://doi.org/10.30574/gjeta.2021.6.2.0013>
- [37] Kpalo, S. Y., Zainuddin, M. F., Manaf, L. A., & Roslan, A. M. (2020). A review of technical and economic aspects of biomass briquetting. *Sustainability*, 12(11), 4609. <https://doi.org/10.3390/su12114609>

- [38] Larbi, K., Ayisi, K. M., and Osei, I. (2024). Design, Development, and Performance Evaluation of a Manually Operated Briquette Machine for Sustainable Energy Production from Agricultural Waste, pp. 1-12.
- [39] Lubwama, M., Yiga, V. A., & Lubwama, H. N. (2022). Effects and interactions of the agricultural waste residues and binder type on physical properties and calorific values of carbonized briquettes. *Biomass Conversion and Biorefinery*, 12(11), 4979–4999. <https://doi.org/10.1007/s13399-020-01001-8>
- [40] Madukasi, A. H., Onyenanu, I. U., Oghenekaro, P. O., Nzenwa, C. C., & Madu, K. E. (2025). Optimization of the Drying Parameters for Plantain Chips using a Locally Made Tray Dryer: A Study on Drying Efficiency and Drying Rate Modeling using RSM. *Journal of Food Technology & Nutrition Sciences*, 206(7), 2–10. DOI: Doi. Org/10.47363/JFTNS/2025
- [41] Manjunath, K. S., Omprakash, M., Pageni, N., & Hanumant, B. (2018). Design and fabrication of a briquetting machine for solid waste. *Int J Latest Eng Res Appl*, 3(5), 61–66.
- [42] Miah, M. (2017). Effect of additives on rice husk briquette by piston press system. <http://lib.buet.ac.bd:8080/xmlui/handle/123456789/4877>
- [43] Morales-Máximo, M., Ruíz-García, V. M., Rutiaga-Quiñones, J. G., & López-Sosa, L. B. (2025). Design and Implementation of a Low-Pressure Briquetting Machine for the Use of Pinus spp. Wood Residues: An Approach to Appropriate Rural Technology. *Clean Technologies*, 7(1), Article 1. <https://doi.org/10.3390/cleantechnol7010022>
- [44] Mulani, S. M., Kumar, A., Shaikh, H. N. E. A., Saurabh, A., Singh, P. K., & Verma, P. C. (2022). A review of recent development and challenges in the automotive brake pad-disc system. *Materials Today: Proceedings*, 56, 447–454. <https://doi.org/10.1016/j.matpr.2022.01.410>
- [45] Mwampamba, T. H., Owen, M., & Pigaht, M. (2013a). Opportunities, challenges, and way forward for the charcoal briquette industry in Sub-Saharan Africa. *Energy for Sustainable Development*, 17(2), 158–170. <https://doi.org/10.1016/j.esd.2012.10.006>
- [46] Ngene, G. I., Bouesso, B., GONZÁLEZ, M., & Nzihou, A. (2024). A review on biochar briquetting: Common practices and recommendations to enhance mechanical properties and environmental performances. *Journal of Cleaner Production*, 143193. <https://doi.org/10.1016/j.jclepro.2024.143193>
- [47] Ninawe, D. A. P., Ingale, M., Raut, S., Chandel, S., Hedao, D., & Kururde, P. (2024). Fabrication And Testing of Briquette Press Machine. 11(2).
- [48] Nnaji, N. B., Owuama, K. C., & Ezechukwu, V. C. (2024). Microstructural and Chemical Analysis of Polypropylene/Pig-Bone-Ash/Hamburger Seed Shell Composite. *International Journal of Progressive Research in Engineering Management and Science (IJPREMS)* e-ISSN, 2583–1062.
- [49] Nwankwo, E. I., Amenta, F., DI CESARE MANNELLI, L., Pacini, A., Bonaccini, L., Ghelardini, C., Tayebati, S. K., & Tomassoni, D. (2011). Central nervous system changes in a model of compressive neuropathy: Thioctic acid enantiomers activity. <https://flore.unifi.it/handle/2158/777149>
- [50] Nwankwo, E., Amenta, F., Tomassoni, D., & Tayebati, K. S. (2012). Central Nervous System Changes in a Model of Compressive Neuropathy: Thioctic Acid Enantiomers Activity: PP356. *Pain Practice*, 12, 95. <https://hdl.handle.net/2158/777149>
- [51] Obi, O. F., Pecenka, R., & Clifford, M. J. (2022). A review of biomass briquette binders and quality parameters. *Energies*, 15(7), 2426. <https://doi.org/10.3390/en15072426>
- [52] Offodum, C. D., Oji, A., & Onyenanu, I. U. (2025). Comparative Thermodynamic Analysis of Inorganic Refrigerants in Cascade LNG Liquefaction Systems: A Performance Metrics. *Journal of Chemistry & Its Applications*, 142(4), 2–8. DOI: Doi. Org/10.47363/JCIA/2025
- [53] Okonkwo, S. I., Eme, L. C., & Swift, O. N. K. (2012). Optimization modeling of borehole water quality in Rumuogwunama in Eneka of Obio-Akpor LGA in Rivers state, Nigeria, 41, 255-258. <https://www.cabidigitallibrary.org/doi/full/10.5555/20133091123>
- [54] Okpala, I. F., Onyenanu, I. U., Ezechukwu, V. C., & Ilochonwu, C. E. (2025). Performance Optimization of a Locally Developed Charcoal Briquette Machine Using Response Surface Methodology. *Scientific Journal of Engineering, and Technology*, 2(1), Article 1. <https://doi.org/10.69739/sjet.v2i1.486>
- [55] Onwugbuta, G. C., Ononiwu, C. F., & John, G. N. (2023). The Production of Briquette from Sawdust and Waste Paper using Manual Briquetting Machine. 2(4). <https://doi.org/10.3390/engproc2024067077>
- [56] Onyenanu, I. U., & Nwigbo, S. C. (2021). Optimization of aluminium metal matrix composite (AMMC) for use in automobile brake disc. *Int. J. Eng. Res. Technol*, 10(7), 634–638.
- [57] Onyenanu, I. U., Ande, J. I., & Ezechukwu, V. C. (2024). Enhancing Energy Efficiency in Locally Developed Steam Boilers: A Response Surface Methodology Approach. *Research Journal in Civil, Industrial and Mechanical Engineering*, 1(1). <https://doi.org/10.61424/rjcime.v1i1.153>
- [58] Onyenanu, I. U., Ilochonwu, C. E., & Atanmo, P. N. (2015). Determining the Energy Value on Different Compressions of Sawdust Briquettes. In *Engineering Solutions for Sustainability*. John Wiley & Sons, Ltd. pp. 225–234. <https://doi.org/10.1002/9781119179856.ch22>

- [59] Onyenanu, I. U., Ofili, I., & Owuama, K. C. (2024). Eco-Friendly Brake Pad Formulation Using Agro-Waste Derived Fillers: Bush Mango Nutshell and Palm Fruit Fiber Reinforced Composites. *International Journal of Applied and Natural Sciences*, 2(2), 27–39. <https://doi.org/10.61424/ijans.v2i2.152>
- [60] Onyenanu, I. U., Ogbogu, M. C., & Nwadiuto, C. J. (2024). Performance optimization of an improved biomass gasifier charcoal stove using response surface method (RSM). *International Journal of Engineering Research & Technology (IJERT)*, 13(08). DOI: 10.17577/IJERTV13IS080031
- [61] Onyenanu, I. U., Swift, O. N. K., & Atanmo, P. N. (2015). Design and analysis of a tubular space frame chassis for FSAE application. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 2(10), 134–140.
- [62] Onyenanu, I. U., Ukwu, N. O., Ezechukwu, V. C., Onyenanu, I. M., & Nwadiuto, C. J. (2024). Modelling and Optimization of Banana/Plantain Fiber Extraction Systems through Dimensional Analysis. *International Journal of Applied and Natural Sciences*, 2(2), 40–52. <https://doi.org/10.61424/ijans.v2i2.161>
- [63] Osarenmwinda, J. O., & Ihenyen, O. I. (2012). The Preliminary Design and Fabrication of a Manually Operated Briquetting Machine. *Journal of Applied Sciences and Environmental Management*, 16(2), Article 2.
- [64] Osei, I., Mwinisin, P., McEben-Nornormey, R. M. A., Larbi, K., & Ayisi-Kwofie, M. (n.d.). Development and Performance Evaluation of a Hydraulic Operated Double Mould Briquette Machine. <https://hdl.handle.net/20.500.11988/1235>
- [65] Osei, I., Mwinisin, P., McEben-Nornormey, R.M.A., Larbi, K. and Ayisi-Kwofie, A. (2022), "Development and Performance Evaluation of a Hydraulic Operated Briquette Machine" Proceedings of the 7th UMaT Biennial International Mining and Mineral Conference, Tarkwa, Ghana. pp. 1- 11
- [66] Owuama, O. C., & Owuama, K. C. (2021). A Drainage System for Road Construction on Flat Terrain in New Owerri, Nigeria. In K. R. Reddy, A. K. Agnihotri, Y. Yukselen-Aksoy, B. K. Dubey, & A. Bansal (Eds.), *Sustainable Environment and Infrastructure* (pp. 301–308). Springer International Publishing. https://doi.org/10.1007/978-3-030-51354-2_27
- [67] Puspa, D., Yerizam, M., Zamheri, A., & Wardhana, A. T. (2023). PERFORMANCE ANALYSIS OF BIO-BRIQUETTING MACHINE WITH SCREW EXTRUDER TYPE BASED ON QUALITY OF BIO-BRIQUETTES. *AUSTENIT*, 15(2), 109–114. <https://doi.org/10.53893/austenit.v15i2.7218>
- [68] Segun, B. R., Olajide, O. A., Temidayo, O. E., & Musiliu, O. A. (2023). Development of a Multiple-Piston Hydraulic Briquetting Press HBP and Characterization of Newsprint Briquettes Produced. *Trends in Agricultural Sciences*, 2(2), 169–188. <https://doi.org/10.17311/tas.2023.169.188>
- [69] Swift, O. N., Chukwumuanya, E. O., & Onwuamaegbu Obiajulu, P. (2012). Fast Tracking Third World Countries' Economic Development through Improved Mechanized Processing of Palm Oil in Farm Settlements. *Proceedings of the World Congress on Engineering*, 3. http://www.iaeng.org/publication/WCE2012/WCE2012_pp1994-1999.pdf
- [70] Tumuluru, J. S., Wright, C. T., Hess, J. R., & Kenney, K. L. (2011). A review of biomass densification systems to develop uniform feedstock commodities for bioenergy applications. *Biofuels, Bioproducts and Biorefining*, 5(6), 683–707. <https://doi.org/10.1002/bbb.324>
- [71] U. Onyenanu, I., Ilochonwu, C. E., & N. Atanmo, P. (2015). Measurement of Energy Value on different Grain sizes of Sawdust Briquettes. *American Academic & Scholarly Research Journal*, 7(5), Article 5. <https://aasrc.org/aasrj/index.php/aasrj/article/view/1721>
- [72] Ubani, A. C., & Onyenanu, I. U. (2024). INVESTIGATION OF THE MECHANICAL AND MORPHOLOGICAL PROPERTIES OF LOCALLY DEVELOPED GRAPHITE CRUCIBLE POT USING KAOLIN CLAY AND OTHER ADDITIVES. *International Journal of Engineering Processing and Safety Research*. 5(5). <https://cambridgeresearchpub.com/ijepsr/article/view/311>
- [73] Ukwu, N. O., Onyenanu, I. U., & Owuama, K. C. (2024). Development of a Low-Cost Banana Fiber Extractor. *International Journal of Innovative Science and Research Technology (IJISRT)*, 1672–1681. DOI:10.38124/ijisrt/IJISRT24APR2282
- [74] Utu, O. G., Onyenanu, I. U., & Onyenanu, I. M. (2024). Innovative Thermo-Kinetic Approaches in Welding: The Impact on Microstructural Integrity of AISI 304L and AISI 316L Stainless Steels. *Research Journal in Civil, Industrial and Mechanical Engineering*, 1(1), 73–94. DOI: 10.61424/rjcime.v1.i1.162
- [75] Vivian, C., Okpalaku-Nath, Onyebuchi, F., Okafor, Arinze, D., Ekpechi, Victor, U., Opara, Ifeanyichukwu, E., Nwankwo, Uwara, O., Ota, Uchenna, I., Malobi, Anthony, C., Nwankwo, & Amarachi, A., Onyemaechi. (2025). Innovative Approaches to Reducing Road Accident Fatalities in Southern Nigeria: A Statistical Analysis and Predictive Model. *Journal of Basic and Applied Research International*, 31(3), 50–65. <https://doi.org/10.56557/jobari/2025/v31i39282>