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DESIGN AND PERFORMANCE EVALUATION OF ECO-FRIENDLY SPORTS MATS FROM CALOTROPIS GIGANTEA–VETIVER FIBER

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Abstract

Sports mats are essential equipment in activities such as yoga, gymnastics, fitness training, and even outdoor sports. They provide cushioning to reduce joint impact, enhance stability, and prevent injuries on a variety of surfaces. The demand for bio-based sports mats is steadily increasing. Conventional mats are made from synthetic polymers like EVA and PVC. These materials are valued for durability and shock absorption. However, they are non-biodegradable and generally lack additional wellness functionalities. The growing interest in multifunctional mats has highlighted the need for products that support recovery, antimicrobial protection, aromatherapy, and cooling effects during exercise. In this context, Calotropis gigantea, a fast-growing tropical shrub, offers a sustainable alternative as a natural fiber. Its fibers are lightweight, strong, biodegradable, and naturally resistant to microbes. This makes them suitable for nonwoven or layered composite mats. Additionally, blending Calotropis gigantea fiber with vetiver fiber (Chrysopogon zizanioides) enhances functionality. Vetiver contributes natural cooling properties, a soothing aroma, and insect-repellent activity. By utilizing this fiber combination, it is possible to create eco-friendly sports mats. These mats can combine ergonomic performance with active recovery, antimicrobial protection, and wellness benefits for both indoor and outdoor physical activities.

Keywords: *vetiver mat, calotropis gigantia, sports mat, eco friendly product and Chrysopogon zizanioides*

1. INTRODUCTION

Sports have evolved into a universal mode of communication between nations, transcending cultural and linguistic boundaries. They have become an integral part of modern life, where individuals continuously strive to give their best on the field. To support this pursuit of excellence, various sports gadgets and accessories have been developed, each designed with a strong emphasis on performance. Consequently, the sports industry often prioritizes the functionality and supportiveness of its products over their sustainability, leading to increasing environmental concerns worldwide.Among these accessories, sports mats and yoga mats hold a unique position. Unlike performance-critical equipment such as shoes or electronic gadgets, mats serve primarily as supportive surfaces for balance, comfort, and safety. Despite this, their production continues to rely heavily on synthetic materials, particularly Ethylene Vinyl Acetate (EVA) and Polyvinyl Chloride (PVC), which dominate the global market due to their low cost, durability, and ease of processing. However, these materials pose significant environmental challenges, including non-biodegradability, chemical toxicity during production, and harmful emissions during disposal *(Yoga*

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*Mats Testing Reveals Greenwashing | Ecology Center, n.d.).*Given that sports and yoga mats have become essential daily accessories for people engaged in fitness and wellness activities, it is crucial to manufacture them responsibly and sustainably. This includes ensuring minimal environmental impact during production, improved comfort and safety during use, and eco-friendly decomposition at the end of their lifecycle. Therefore, this paper aims to conceptualize and evaluate the potential of eco-friendly sports mats developed from Calotropis gigantea–Vetiver fiber composites as sustainable alternatives to conventional PVC and EVA mats. The subsequent sections present a literature review on material sustainability in sports equipment, the conceptual framework for fiber-based mat design, performance evaluation criteria, and future directions for sustainable sports product innovation (Qi et al., 2018).

Table 1. Yoga / Sports Mat Market Composition

Product	Composition / Key Materials	Price (Indian ₹ approx)
General Synthetic Range	PVC, EVA, TPE or standard synthetic polymer mats	~₹300–₹1,500 (budget) to ₹2,000+ (better synthetics)
Cork & Natural Rubber Yoga Mat (WiseLife)	Top layer cork; Base = 100% natural rubber	~₹4,214 for 5 mm variant
Wildlense Eco-Friendly Cork Yoga Mat	Cork + natural rubber backing (as stated)	~₹3,080
Fitness Mantra Premium Natural Cork & Rubber Yoga Mat	Blend of cork + natural tree rubber, plastic-free	~₹4,800
Premium Cork Yoga Mat (Being Yogi)	Cork + natural rubber base; eco-friendly	~₹2,399
Yogpro 100% Natural Cork Yoga Mat	100% cork top, unspecified backing but implied rubber base.	~₹1,699

2. LITERATURE REVIEW

Sustainable Material Use in Sports and Fitness Accessories

The field of sports and fitness accessories has historically prioritised performance (cushioning, durability, grip) often at the expense of environmental considerations. The dominance of synthetic polymers such as Polyvinyl Chloride (PVC) and Ethylene Vinyl Acetate (EVA) in mats has been linked to significant challenges in life-cycle sustainability, including non-biodegradability, toxic production processes and problematic end-of-life disposal. For example, a report by the Ecology Center found many yoga mats labelled "eco" still comprised primarily PVC and contained hazardous plasticisers. Such findings underscore the research gap with respect to truly eco-friendly alternatives in this accessory category *(Yoga Mats Testing Reveals Greenwashing | Ecology Center, n.d.).*

Natural-Fibre Reinforced Composites as Sustainable Alternatives

Natural fibres are emerging as renewable reinforcements in polymer composites due to their low density, biodegradability, and relatively good mechanical properties. Studies show substitution of synthetic fibre or polymeric filler with natural fibres can lead to reduced carbon footprint and improved sustainability

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credentials. For instance, treatments and interfacial modifications of natural fibres (to improve fibre–matrix bonding) have been shown to significantly influence composite mechanical performance, tensile, flexural strength, impact behaviour and durability. *(Rayyaan et al., n.d.).*

Research on Calotropis gigantea Fibre

Several studies have investigated Calotropis gigantea fibre (CGF) as a reinforcing material in composites:

- **Extraction & Physical-Chemical Characterisation:** CGF-based bast fibres found that alkali-treatment increased fibre crystallinity index and improved tensile strength but reduced thermal stability compared to untreated fibres (Ramasamy et al., 2018).
- **Mechanical Evaluation in Composite Form:** Studied phenol-formaldehyde (PF) composites reinforced with CGF and found that untreated composites at ~40 wt% fibre loading offered good mechanical properties; alkali treated fibres further improved performance (Sanjeevi et al., 2019; Ramshankar et al., 2023).
- **Surface Modification & Interfacial Performance:** In a PP (polypropylene) matrix, CGF with silane/alkali surface treatment improved tensile modulus and impact strength significantly compared to untreated CGF composites; treatment improved water-absorption resistance (Jahan et al., 2016).
- **Textile/Non-Textile Applications:** Study explored blending CG fibre with cotton yarns in textile applications, highlighting the fibre's viability in non-traditional forms (REEMA BORA*, SARADI JYOTSNA GOGOI and BINITA B. KALITA, 2023).

These contexts indicate CGF's potential as a sustainable reinforcement material: decent mechanical properties, treatment-responsive interfacial behaviour, and a lower-impact origin (plant-based). However, their direct application in sports mats (with requirements of cushioning, grip, durability, hygiene) remains unexplored, representing a gap.

Research on Vetiveria zizanioides Fibre

Vetiver fibre has also been studied in composite and construction-material contexts:

- **Physico-mechanical & Interfacial Properties:** Vetiver fibre (VF) reinforced polypropylene (PP) composites found that up to ~30 wt% VF loading improved tensile strength, modulus, impact strength, and reduced water absorption when treated (SDS/benzoyl chloride) to improve compatibility (Pattnaik et al., 2023).
- **Biocomposite Application:** Use of vetiver root fibre in soy-resin biocomposites with a leaf filler (Sal leaf) achieved tensile strength ~53.85 MPa and flexural strength ~55.87 MPa, plus favourable biodegradation behaviour (Arpitha et al., 2021).

These findings suggest vetiver fibre is a promising eco-friendly reinforcement, with good mechanical behaviour and environmental potential, yet specific work for mat-type applications (cushioning, surface grip, durability under cyclical loads) is scarce.

Summary of Research Gap

While substantial work exists on CGF and vetiver fibre in composite contexts, two major gaps remain in the literature relevant to sports/yoga mats:

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1. **Application-specific studies:** For mat surfaces (cushioning, grip, comfort, durability under repeated mechanical/tribological loading) using CGF or vetiver fibre.
2. **Life-cycle or environmental-impact assessments:** Comparing natural-fibre mats vs synthetic counterparts (PVC/EVA). Thus, while the material potential is evidenced, their functional performance and market feasibility in the specific context of sports mats remains under-researched.

3. CONCEPTUAL FRAMEWORK

This conceptual framework explains how an eco-friendly sports mat can be developed using Calotropis gigantea and Vetiver fibers as sustainable materials. The concept focuses on integrating comfort, functionality, and environmental responsibility to replace harmful synthetic materials like PVC and EVA that currently dominate the sports mat market.

Material Selection and Concept

An ideal sports mat must provide soft cushioning, anti-slip grip, elastic recovery, and moisture resistance. However, most commercial mats are made from Polyvinyl Chloride (PVC) and Ethylene Vinyl Acetate (EVA), which, although effective in performance, are non-biodegradable and emit harmful chemicals during production and disposal *(Yoga Mats Testing Reveals Greenwashing | Ecology Center, n.d.).*

To overcome these environmental drawbacks, natural fibers offer a renewable and biodegradable alternative. Among various natural options, Calotropis gigantea fiber (CGF) and Vetiver fiber (VF) stand out due to their unique microstructure and inherent functional properties. Past studies indicate that CGF possesses a hollow tubular structure, low density, and high flexibility, resulting in superior softness and cushioning compared to denser fibers like jute or coir. The hollow lumen traps air, offering natural thermal insulation and elastic recovery desirable in mats used for yoga and fitness activities. Furthermore, CGF has mild hydrophobicity, which prevents excessive moisture absorption while maintaining comfort (Narayanasamy et al., 2020).

Similarly, Vetiver fiber provides complementary benefits. VF exhibits excellent moisture regulation, natural antibacterial activity, and fragrant aromatic compounds that enhance hygiene and user experience. The long, smooth, and resilient texture of VF ensures better surface grip and abrasion resistance during repeated use (Pattnaik et al., 2025).

In comparison with other natural fibers such as jute, banana, or sisal – which tend to be coarse, heavy, or overly hydrophilic – the CGF-VF combination provides a balanced set of properties ideal for sports mat applications. While jute and banana fibers absorb too much moisture and coir lacks sufficient softness, the CGF-VF blend achieves light weight, comfort, and resilience while being completely biodegradable and non-toxic (Armel et al., 2023). The fibers can be processed through needle-punching technology to form a nonwoven structure. This process entangles the fibers mechanically, improving elasticity, breathability, and durability.

Final Conceptual Properties of the Calotropis-Vetiver Sports Mat

Core Functional Properties:

- **Soft cushioning:** CGF provides hollow, flexible fibers that absorb impact and protect joints.
- **Elastic recovery:** CGF's tubular structure allows the mat to regain shape after repeated use.
- **Good surface grip:** VF's long and resilient fibers improve traction and reduce slipping.

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- **Moisture regulation:** VF naturally absorbs and releases moisture, keeping the mat dry and hygienic.
- **Lightweight and flexible:** CGF's low density makes the mat easy to carry, roll, and store.
- **Durable and resilient:** The combination of CGF and VF fibers forms a mechanically stable network that withstands repeated use.
- **Environmentally safe and biodegradable:** Both CGF and VF are plant-based and fully compostable (Jahan et al., 2016).

Additional Functional Properties:

- **Antimicrobial:** VF contains natural antibacterial compounds that inhibit microbial growth.
- **Natural fragrance:** VF imparts aromatic properties, enhancing the user experience.
- **Thermal comfort / heat reduction:** CGF's hollow fibers and VF's breathable network help reduce surface heat during exercises.
- **Shock absorption:** CGF's flexible structure distributes impact pressure evenly across the mat.
- **Eco-friendly odor neutralization:** VF fibers naturally control and neutralize odors (Shakthivel & Kurmapu, 2021).
- **Aesthetic and tactile appeal:** CGF provides a soft, cushioned feel, while VF adds a smooth, pleasant texture.

Sustainable Design Principles

The proposed Calotropis-Vetiver mat concept follows three sustainability-based design principles:

1. **Design for Environment (DfE):** Using renewable plant fibers and natural binders instead of petrochemical-based polymers.
2. **Cradle-to-Cradle Design:** Ensuring the mat can return safely to nature without toxic residue after its lifecycle.
3. **Circular Economy Approach:** Encouraging local sourcing, minimal waste generation, and compostable materials (Klose & Fröhling, 2025).

These design approaches reduce environmental load while maintaining product performance and market competitiveness.

Conceptual Performance Evaluation

A theoretical comparison between conventional PVC/EVA mats and the proposed Calotropis–Vetiver concept highlights the potential advantages:

Table 2. Theoretical Comparison: Conventional vs. Calotropis–Vetiver Mat

Property	Conventional PVC/EVA Mat	Calotropis–Vetiver Conceptual Mat
Cushioning	High due to foam structure	High due to fiber resilience
Grip	High (synthetic texture)	High (natural surface texture)

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Moisture Control	Low; traps sweat	High; breathable and quick drying
Durability	Very high	Moderate to high (according to finish)
Environmental Impact	Non-biodegradable, toxic	Fully biodegradable and renewable

These insights suggest that combining Calotropis gigantea and Vetiver fibers can yield mats with strong comfort and grip characteristics while supporting ecological sustainability (Somarelli et al., 2025).

Market and Consumer Relevance

Consumer awareness and demand for eco-friendly fitness and lifestyle products have grown significantly in recent years. People are increasingly willing to choose environmentally safe alternatives that align with wellness and sustainability values. Therefore, the Calotropis–Vetiver sports mat concept could achieve strong acceptance in the market by addressing both environmental and performance expectations *(Role of Consumer's Attitudes towards the Sustainable Products in India, 2024).*

4. DISCUSSION

The conceptual framework developed in this study demonstrates that the integration of Calotropis gigantea and Vetiver fibers can provide a viable pathway toward sustainable innovation in the sports mat industry. Traditional mats made from Polyvinyl Chloride (PVC) and Ethylene Vinyl Acetate (EVA) dominate the market because of their mechanical resilience, cushioning, and affordability. However, these synthetic materials are derived from non-renewable petrochemical sources, release harmful emissions during production, and remain non-biodegradable throughout their lifecycle, contributing to microplastic pollution and waste accumulation.

In contrast, natural fibers such as Calotropis and Vetiver align both with performance and ecological safety. The unique hollow structure of Calotropis offers natural cushioning and lightness, while Vetiver contributes strength, moisture regulation, and antimicrobial properties. Together, they form a balanced composite suitable for sports mats that require comfort, durability, and hygiene. When combined through needle-punched nonwoven processing, these fibers can produce a breathable and elastic mat surface that rivals EVA-based mats in performance while remaining fully biodegradable.

From an industrial perspective, the transition to plant-based fibers faces practical challenges, including the seasonal availability of raw material, standardization of fiber quality, and scalability of production methods. However, since both Calotropis and Vetiver are abundantly available in tropical regions like South India and require minimal cultivation inputs, they present an economically feasible raw material base. The cost advantage becomes even stronger when local sourcing and small-scale community processing are integrated, reducing transportation and energy expenses. Furthermore, as global awareness of sustainability rises, consumer acceptance of eco-friendly alternatives is increasing, even when the cost is marginally higher than conventional synthetic products.

The adoption of such materials aligns strongly with the United Nations' Sustainable Development Goal 12 (Responsible Consumption and Production), which emphasizes resource efficiency, waste reduction, and the development of sustainable goods. By promoting locally sourced, biodegradable sports mats, manufacturers can contribute directly to this goal while catering to the growing market demand for sustainable fitness accessories.

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Overall, the Calotropis-Vetiver conceptual mat design not only demonstrates the technical feasibility of natural fiber integration in sports materials but also highlights how thoughtful material innovation can harmonize performance, affordability, and environmental responsibility. It represents a model for transitioning from synthetic dependency to a circular, bio-based design philosophy within the sports industry.

5. FUTURE SCOPE

Standardization of Fiber Processing

Future research may optimize Calotropis and Vetiver fiber extraction, drying, and cleaning methods to improve efficiency and consistency.

Developing standardized blend ratios and processing parameters will help achieve uniform cushioning, durability, and grip performance.

Scaling Production and Localized Manufacturing

Establishing small-scale rural or semi-industrial processing clusters can support local employment and affordable sourcing.

This can enable decentralized production models that reduce dependence on synthetic imported materials and lower transportation emissions.

Advanced Functional Improvements

Integration of slow-release essential oils (e.g., eucalyptus, lemongrass, camphor) using techniques like microencapsulation or biopolymer carrier systems could add wellness benefits without affecting surface feel.

Future studies may evaluate long-term release profiles, user safety, and aromatherapy effectiveness during exercise.

End-of-Life Sustainability Research

Compostability assessments, biodegradation rates, and soil regeneration potential can further validate sustainable lifecycle benefits.

Future frameworks can include circular take-back systems, cradle-to-cradle certification, or compost facility alignment.

Strengthening the Market Potential for Calotropis Fiber

This research highlights that Calotropis gigantea fiber possesses high functional potential but currently has low market feasibility due to limited awareness, minimal industrial use, and absence of standardized harvesting and processing systems.By demonstrating its superior properties such as hollow structure, softness, low density, hydrophobicity, and cushioning ability this work may help reposition Calotropis from an underutilized wild plant to a valuable fiber resource.

Future industry partnerships, government support programs, and sustainable product branding can contribute to increasing demand and establishing CGF as a commercially recognized eco-fiber.

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Certification and Standards Alignment

Upcoming developments may target compliance with sustainability standards like OEKO-TEX®, GOTS, USDA BioPreferred, or Cradle-to-Cradle® to support market credibility and international commercialization.

6. CONCLUSION

This research explored the potential of using Calotropis gigantea fiber (CGF) and Vetiver fiber (VF) as sustainable material candidates for sports and yoga mats, addressing the growing need to replace synthetic materials such as PVC and EVA that contribute significantly to environmental pollution and long-term waste accumulation. By examining the functional characteristics of both fibers and aligning them with key sports mat performance requirements such as cushioning, grip, elasticity, moisture regulation, durability, and hygiene, this study demonstrates that a CGF-VF fiber blend presents a viable and environmentally responsible alternative.The proposed model emphasizes not only material performance but also lifecycle responsibility, framed through sustainability principles such as Design for Environment, Cradle-to-Cradle approaches, and circular economy thinking. The conceptual framework shows that needle-punched nonwoven processing can enhance softness, resilience, breathability, and fiber entanglement without chemical reinforcement, thereby preserving biodegradability and reducing the carbon footprint associated with conventional mat production.

Beyond technical feasibility, this study recognizes larger ecosystem implications. As global fitness culture shifts toward environmentally conscious consumption and wellness-centric design, natural materials with functional bioactive properties gain relevance. In this context, Calotropis and Vetiver fibers provide unique advantages including natural aroma, antibacterial behavior, low allergenicity, and moisture handling that align with health and well-being values.

The findings also highlight an important market implication: despite its high material potential, Calotropis fiber remains underutilized in the commercial textile ecosystem. This research positions it as a promising future resource capable of creating new value chains, particularly in regions where the plant grows abundantly but remains overlooked.

Overall, this study contributes to the growing discourse on sustainable sports material development and establishes a conceptual foundation for further experimental validation, industrial scaling, and commercial application. Compared to existing natural-fiber mats made from jute, coir, cork, hemp, or natural rubber – many of which are coarse, moisture-retentive, heavy, or expensive to process – the CGF–Vetiver combination offers a more balanced performance profile. Its naturally softer texture, hollow lightweight microstructure, moisture-regulating behavior, antibacterial characteristics, and inherent aroma provide advantages in comfort, hygiene, and user experience that many existing natural mats do not inherently possess.

Additionally, the widespread availability and low harvesting or cultivation cost of both Calotropis gigantea and Vetiver make this proposed material system potentially more cost-efficient than both synthetic mats (PVC/EVA) and premium eco-mats currently available in the market. As the sports and wellness sector continues shifting toward sustainability and material transparency, the CGF–VF based sports mat concept demonstrates a pathway for innovation that is not only functionally competitive but also economically accessible, ethically responsible, and environmentally aligned.

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References

1.Armel, M., Segovia, C., Anny Géraldo, S., Ebanda, F. B., Njom, A. E., Ateba, A., & Nicolas, B. (2023). Investigation of the performance of needle-punched nonwoven fabrics using Triumfetta cordifolia and thermoplastic fibers, compared to other commercial bast fibers used in preformed biosourced composites. *Heliyon*, 9(7), e17888. https://doi.org/10.1016/J.HELIYON.2023.E17888

2.Arpitha, G. R., Verma, A., Sanjay, M. R., Alosaimi, A. M., Khan, A., Hussein, M. A., Asiri, A. M., & Siengchin, S. (2021). Fabrication and experimental study of corn starch based vetiver cellulose reinforced bio-composite film for food packaging application. https://doi.org/10.21203/RS.3.RS-202867/V1

3.Jahan, N., Mushir, A., & Ahmed, A. (2016). A review on Phytochemical and biological properties of Calotropis gigantea (Linn) R.Br. *Discovery Phytomedicine*, 3(3). https://doi.org/10.15562/PHYTOMEDICINE.2016.32

4.Klose, S. A., & Fröhling, M. (2025). A new circular economy conception for sustainable product design. *Journal of Industrial Ecology*, 29(2), 546–560. https://doi.org/10.1111/JIEC.13620

5.Narayanasamy, P., Balasundar, P., Senthil, S., Sanjay, M. R., Siengchin, S., Khan, A., & Asiri, A. M. (2020). Characterization of a novel natural cellulosic fiber from Calotropis gigantea fruit bunch for ecofriendly polymer composites. *International Journal of Biological Macromolecules*, 150, 793–801. https://doi.org/10.1016/J.IJBIOMAC.2020.02.134

6.Pattnaik, S. S., Behera, D., Tarei, S., Mallick, S., Das, N., & Behera, A. K. (2025). Sustainable Reinforcement: Development and Characterization of Vetiver Fiber-Soy Resin Biocomposites With Shorea robusta Leaf Filler. *Polymer Composites*. https://doi.org/10.1002/PC.70013

7.Pattnaik, S. S., Mohapatra, S. K., Mohanty, C., Behera, A. K., & Tripathy, B. C. (2023). Influence of Waste Vetiver Root Fiber on Mechanical, Hydrophobicity, and Biodegradation of Soy-Based Biocomposites as Plastic Substitute. *Fibers and Polymers* 2023 24:1, 24(1), 265–274. https://doi.org/10.1007/S12221-023-00085-Z

8.Qi, Y., Xu, F., Cheng, L., Zhang, R., Liu, L., Fan, W., Zhu, B., & Li, J. (2018). Evaluation on a Promising Natural Cellulose Fiber-Calotropis Gigantea Fiber Volume 2-Issue 4. https://doi.org/10.31031/TTEFT.2018.02.000543

9.Ramasamy, R., Obi Reddy, K., & Varada Rajulu, A. (2018). Extraction and Characterization of Calotropis gigantea Bast Fibers as Novel Reinforcement for Composites Materials. *Journal of Natural Fibers*, 15(4), 527–538. https://doi.org/10.1080/15440478.2017.1349019

10.Ramshankar, P., Sashikkumar, M., Ganeshan, P., & Raja, K. (2023). Experimental investigation of hybrid composites using biowastes and Calotropis gigantea: an eco-friendly approach. *Global Nest Journal*, 25(4), 70–76. https://doi.org/10.30955/GNJ.004620

11.Rayyaan, R., Kennon, W. R., Potluri, P., & Akonda, M. (n.d.). Fibre architecture modification to improve the tensile properties of flax-reinforced composites.

12.REEMA BORA*, SARADI JYOTSNA GOGOI and BINITA B. KALITA. (2023). DEVELOPMENT OF CALOTROPIS/COTTON BLENDED YARN AND ITS PROPERTIES. *The Journal of Research ANGRAU*, 51(1), 58–67. https://doi.org/10.58537/JORANGRAU.2023.51.1.08

https://doi.org/10.64151/PSGCARE-23

ISSN 2394 - 9554

13.Role of Consumer's Attitudes towards the Sustainable Products in India. (2024). www.jetir.org

14.Sanjeevi, S., Ayyanar, A., Kalimuthu, R., & Susaiyappan, S. (2019). Effects of chemical modification on the mechanical properties of Calotropis Gigantea fiber-reinforced phenol formaldehyde biocomposites. *Medziagotyra*, 26(3), 295–299. https://doi.org/10.5755/J01.MS.26.3.17749

15.Shakthivel, S., & Kurmapu, S. (2021). Characteristic investigation on vetiver fibre reinforced polyethylene composites. *AIP Conference Proceedings*, 2317. https://doi.org/10.1063/5.0036549

16.Somarelli, J. A., Diana, Z. T., Rittschof, D., Dunphy-Daly, M. M., Virdin, J., Nowlin, M., Vincoff, S., Bossa, N., Wiesner, M., Jayasundara, N., Mendis, G., Lauer, N., Eward, W. C., & Arnold, J. W. (2025). A pollution crisis of synthetic plastic polymers and their hidden chemical complexity. *One Earth*, 8(11), 101518. https://doi.org/10.1016/J.ONEEAR.2025.101518

17.Yoga Mats Testing Reveals Greenwashing | Ecology Center. (n.d.). Retrieved November 30, 2025, from https://www.ecocenter.org/our-work/healthy-stuff-lab/reports/yoga-mats-testing-2019/yoga-mats-testing-reveals-greenwashing

https://doi.org/10.64151/PSGCARE-23