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Development of cashew apple bagasse based bio-composites for high-performance applications with the concept of zero waste production

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Highlights

- Efficient acoustic panels were achieved using cardanol based resin and cashew apple bagasse as filler material.
- A bio-composite with high coefficient of friction is achieved with cashew apple bagasse and its derivatives as filler materials.
- A route for the adoption of the concept of a circular bio-economy in the cashew processing industry is demonstrated.
- Robust bio-composites are produced from the cashew processing waste, suggesting the concept of zero- waste production.

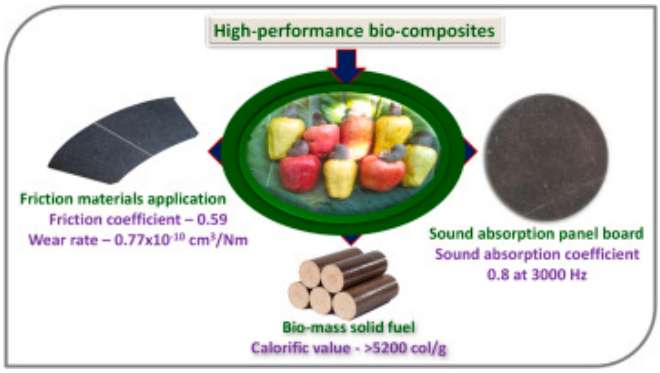
Abstract

This study suggests a comprehensive concept for using waste generated from the cashew processing industry in the production of some functional and high-performance bio-composites.

Cashew apple bagasse (CAB), cashew nut shell (CNS), and cardanol were used as primary feedstock. Cardanol was used to synthesize cardanol-based benzoxazines that were used as resins. CAB was used to prepare carbon and ash that were used as filler materials in preparing the composites. Thus, three ingredients (resins, carbon, and ash) were obtained, while the CAB and CNS were used directly as feedstock. Firstly, a high-performance CAB-filled panel board composite was prepared as an acoustic barrier, and sound absorption coefficients value of 0.8 at 3000 Hz and 0.7 at 6400 Hz were achieved. Secondly, CNS and CAB were used at different ratios to prepare fuel briquettes, and findings reveal that the briquettes have a calorific value and an ash content of 5225 cal/g and 7%, respectively. Lastly, CAB, carbon, and ash were employed as filler materials in the production of a friction composite, which was found to have a friction coefficient and wear rate of 0.59 and 0.77×10^{-10} cm^3/Nm respectively. Overall, this study suggests the concept of zero waste production, as waste from the cashew processing industry was successfully used to produce composite materials for use as acoustic barriers and fuel briquettes. While the ash produced as a waste after using fuel briquettes served as filler material in the production of a robust friction composite.

Graphical abstract

The present work, an attempt has been made in the concept of zero waste generation in the production of cashew apple bagasse based bio-composites in the form of acoustic panel board, bio-mass solid fuel and friction materials.



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Introduction

The cashew plant is a native of Brazil that has been dispersed to almost all parts of the world. In 2020, the total world production stood at 5,535,510 tons(FAOSTAT, 2022). These productions are mostly for processing industries that target the production of juice from the apple and the cashew nut (kernel) for consumption as snacks or/and use in preparing meals. The processing of the juice from the apple and the nut from the cashew nut shell (pericarp) generates wastes, viz., the cashew apple bagasse (CAB) and the cashew nut shell (CNS), respectively. The CAB waste accounts for about 20% of the total weight of apples processed (Silva et al., 2018). On the other hand, cashew nut shell liquid (CNSL) could be extracted from the CNS waste, and up to about 67% of the total