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Hybridization of Lignocellulosic and Keratinous Fibre in Polypropylene Composites: A Novel Reinforcement Strategy Using Corn Husk and Peacock Feather

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Abstract:
Natural fibre-reinforced polymer composites (NFRPCs) have emerged as sustainable alternatives to synthetic composites, offering environmental compatibility, mechanical reliability, and economic viability. Their biodegradability, low density, and renewable origin render them attractive for lightweight applications under increasing ecological awareness. In this study, hybrid composites were developed by reinforcing a polypropylene matrix with corn fibre and peacock feather barbs, both derived from bio-waste. Fibre loadings of 0, 5, 10, and 15 wt.% were prepared with a fixed 1:1 corn-to-feather ratio. Additionally, 5 wt.% composites with 3:1 and 1:3 ratios were fabricated to evaluate the influence of fibre proportion. Fabrication was carried out by compression moulding using a hot press. Mechanical, thermal, and moisture-related properties were investigated through tensile, flexural, impact, hardness, thermogravimetric (TGA), and water absorption analyses. Results indicated that tensile strength decreased marginally with fibre loading, whereas flexural strength, tensile modulus, impact resistance, and hardness attained maximum values at 5 wt.% before declining. The 1:3 ratio composite at 5 wt.% exhibited superior overall performance. Water absorption increased with fibre content, with the 3:1 ratio showing the highest uptake due to the higher cellulose content of corn fibres. TGA confirmed thermal stability up to 200 °C, supporting their suitability for low-to-moderate temperature applications.

Keywords: *Hybrid Polypropylene Composite; Corn Husk and Peacock Feather Fiber; Thermo-Mechanical Properties*

1. Introduction
The pursuit of sustainable alternatives to synthetic composites has led to growing interest in natural fibre-reinforced polymer composites (NFRPCs), particularly for applications requiring lightweight, cost-effective, and environmentally responsible materials [1]. Unlike synthetic fibres such as glass, aramid, or carbon, natural fibres offer biodegradability, renewability, lower energy consumption during processing, and reduced environmental impact across their life cycle [2]. These advantages align with current trends in green engineering and the circular economy, where materials are increasingly assessed not only for their performance but also for their ecological footprint [3]. Natural fibres, generally classified into plant-based (lignocellulosic) and animal-based (proteinaceous) categories, exhibit diverse reinforcement behavior due

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to their inherent structural and chemical compositions. Lignocellulosic fibres—such as jute, flax, hemp, and corn husk—are rich in cellulose and hemicellulose and are typically hydrophilic, which poses challenges when combined with hydrophobic thermoplastics like polypropylene (PP) [4].

Conversely, protein-based fibres such as wool or feather keratin offer distinct morphologies, low densities, and unique thermal insulation properties [5]. Corn fibre, derived as an agricultural by-product from maize (Zea mays), contains approximately 43–45% cellulose, 30–32% hemicellulose, and about 15% lignin [6]. As a waste stream from food and bioethanol industries, it represents a sustainable and economical resource for composite reinforcement. Its inherent stiffness and low density (~1.3 g/cm^3) make it suitable for use in polymer matrices [7]. Additionally, utilizing corn fibre supports the valorization of agricultural residues and contributes to rural bioeconomies, especially in countries like Bangladesh where maize production is significant [8]. Conversely, protein-based fibres such as wool, silk, and feathers are less frequently employed in structural composites but offer distinct advantages [9]. Feather fibres, especially those derived from poultry or ornamental birds like peacocks, are primarily composed of β-keratin—a fibrous structural protein characterized by a hierarchical microstructure and high resilience. These fibres have hollow cores, extremely low density (as low as 0.89 g/cm^3), and superior thermal insulation characteristics [9], [10]. While chicken feathers have been partially explored in composite systems [11], peacock feather barbs remain underutilized despite their availability from naturally molted feathers and their ornamental and mechanical uniqueness.

Polypropylene, a semicrystalline thermoplastic polymer, is widely used due to its excellent balance of mechanical strength, chemical resistance, low density, and thermal stability [12]. With a global production exceeding 80 million tons annually, it is extensively adopted in automotive, construction, consumer product, and packaging industries [13]. Its processability via injection molding, extrusion, and thermoforming makes it an ideal matrix for fibre reinforcement. However, challenges such as fibre-matrix incompatibility, thermal degradation of natural fibres during processing, and moisture absorption need to be strategically addressed to ensure composite stability [14].

While lignocellulosic fibres have received considerable attention in literature [15], keratinous fibres—especially in hybrid systems—are still in their infancy. Combining corn and peacock feather fibres offers a unique synergy: the structural stiffness of corn fibre complements the resilience and lightness of peacock feathers [16]. This novel hybrid reinforcement strategy may yield composites with enhanced mechanical integrity, toughness, and multifunctional properties suitable for semi-structural, low-load-bearing applications [17].

Therefore, present study investigates the fabrication and characterization of corn fibre and peacock feather fibre reinforced polypropylene composites, aiming to evaluate their mechanical, thermal, and physical performance. The proposed approach not only utilizes underexploited and biodegradable resources but also contributes to the development of environmentally friendly composite materials tailored for emerging sustainability-driven markets. Although peacock feathers are not as widely available as conventional natural fibres, their use in low-load or specialty composites demonstrates the potential of keratinous waste as a value-added, sustainable reinforcement [18], [19]. This study provides insights into hybrid composites that could inspire economically scalable alternatives using more abundant keratinous or lignocellulosic fibres in future applications. This aligns with global efforts to reduce reliance on petroleum-based materials and supports innovation in green materials science [20].

1 Materials and Methods

1.1 Materials

Commercial-grade polypropylene (PP), presented in granular form, was used as the matrix material in this study, as illustrated in Figure **1**(a). The polypropylene was purchased from the local market and had a melting temperature range of approximately 130–171 °C. The molecular weight of the PP used was approximately 150,000 g/mol. Natural fibres were sourced locally: corn fibres were extracted from corn husks and peacock feather fibres were obtained from naturally molted feathers collected from local markets. Representative images of the raw corn fibre and mechanically fragmented peacock feathers are also shown in Figure **1** (b) and (c) respectively.

Figure 1: (a) PP granules, (b) corn fibre and (c) peacock feather barbs

1.2 Fabrication of Composites

Hybrid composites were fabricated using a polypropylene (PP) matrix reinforced with peacock feather and corn fibres via compression moulding. A stainless steel mould (150 mm × 150 mm × 5 mm) was used in a hot press operating at up to 30 kN load and 180°C. Prior to processing, fibres were manually cleaned and cut to a uniform length of approximately 3–5 mm. PP granules and fibres were weighed, and the mould cavity was cleaned and coated with a mould release agent. Composite lay-up involved sequential layering: PP granules at the base, followed by a homogeneous layer of the pre-weighed fibre mixture, and topped with PP to fully encapsulate the fibres. The moulded assembly was placed in the hot press, and a pressure of 30 kN was applied from the beginning of the heating cycle. The temperature was then raised to 150 °C and held isothermally for 15–20 minutes to facilitate fibre impregnation and matrix melting. Subsequently, the temperature was increased to 180 °C and maintained for an additional 2–3 minutes to ensure full consolidation. Cooling was achieved via water circulation, after which the composite was demoulded. No separate post-curing step was performed; the controlled cooling cycle was found sufficient to achieve full consolidation and dimensional stability. Two sets of hybrid composites were prepared. In the first set, total fibre loading was varied at 5, 10, and 15 wt.% while maintaining a constant feather-to-corn fibre ratio of 1:1. In the second set, the total fibre content was fixed at 5 wt.%, but the reinforcement ratio was altered to explore the effect of fibre proportion. Specifically, feather-to-corn ratios of 3:1 and 1:3 were used to evaluate their influence on composite performance.

1.3 Mechanical Tests

Mechanical characterization was carried out to assess the structural performance of the developed hybrid composites in comparison to neat polypropylene (PP). The evaluated properties included tensile strength and modulus, flexural strength and modulus, impact resistance, and surface hardness. All tests were conducted in accordance with relevant ASTM standards. Tensile specimens were prepared in accordance with ASTM D638 Type IV, flexural specimens followed ASTM D790, and impact specimens were rectangular bars with a length of 70 mm, width of 10 mm, and thickness of 5 mm. All specimens were cut from compression-moulded sheets and conditioned under ambient laboratory conditions prior to testing. For each formulation, three replicate specimens were tested and the average values were reported to ensure reliability. Tensile properties were evaluated using an Instron Universal Testing Machine (System ID: 3369J8567, maximum capacity: 50 kN) following ASTM D638-01. Ultimate tensile strength and tensile modulus were calculated based on the applied load and the corresponding deformation within the gauge section. Flexural properties were determined via three-point bending tests conducted on the same Instron machine, adhering to ASTM D790-98. A central load was applied until fracture or significant deformation occurred, and both flexural strength and flexural modulus were derived from the load–deflection behavior. Impact resistance was measured using a Charpy impact tester (Model: MT 3016) in accordance with ASTM D6110-97. Surface hardness was assessed using a Shore D Durometer, suitable for evaluating the hardness of rigid polymeric materials. Multiple readings were taken across each sample to minimize local variation, and mean values were reported.

1.4 Water Absorption Test

Water absorption testing was performed to evaluate the moisture uptake behavior of the hybrid composites. Rectangular specimens measuring 30 mm in length, 10 mm in width, and 5 mm in thickness were used. Specimens were air-dried for 24 hours, were weighed before being immersed in water at room temperature for 24 hours. After immersion, surface moisture was removed, and specimens were reweighed to determine the percentage increase in weight.

1.5 Thermogravimetric Analysis (TGA)

Thermal stability of the composites was assessed using a thermogravimetric analyzer (TA Instruments TGA Q50, model V6.4 Build 193). Approximately 30 mg of each sample was placed in an alumina crucible and heated from room temperature to 500°C at a rate of 10°C/min under a nitrogen atmosphere with a flow rate of 50 mL/min. Both TGA and derivative thermogravimetry (DTG) curves were recorded to evaluate thermal degradation behavior and identify distinct decomposition stages.

2 Results and Discussion

2.1 Tensile Properties

The tensile properties of hybrid polypropylene composites reinforced with a 1:1 blend of corn fibre and peacock feather were evaluated at different fibre loadings (0, 5, 10, and 15 wt.%) using stress–strain analysis. The influence of fibre content on tensile strength and Young's modulus is illustrated in Figure 2. Figure **2**(a) shows that tensile strength decreased progressively with increasing fibre loading. This decline is attributed to the weak interfacial bonding between the hydrophilic lignocellulosic corn fibres and the hydrophobic polypropylene matrix, which leads to ineffective stress transfer [21], [22]. The weak bond forms because hydrophilic fibres contain abundant polar –OH groups that attract moisture and do not interact favorably with the nonpolar polypropylene chains, resulting in poor adhesion at the fibre–matrix interface. This polarity mismatch prevents efficient load transfer from the matrix to the fibres under stress [23], [24]. At higher fibre loadings (particularly at 15 wt.%), the polymer matrix fails to adequately encapsulate all fibres, resulting in fibre-rich zones and the formation of voids. These discontinuities disrupt the load-bearing capability of the composite, further diminishing tensile strength. In contrast, Figure **2**(b) shows that Young's modulus increased initially, peaking at 5 wt.% fibre loading before declining. The initial rise in modulus suggests that moderate fibre incorporation enhances stiffness by restricting polymer chain mobility and introducing more rigid filler phases [25], [26]. However, at higher loadings (10–15 wt.%), poor dispersion and agglomeration of fibres likely occurred, forming microstructural defects that inhibit efficient stress propagation [27]. Additionally, insufficient wetting during compounding may lead to increased porosity, exacerbating the reduction in both modulus and strength [28].

The influence of fibre blend ratio on the tensile strength and young's modulus of hybrid polypropylene composites reinforced with corn fibre and peacock feather is illustrated in **Error! Reference source not found.**. Composites were prepared with three different weight ratios of corn to feather fibre: 3:1, 1:1, and 1:3. The mechanical response exhibited a distinct dependence on the fibre blend ratio. Among the tested compositions, the highest tensile strength was recorded for the composite with a 1:3 corn-to-feather ratio (Figure 3 (a)), indicating optimal reinforcement at higher feather content. This improvement can be

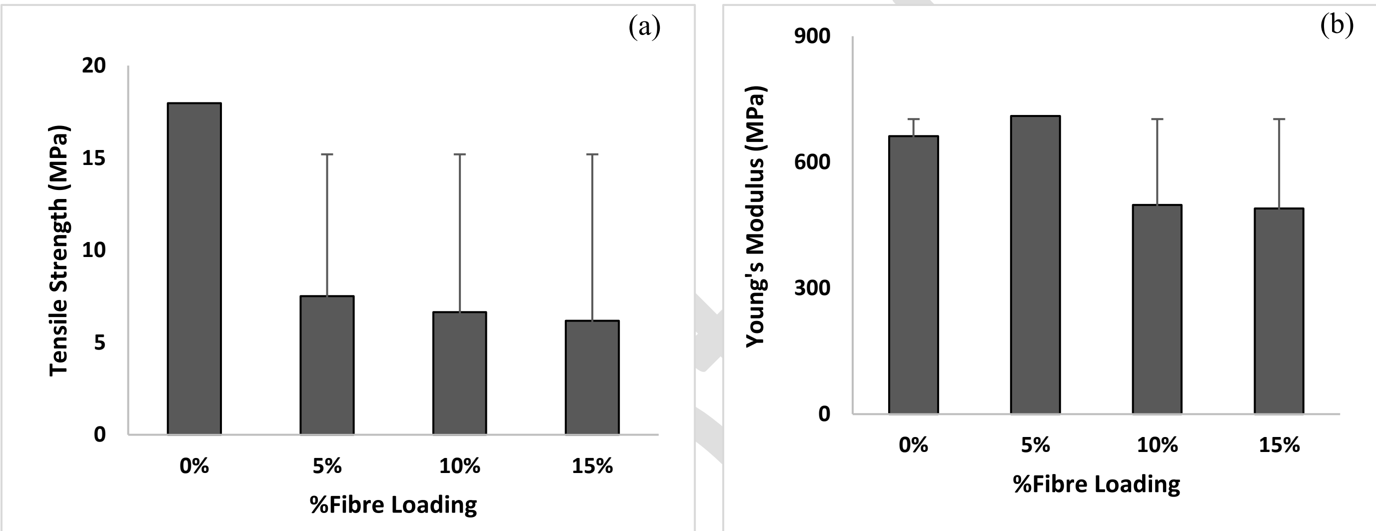

Figure 2: Effect of fibre loading on (a) tensile strength and (b) Young's modulus of the composites.

attributed to the superior chemical compatibility between peacock feather fibres and the polypropylene matrix. Keratin, the primary structural protein in feather barbs, contains approximately 60% hydrophobic and 40% hydrophilic amino acid sequences [29], which facilitates better interaction with the hydrophobic polypropylene matrix compared to the highly hydrophilic, cellulose-based corn fibres. Enhanced matrix adhesion leads to stronger fibre-matrix bonding and more effective stress transfer [30]. Interestingly, the composite with a 3:1 corn-to-feather ratio also exhibited higher tensile strength than the 1:1 ratio, despite corn fibre's lower intrinsic strength. This counterintuitive behavior can be explained by the hybrid weakening effect. At an equal blend (1:1), the composite suffers from interfacial incompatibility due to the simultaneous presence of hydrophilic (corn) and semi-hydrophobic (feather) fibres. This mismatch often leads to fibre–fibre interference, poor dispersion, and the formation of micro-voids or agglomerates, reducing the load transfer efficiency across the interface [31]. In contrast, when one fibre type dominates the matrix (either in 3:1 or 1:3), the composite behaves more like a single-fibre system, allowing improved phase continuity and reducing interfacial stress concentration zones [32]. This phenomenon has been reported in previous studies on hybrid composites, where intermediate fibre blends (particularly 1:1) performed worse than fibre-dominant compositions due to phase heterogeneity and aggregation tendencies [31]. Quantitatively, increasing the feather fibre proportion to 75% (1:3 ratio) led to a 64.35% increase in tensile strength relative to the 1:1 ratio, while the 3:1 (corn-dominant) ratio still provided a substantial increase of 58.7%. This trend is consistent with the intrinsic tensile properties of the fibres: peacock feather fibres typically exhibit strengths of 60–70 MPa, while corn fibres range between 34–35 MPa [33], [34]. A similar trend was observed for Young's modulus (Figure 3 (b)), which increased progressively with higher feather content, peaking at the 1:3 ratio. This outcome reflects the higher stiffness of feather fibres (2.8–

3.0 GPa) compared to corn fibres (1.3–1.5 GPa) [33], [34]. Increased feather content introduces a more rigid reinforcement network, thereby enhancing the composite's resistance to deformation under tensile loading [35]. The improved stiffness also indicates better stress propagation through the matrix–fibre interface, especially when interfacial compatibility is maximized, as in feather-rich systems [6]. After evaluating tensile behaviour, which reflects the composites' resistance to uniaxial loading, flexural properties were examined to assess stiffness and load-bearing capacity under bending.

2.2 Flexural Properties

The influence of fibre loading on the flexural strength and modulus of hybrid polypropylene composites reinforced with a 1:1 ratio of corn fibre and peacock feather is illustrated in Figure 4. The composites exhibited a clear trend in flexural behaviour, with both strength and stiffness increasing initially up to 5 wt.% fibre loading, followed by a gradual decline at higher loadings. As illustrated in Figure 4 (a), at low fibre loading (up to 5 wt.%), a significant enhancement in flexural strength was observed. This improvement can be attributed to the favourable entanglement of the polymer chains with the fibre surface

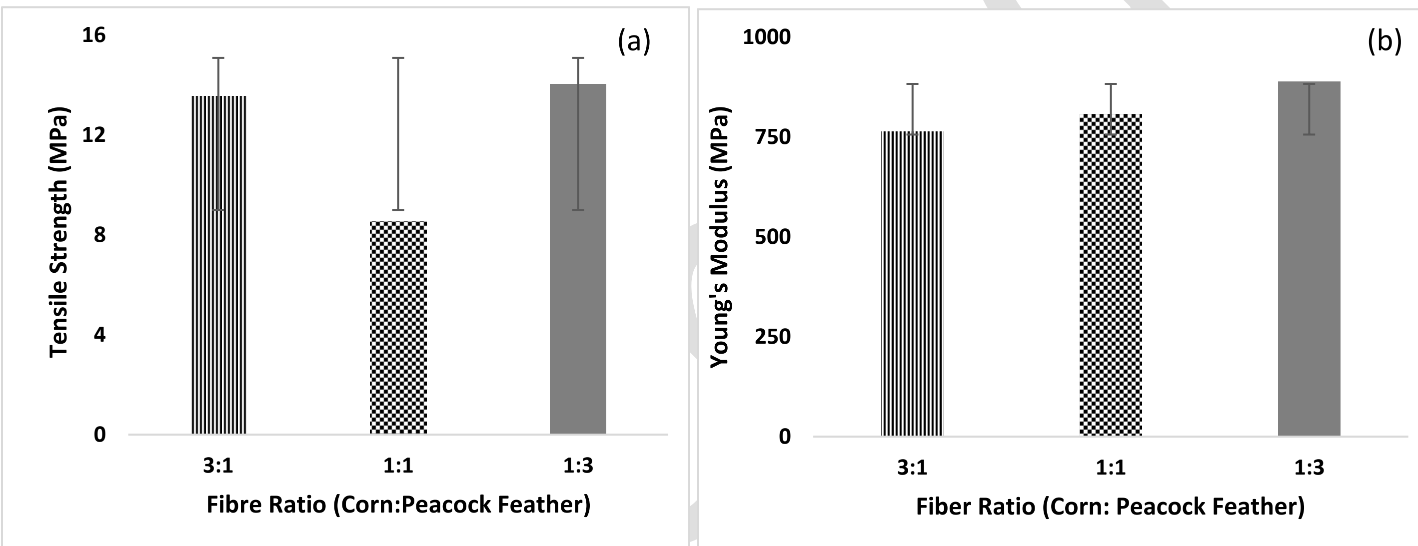

Figure 3: Effect of fibre ratio on (a) tensile strength and (b) Young's modulus of the composites.

and the relatively uniform dispersion of fibres within the matrix [36]. At this loading level, the fibre content remains sufficiently low to ensure adequate wetting by the matrix, promoting effective stress transfer across the fibre-matrix interface [12]. Additionally, the reinforcing fibres restrict the mobility of polymer chains under bending, thereby increasing the load-bearing capacity of the composite [14], [37]. In Figure 4 (b), The increase in flexural modulus at 5 wt.% fibre loading also reflects the stiffening effect of the reinforcing fibres. Both corn and feather fibres possess relatively high intrinsic modulus values and their integration into the softer polypropylene matrix forms a more rigid composite structure [32], [38]. At low to moderate fibre loadings, this rigidity effectively enhances the resistance of the composite to elastic deformation under bending stress [39].

However, at fibre loadings beyond 5 wt.% (i.e., 10–15 wt.%), a decline in both flexural strength and modulus is evident. This reduction is primarily due to the formation of fibre agglomerates, which act as stress concentration sites and hinder uniform stress distribution [40]. Excess fibre also reduces the matrix's ability to encapsulate each fibre strand, leading to insufficient wetting and weak interfacial adhesion [41], [42]. The interstitial voids or porosity created during processing further exacerbate this issue. These voids may arise from trapped air, incomplete fibre wetting, or the collapse of fibre lumens and hollow regions under processing pressure, all of which compromise the mechanical integrity of the composite [43], [44]. Moreover, the heterogeneous fibre packing at higher loading disrupts the stress transfer pathways, resulting in premature micro-crack initiation and propagation under flexural loading. Such behaviour is consistent with findings from prior studies on natural fibre composites, where excessive fibre content adversely affects mechanical performance due to poor matrix flow, reduced compaction, and structural discontinuities [12].

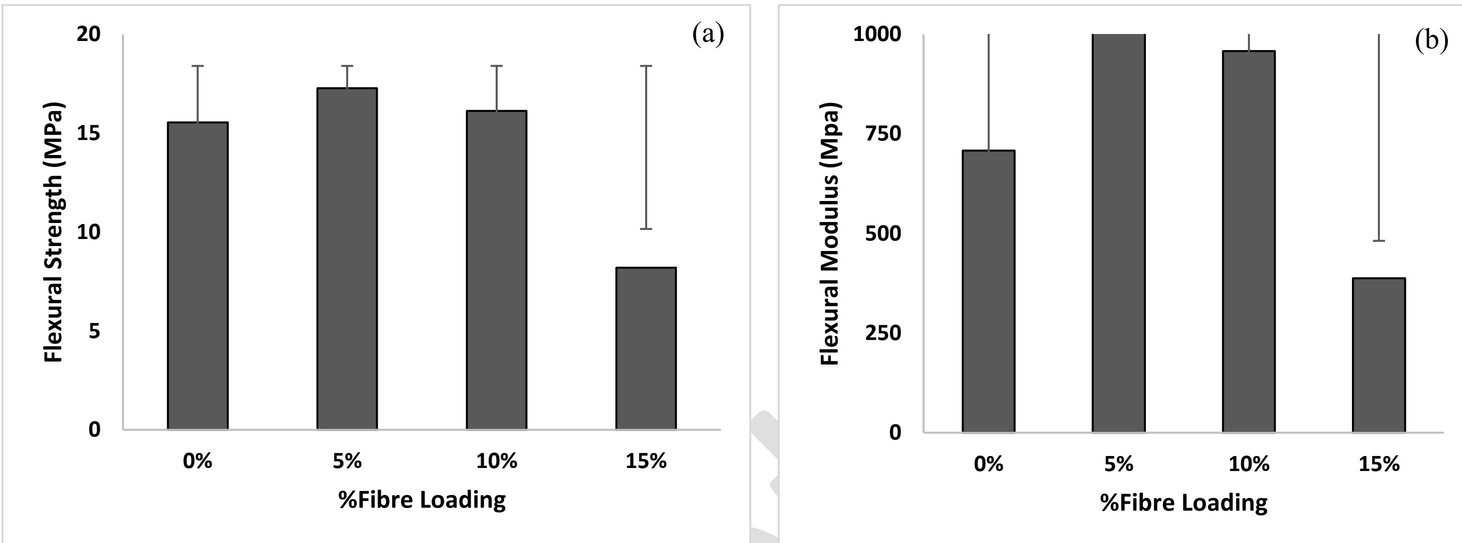

Figure 4: Effect of fibre loading on (a) flexural strength and (b) flexural modulus of the composites.

As shown in Figure 5 (a), the hybrid composite with a 3:1 corn-to-peacock feather ratio exhibited the highest flexural strength, followed closely by the 1:3 ratio composite. This suggests that both fibres contribute to strength, but the higher proportion of corn fibre—rich in cellulose—enhances stress transfer efficiency and rigidity under flexural load [37], [38]. Cellulose, a semi-crystalline polysaccharide, reinforces the matrix through improved interfacial adhesion and mechanical integrity. In contrast, feather fibre is keratin-based, lacking cellulose, and offers toughness but less stiffness under flexural load [35]. The superior strength of the corn-rich composite highlights the reinforcing role of cellulose. In contrast, Figure 5 (b) shows a more pronounced difference in flexural modulus, with the 1:3 corn-to-feather composite exhibiting the highest stiffness. This is attributed to the structural characteristics of keratin in feather fibres, particularly the β-sheet configurations, which resist deformation more effectively than the amorphous regions in lignocellulosic corn fibres [45]. The modulus enhancement with increased feather content aligns with prior findings on keratinous fibre-reinforced composites, where molecular alignment and structural compactness of keratin significantly improve elastic properties [46]. These results suggest that while flexural strength is relatively comparable between the 3:1 and 1:3 composites, the flexural modulus is more sensitive to fibre type.

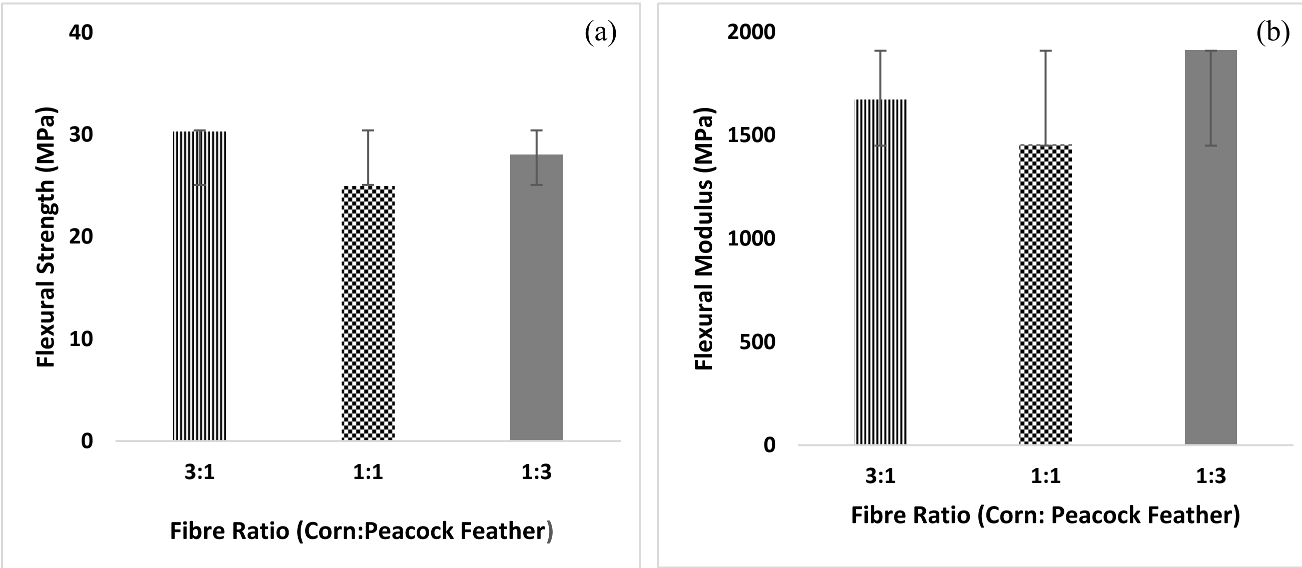

Figure 5: Effect of fibre ratio on (a) flexural stress and (b) flexural modulus of the composites.

Quantitatively, increasing corn content from 1:1 to 3:1 raised flexural strength by 21.3%, while increasing feather content to 1:3 improved it by 12.33%. In terms of stiffness, flexural modulus rose by 31.58% with higher feather content (1:1 to 1:3), and by 14.93% with higher corn content (1:1 to 3:1). The lowest strength and modulus were observed at the 1:1 ratio, likely due to poor interfacial compatibility between hydrophilic corn and semi-hydrophobic feather fibre [12], [32]. This mismatch can cause inadequate bonding, fibre clustering, and ineffective stress transfer [42]. The use of coupling agents or compatibilizers could potentially resolve this issue and enhance performance [6]. Following stiffness and load-bearing capacity, toughness was evaluated through impact strength.

2.3 Impact Strength

Figure 6 illustrates the impact strength variation of corn–feather fibre reinforced polypropylene composites with different fibre loadings and blend ratios. In Figure 6 (a), impact strength increased from 0 to 5 wt.% fibre loading, then declined at 10–15 wt.%. The initial improvement is due to effective fibre-matrix entanglement and energy dissipation via fibre pull-out [41], [47]. At low fibre content, good dispersion and matrix wetting enable efficient energy absorption [48]. Beyond 5 wt.%, the decrease is attributed to fibre agglomeration, stress concentration at fibre ends, and interfacial voids, which act as crack initiation sites and reduce toughness [49]. In Figure 6 (b), at constant 5 wt.% loading, varying the corn-to-feather ratio shows that impact strength increases with higher feather content. Compared to the 1:1 blend, 3:1 and 1:3 ratios showed 57.5% and` 74.3% higher impact strength, respectively. This improvement can be attributed to the keratinous nature of feather fibres, which are known to possess a hierarchical structure that contributes to toughness and energy dissipation under impact [50], which allows α-helices to uncoil under stress, improving energy absorption. Additionally, feather fibres promote controlled debonding due to weaker interfacial bonding, which enhances fracture energy by creating new surfaces during impact [51]. In contrast, corn fibres are more brittle and prone to moisture uptake, reducing adhesion and impact strength. After toughness, hardness was examined to assess resistance to indentation.

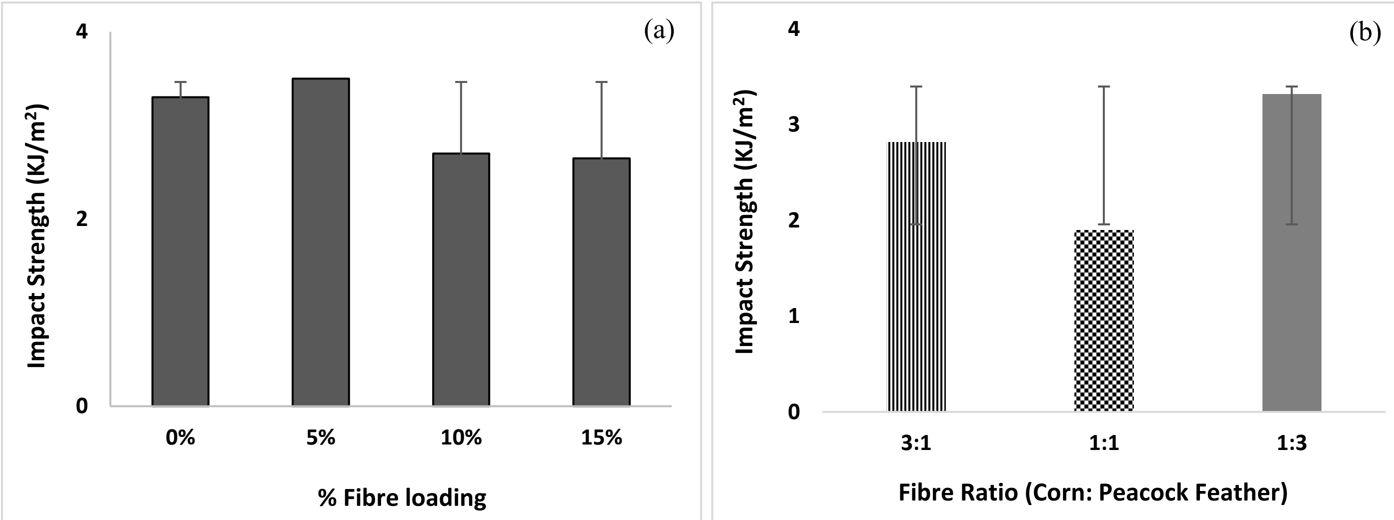

Figure 6: Variation of impact strength against (a) fibre loading and (b) fibre ratio

2.4 Hardness Properties

The influence of fibre loading and corn-to-feather fibre ratio on the hardness of polypropylene-based hybrid composites is illustrated in Figure 7. Hardness, which measures a material's resistance to localized deformation, is influenced by fibre distribution, matrix flexibility, and fibre-matrix interaction. In composite materials, hardness is typically correlated with stiffness and follows a similar trend to Young's modulus [52].

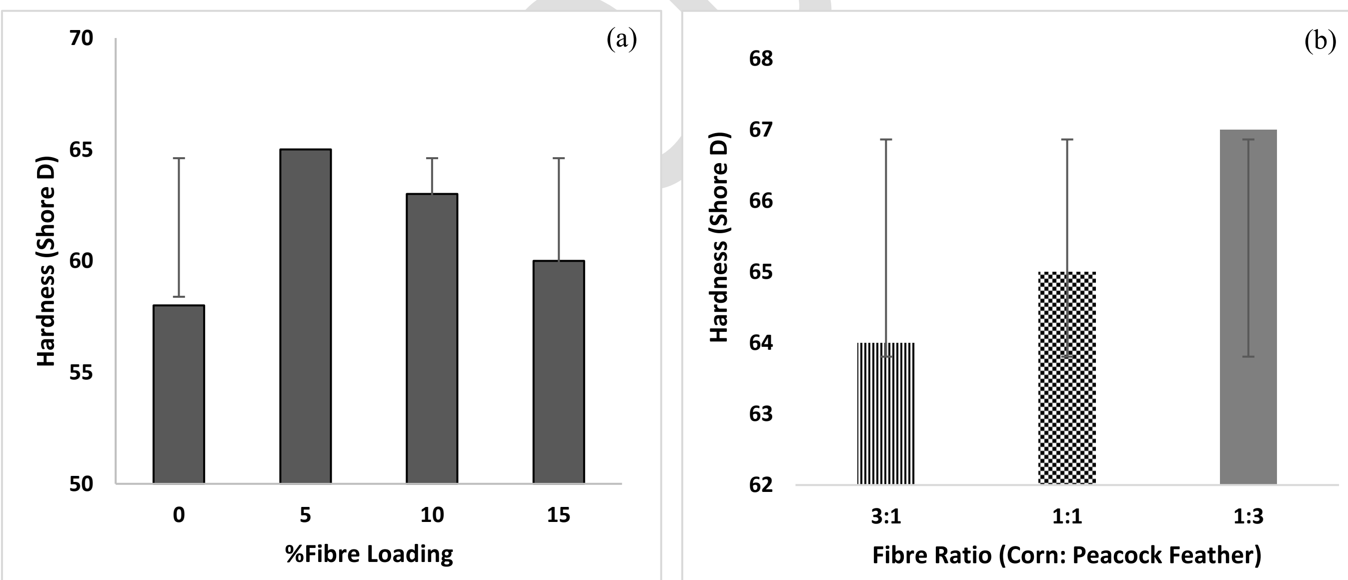

Figure 7: Variation of hardness against (a) fibre loading and (b) fibre ratio

As shown in Figure 7 (a), the highest hardness was recorded at 5 wt.% fibre loading, after which it declined at 10% and 15%. The increase at 5% can be attributed to improved fibre dispersion and reduced matrix flexibility, leading to a stiffer, more rigid composite [14]. At higher fibre contents, however, poor dispersion and void formation at the fibre-matrix interface likely reduced resistance to indentation, lowering the overall hardness [53]. In Figure 7 (b), the effect of fibre ratio at constant 5 wt.% total loading reveals that hardness increased with a higher feather fibre proportion. When the corn-to-feather ratio changed from 1:1 to 1:3, hardness increased by 3%. In contrast, increasing corn content to a 3:1 ratio resulted in a 1.5% decrease in hardness. This trend is consistent with the stiffness contribution of feather fibres, which possess higher intrinsic modulus than corn fibres, and with the composite behaviour observed in Young's modulus trends (Figure 3 (b). Subsequent to mechanical properties, water absorption was analysed to evaluate durability against moisture.

2.5 Water Absorption Characteristics

Water absorption of the hybrid composites increased progressively with fibre loading, as illustrated in Figure 8 (a). This trend is attributed to the higher concentration of hydroxyl groups introduced by the natural fibres, which enhances hydrophilicity [28], [32]. As fibre content rises, the greater availability of these polar sites promotes increased moisture uptake. Additionally, swelling of the fibres upon exposure to water can induce microcracking at the fibre-matrix interface, further facilitating water diffusion into the composite structure [12], [54].

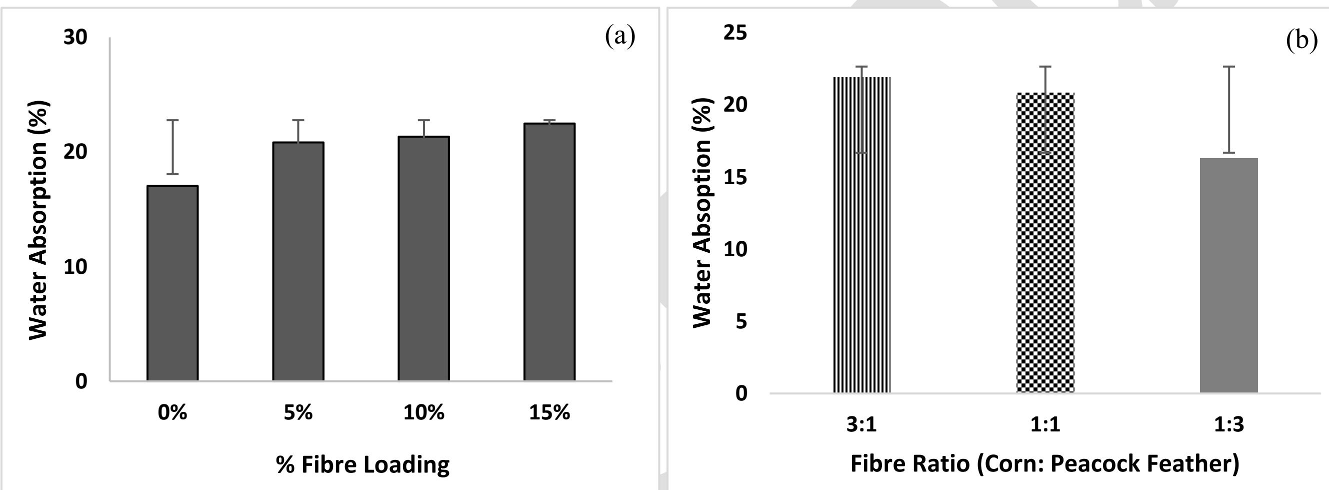

Figure 8: Variation of water absorption against (a) fibre loading and (b) fibre ratio

The influence of fibre type and proportion is further demonstrated in Figure 8 (b), where composites with a higher corn fibre content (3:1 corn:peacock) exhibit the greatest water absorption. This is consistent with the lignocellulosic nature of corn fibre, which contains abundant cellulose and hemicellulose, known for their strong water affinity [28], [32]. In contrast, composites with a higher proportion of peacock feather fibres (1:3 ratio) show significantly reduced absorption, owing to the keratinous structure of feather fibres, which are less hygroscopic and more dimensionally stable in moist environments [45], [55]. Beyond moisture uptake, thermal stability was investigated using TGA. Following the evaluation of moisture uptake, which indicates hydrophilicity and durability in humid environments, thermal stability was investigated using TGA to determine degradation behaviour.

2.6 Thermo Gravimetric Analysis Results

Thermal stability of the fibre-reinforced polypropylene composites was assessed via TGA and DTG analysis, as shown in Figure 9. All samples exhibited minor initial weight loss below 100°C due to moisture evaporation. Major degradation began above 200°C, suggesting a safe service temperature below this threshold. The composite with a 1:1 corn-to-peacock feather ratio at 5 wt.% showed the highest thermal stability, with degradation occurring between 215°C and 480°C. The 3:1 (corn:peacock) composite degraded between 215°C and 465°C, while the 1:3 variant ranged from 213°C to 470°C. These differences reflect the varying decomposition behaviors of lignocellulosic and keratinous fibres. DTG curves confirmed multi-stage degradation, corresponding to hemicellulose, cellulose, and keratin breakdown

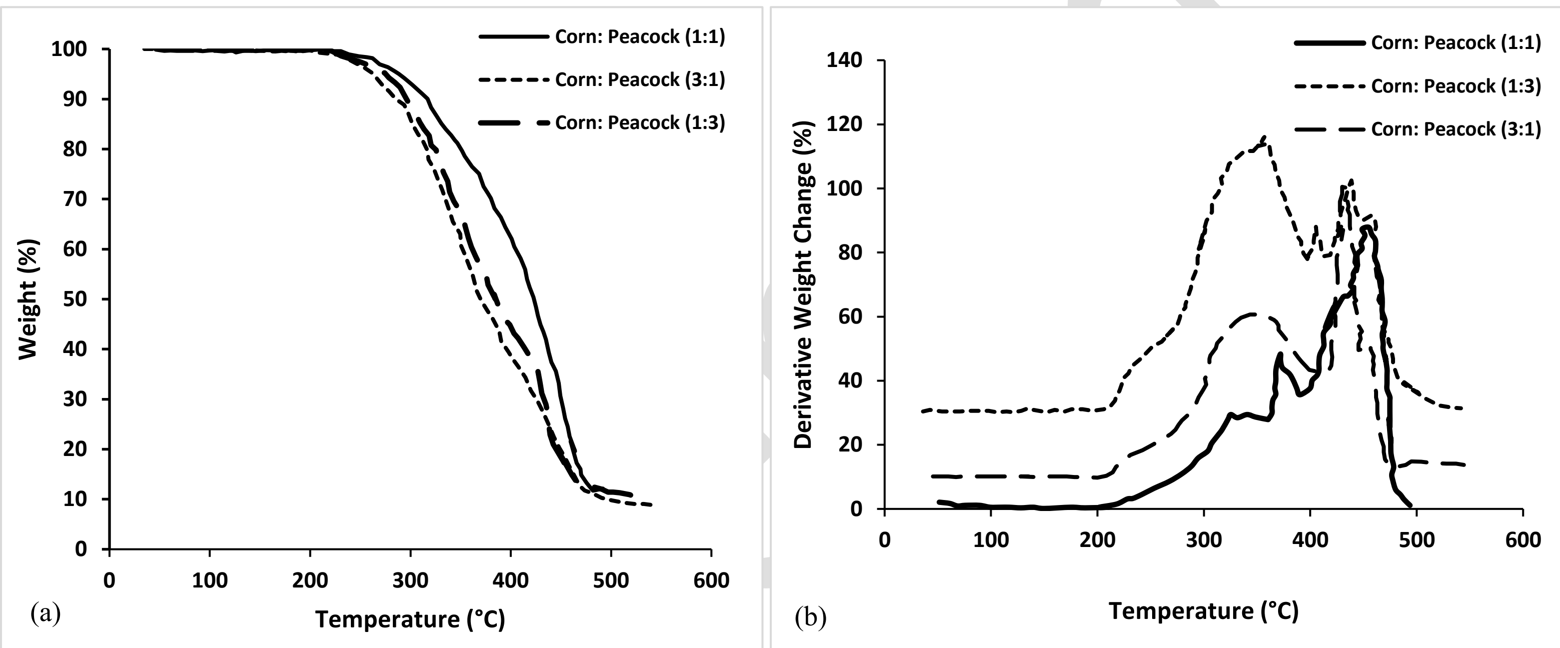

Figure 9: (a) TGA and (b) DTGA curves against fibre ratio

3 Conclusion

In present study, hybrid polypropylene composites reinforced with corn fibre and peacock feather fibre were fabricated via hot press moulding at four fibre loadings (0, 5, 10, and 15 wt.%). Mechanical characterization, water absorption analysis, and thermogravimetric evaluation were carried out to assess composite performance. While tensile strength declined with increasing fibre content, optimal values for flexural strength, modulus, impact resistance, and hardness were observed at 5 wt.% fibre loading. Among the hybrid ratios investigated (1:1, 3:1, and 1:3), the 1:3 (corn:peacock feather) configuration delivered the best overall mechanical performance. Water absorption increased with higher fibre loading, with the 3:1 (corn:peacock) composite exhibiting the highest uptake due to corn fibre's higher cellulose content. TGA results confirmed that all composites maintained thermal stability above 200 °C, recommending a safe service temperature below this threshold. In conclusion, the synergistic use of lignocellulosic and keratinous fibres offers enhanced property tuning that cannot be achieved by individual fibres alone. The results indicate that corn–peacock feather fibre hybrids present a promising, eco-friendly reinforcement strategy for lightweight, low-load-bearing thermoplastic composites. Nevertheless, the present work has certain limitations. The composites were developed without fibre surface treatment or compatibilizers, which may have restricted fibre-matrix adhesion and overall load transfer efficiency. Future work could explore chemical or enzymatic fibre treatments, coupling agents, and compatibilizers to improve interfacial bonding. Investigations on fibre alignment, nano/micro-filler hybridization, and processing scalability would also provide valuable insights. Furthermore, life-cycle assessment, recyclability, and cost–performance analysis should be undertaken to strengthen the case for industrial adoption.

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