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| RESEARCH ARTICLE

Production Of Briquettes From Sugarcane Bagasse Using Selected Binders: A Comparative Study Of Physicochemical Properties

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| ABSTRACT

The increasing demand for domestic energy and the continued dependence on fuelwood have contributed significantly to deforestation and environmental degradation in many developing countries. Sugarcane bagasse, an abundant agricultural residue generated by the sugar industry, presents a sustainable alternative for renewable energy production. This study evaluated the suitability of sugarcane bagasse for briquette production using four different binders: clay, cement, paper, and a mixture of the three. Bagasse was carbonized, pulverized, mixed with binders at a ratio of 6:1, compressed into briquettes, and dried under sunlight. The produced briquettes were analyzed for ignition time, moisture content, ash content, volatile matter, fixed carbon, density, burning performance, and calorific value. Results indicated that paper-bound briquettes exhibited the highest calorific value (26,700 kJ/kg) and the shortest ignition time (244 s), while clay-bound briquettes recorded the highest ash content (34.5%). Briquettes produced using the mixed binder demonstrated balanced physicochemical properties, including a high calorific value (26,192 kJ/kg), moderate ash content (25%), and the shortest water-boiling time (41 min). The findings suggest that mixed binders provide the most suitable combination of combustion and handling characteristics for bagasse briquette production.

| KEYWORDS

Bagasse, Briquettes, Biomass Energy, Calorific Value, Binder, Renewable Fuel

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Introduction:-

Biomass remains a major source of domestic energy in many developing countries, particularly in rural regions where firewood and charcoal are widely used. The excessive reliance on these traditional fuels has accelerated deforestation,

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environmental degradation, and greenhouse gas emissions. At the same time, large quantities of agricultural residues are generated annually and often disposed of through open burning or uncontrolled decomposition.Sugarcane bagasse is one of the most abundant agro-industrial wastes in Kenya. Approximately 300 kg of bagasse is produced per ton of processed sugarcane, generating over 1.6 million tons annually. Although a portion of this residue is used within sugar industries, substantial amounts remain underutilized.Briquetting technology offers an effective means of converting biomass waste into a dense and energy-rich fuel. The quality of briquettes depends significantly on the binder used during production. Common binders include clay, paper, cement, and molasses. These materials influence important fuel characteristics such as calorific value, ash content, density, ignition behavior, and combustion efficiency.

This study aimed to evaluate the physicochemical characteristics of briquettes produced from sugarcane bagasse using selected binders and identify the most suitable binder for energy production.

2. Materials and Methods

2.1 Study Area

The study was conducted in Kisii County, Kenya. Sugarcane bagasse samples were collected from sugar-producing regions within western Kenya.

2.2 Raw Materials

The materials used included:

- Sugarcane bagasse
- Paper waste
- Clay soil
- Cement
- Water

2.3 Preparation of Bagasse Charcoal

Bagasse was dried under direct sunlight to reduce moisture content. The dried material was carbonized using an improvised drum kiln under limited oxygen conditions. The resulting charcoal was cooled, crushed, and pulverized into fine particles.

2.4 Preparation of Binders

Paper binder was prepared by soaking shredded waste paper in water for 24 hours and converting it into a slurry. Clay binder was obtained from local clay deposits and sieved to remove coarse particles. Cement binder was used in its original powdered form. A mixed binder was prepared by combining clay, cement, and paper.

2.5 Briquette Production

Bagasse charcoal dust was mixed with each binder in a ratio of 6:1 by volume. Approximately 20 mL of water was added to improve moldability. The mixture was compressed using an improvised briquetting press and dried under sunlight until constant weight was achieved.

2.6 Determination of Physicochemical Properties

The following parameters were determined:

- Moisture content
- Ash content
- Volatile matter
- Fixed carbon
- Dry density
- Ignition time
- Burning time
- Gross calorific value

Standard gravimetric procedures and empirical calorific value calculations were employed.

3. Results and Discussion

3.1 Physical Characteristics

The produced briquettes exhibited distinct physical appearances depending on the binder used. Clay and cement briquettes were darker and denser than paper-bound briquettes.

3.2 Ignition Time and Density

Binder	Ignition Time (s)	Density (g/cm³)
Clay	482	0.1837
Cement	420	0.1464
Paper	244	0.1324
Mixture	380	0.1812

Paper-bound briquettes ignited more rapidly than all other briquettes because of their high volatile matter content. Clay-bound briquettes required the longest ignition period due to their higher ash-forming mineral content.

3.3 Moisture Content

Binder	Moisture Content (%)
Paper	8.0
Mixture	6.5
Cement	4.0
Clay	3.5

Paper briquettes retained more moisture because paper fibers possess significant water-holding capacity. Lower moisture contents in clay and cement briquettes improve combustion efficiency.

3.4 Ash Content

Binder	Ash Content (%)
Paper	4.0
Mixture	25.0
Cement	33.5
Clay	34.5

Ash content is an important quality indicator because excessive ash reduces combustion efficiency. Paper briquettes produced the least ash, while clay and cement briquettes generated substantially higher ash residues due to their inorganic composition.

3.5 Volatile Matter and Fixed Carbon

Paper briquettes recorded the highest volatile matter content (92%), which contributed to their rapid ignition. Clay and cement briquettes exhibited higher fixed carbon contents, indicating longer burning durations but slower ignition rates.

3.6 Calorific Value

Binder	Calorific Value (kJ/kg)
Cement	19,377
Clay	20,398
Mixture	26,192
Paper	26,700

The paper binder briquettes achieved the highest calorific value. The mixed binder briquettes also demonstrated excellent energy output while maintaining acceptable combustion properties.

3.7 Water Boiling Performance

The mixed binder briquettes boiled 800 g of water in 41 minutes, outperforming all other briquette types. This indicates superior combustion efficiency and energy transfer.

The overall performance ranking based on ignition behavior, calorific value, ash content, and boiling efficiency was:

Mixed Binder > Paper Binder > Clay Binder > Cement Binder

4. Conclusion

Sugarcane bagasse is a promising biomass resource for briquette production and can contribute to reducing dependence on fuelwood and charcoal. The choice of binder significantly influences briquette performance. Paper-bound briquettes demonstrated the highest calorific value and fastest ignition, whereas clay and cement binders produced higher ash content and longer ignition times. Briquettes prepared using a mixture of binders exhibited balanced physicochemical properties, including high calorific value, moderate ash content, satisfactory ignition characteristics, and superior water-boiling performance. Therefore, mixed binders are recommended for commercial production of bagasse briquettes.

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