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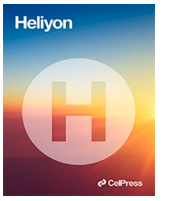

Preparation and characterization of short date palm mat (DPM) fiber reinforced polystyrene composites: Effect of gamma radiation

Most Afroza Khatun [a,b,*], Shahin Sultana [c], Mohammad Shahriar Kabir [d], Md Sahadat Hossain [e], Husna Parvin Nur [c], A.M Sarwaruddin Chowdhury [a]

[a] *Department of Applied Chemistry and Chemical Engineering, Faculty of Engineering and Technology, University of Dhaka, Dhaka, 1000, Bangladesh*
[b] *Department of Chemical Engineering, Faculty of Engineering, Jashore University of Science and Technology, Jashore, Bangladesh*
[c] *Fiber and Polymer Research Division, BCSIR Laboratories Dhaka, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhanmondi, Dhaka, 1205, Bangladesh*
[d] *Department of Chemistry, Primeasia University, Bananai, Dhaka, 1213, Bangladesh*
[e] *Glass Research Division, Institute of Glass and Ceramics Research and Testing (IGCRT), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, 1205, Bangladesh*

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ABSTRACT

The utilization of natural fiber reinforced polymer composites is growing fast in numerous sectors. In this study, the effect of the addition of short date palm mat (DPM) fibers in polystyrene matrix on the physico-mechanical and thermal properties were studied. Short DPM fiber reinforced polystyrene composites were produced by compression moulding process and the fiber content was 5, 10, 15, 20 and 25 wt%. Physico-mechanical and thermal properties were examined. Scanning electron microscopy (SEM) and Fourier-transform infrared (FT-IR) analysis of the composites were also done. The findings from the investigates exposed that the composites with 10 % fiber content showed improved mechanical and thermal characteristics as compared to other composites. The morphological analysis also supported the results where good interfacial bonding among fiber and polystyrene matrix was found for the composites with 10 % fiber content. The optimized (10 % fiber content) composites were exposed to gamma radiation (2.5–7.5 kGy) and the best result was found at 5.0 kGy radiation dose. Degradation of gamma irradiated composites was conducted in four different media such as water, acid, base, and brine.

1. Introduction

Environmental pollution caused due to the increasing consumption of synthetic plastic materials and their non-biodegradability which has become a worldwide concern. The development of polymer composites with natural fibers has received great attention as an environmental friendly and economically sustainable substitute [1,2]. Polystyrene is the most extensively used synthetic plastic materials in the world which displays good mechanical properties, dimensional stability, electrical insulation properties, anticorrosive

* Corresponding author. Department of Applied Chemistry and Chemical Engineering, Faculty of Engineering and Technology, University of Dhaka, Dhaka, 1000, Bangladesh.
E-mail address: afroza.jstu@gmail.com (M.A. Khatun).

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properties, transparency and easy processing [3,4]. Hence, polystyrene finds use in a variety of applications for instance refrigerator liners, home appliances, food packaging, vending cups, cousion materials during transportation of products, automotive and engineering industry etc [4–6].

The usage of natural fibers in polymer matrix composites has garnered significant attention and finds variety of applications in many fields. Natural fibers have good properties and benefits over traditional synthetic fibers. The benefits of natural fibers are low cost, low weight, less damage to equipment during processing, better surface finish of moulded parts composite, good comparative mechanical characteristics, flexibility in processing, easy availability and renewability, biodegradability, and minimal health hazards etc [7,8].

Nowadays, natural fiber reinforced composites are well-established and varieties of natural fibers have been used for the development of composites such as jute [9], kenaf [10], hemp [11], banana [12], coir [13], flax [14], rice husk [15], sisal [16]. In recent times, the utilization of agricultural waste and forest residues has drawn concentration from researchers due to sustainability. Agricultural waste and residues from plants possess identical structure and chemical compositions which could be a potential reinforcement in plastic [17]. Zadeh et al. prepared date palm leaf fiber reinforced recycled ternary blend of LDPE, HDPE and PP composites and found improved thermal and mechanical properties [18]. Raghavendra et al. developed and investigated mechanical properties of date palm frond fiber reinforced polyester composites [19]. Ibrahim et al. produced and characterized date palm and flax fibers reinforced starch composites [20]. Ali et al. synthesized and characterized date palm fiber reinforced recycled polymer composites [21]. Saba et al. prepared and examined mechanical and morphological properties of date palm stem fiber reinforced epoxy composites [22].

The mechanical characteristics of the composites are the primary concern of using natural fibers in thermoplastic matrices. Long natural fibers in the form of plain, twill, and sateen fabrics, as well as unidirectional sheets or braided form, are best choices as reinforcement in polymer matrices because of their superior formability and mechanical properties. Producing long fiber-based preforms involves a number of expensive and energy-intensive steps. To overcome these limitations, short natural fibers are currently gaining more attention in thermoplastic composites research [23].

Despite of several advantages, the main limitations of natural fibers in composites are their relatively high moisture absorption and low compatibility with the matrix. Natural fibers easily produce voids in composites, weakening the material's mechanical properties [24]. Chemical treatment is the technique that is most frequently used to increase the compatibility of natural fibers and matrices. In certain situations, chemical processing cannot be used to make natural fiber composites in large quantities. Environmental concerns put more pressure on composite researchers to adopt sustainable modifications of composites to enhance composite performance. Contrarily, during the past few decades, researchers' inclination has changed toward modifying natural fibers using gamma radiation [25]. Gamma radiation-induced composites have a variety of advantages, including uninterrupted operation, a brief curing duration, less environmental contamination, room-temperature curing, more flexible design via process control, etc [26].

In Bangladesh, date palm tree (*Phoenix sylvestris*) from Arecaceae family, local name Khejur grows naturally or it is cultivated in the southwestern districts [27,28]. This tree produces large quantity of agricultural waste which is mainly used as fuel in the household. The fibers from date palm trees obtained from various parts such as rachis, leaflets, petiole, fruit branches, mesh, and trunk [29]. The date palm tree stem is encircled by a natural, woven mat of crossed fibers or mesh used in this present study. Currently, there is no systematic use of the fibers from date palm mat (DPM) as resources for materials. However, the utilization of date palm mat fibers as reinforcement in polystyrene has not been studied earlier. The objective of this study is to prepare and assess the physical, mechanical and thermal performance of short palm DPM fiber reinforced polystyrene composites as well as the influence of gamma radiation on the composites. Gamma radiation was applied in the present study for enhancing the mechanical properties of the composites. The application of gamma radiation in composites is not novel, however it is new to prepare gamma-irradiated DPM fiber reinforced polystyrene composites.

2. Materials

In our study, polystyrene was utilized as matrix which purchased from Chi Mei Corporation, Taiwan. Polystyrene granules were ground by a grinding machine and a particle size of 0.595 mm was taken. DPM fibers were collected from Jashore, Bangladesh. The fibers were cut into 2–3 mm.

2.1. Preparation of composites

Compression moulding method was adopted to prepare DPM fiber reinforced polystyrene composites. Measured amount of DPM

Table 1
Fiber and polystyrene content percentages in the composite.

Samples	Fiber Content (wt%)	Polystyrene (wt%)
C1	0	100
C2	5	95
C3	10	90
C4	15	85
C5	20	80
C6	25	75

fiber and polystyrene were taken in a blender for proper mixing according to Table 1 and transferred into the mould ($12 \times 15\ cm^2$). The mould was placed in a compression moulding system (Paul Ottoo Weber Press Machine) at 210 °C and 200 kN for 5 min, followed by cooling to room temperature under 200 kN pressure and cured composites were removed from the mould.

2.2. Bulk density of the composites

Bulk density of the prepared composites was calculated from weight and dimensions of the samples utilizing the following Eq. (1) [33]. The average results for five composite samples were stated.

$$D = \frac{Weight\ of\ the\ composite}{(Length \times Width \times Height)\ of\ the\ composite} \tag{1}$$

2.3. Water uptake of the composites

Water uptake experiments of the composites were conducted to investigate the influence of water on the composites with various percent of fiber content. Water absorption of the composites was conducted in accordance with ASTM D570-99. With the purpose of measuring the water uptake capacity, the samples were placed in an oven at a specific temperature and time. After that the samples were cooled in a desiccator. The weight of the samples were taken and allowed to remain in distilled water for 24 h. The composite specimens were drawn from the water, wiped dry using a piece of fabric to eliminate any remaining water, and weighed. Three samples were tested to get an average result. The amount of water uptake was estimated utilizing the aforementioned Eq. (2) [34]:

$$\text{Increase in weight}, \% = \frac{(W - W_0)}{(W_0)} \times 100 \tag{2}$$

where, W and W_0 are the wet and conditioned weight of the composites respectively.

2.4. Mechanical properties

The tensile properties investigation was performed to ascertain the tensile strength of the composite samples. The samples were cut suitable for the ASTM D 882–02. The experiment was conducted via universal strength tester (model 1410 Titans, capacity 5 kN, England) operating at a constant crosshead speed of 10 mm/min. Bending strength (three point bending) of the composites were also performed following ASTM D7900. Five measurements in each composition of the composite samples were taken and the average results were stated.

2.5. FTIR spectroscopy

The functional group of the composites was determined from FTIR spectra. The composites' FTIR spectra were captured using a Frontier FT-IR/NIR spectrometer (PerkinElmer, USA) with a wavelength range of 4000-650 cm^{-1}.

2.6. Thermal analysis

The thermogravimetric (TGA) and differential scanning calorimetry (DSC) investigation of the composite C1 and C3 were performed by a NETZSCH instrument (STA 449 F3, Jupiter) in a temperature range 30–900 °C at nitrogen atmosphere. The heating rate was 10 °C/min.

2.7. SEM analysis

The morphology of the fracture surfaces of the tensile samples were examined by utilizing a field emission scanning electron microscope (JEOL JSM-7600F) which was run at an accelerating voltage 3.0 kV. The samples were cut into a small portion, coated with gold and mounted onto holders using carbon tape. Samples were focused onto the surfaces and examined with different magnification.

2.8. Gamma radiation

The optimized composite samples were subjected to gamma radiation to enhance their mechanical characteristics. Composite samples were sealed in an airtight plastic bag. 90 kCi Cobalt 60 was served as radiation source. Composites were subjected to various gamma radiation doses (2.5, 5.0, and 7.5 KGy) at room temperature with a dose rate 350 krad/h.

2.9. Degradation behavior

For the observation of degradation behavior of the composites the degradation tests were performed in four different media such as water, brine, acid, and base for 60 days at room temperature. 5 % NaCl, 5 % H_2SO_4, and 5 % NaOH solution were used as brine, acid, and base media. A certain amount of composite sample was immersed in water or specific media. After 15 days interval of immersion,

the composite samples were taken out and dried in an oven for 4h at 60 °C. The weight of the dry samples was recorded. The composites degradation as a percentage was determined using Eq. (3).

$$\%\ \text{of Degradation} = \frac{(W_i - W_f)}{(W_i)} \times 100 \tag{3}$$

where, W_i stands for the sample's starting weight before immersion, and W_f for the dried sample's final weight in different media.

3. Result and discussion

3.1. Bulk density of the composites

The influence of different wt% of DPM fibers on the bulk density of the composites is illustrated in Fig. 1. The bulk density of short DPM fiber reinforced polystyrene composites decreases with increasing fiber loading. The density of the composites decreases 1.6805 g/cm^3 to 1.5338 gm/cm^3. A poor contact between the matrix and fiber of the composite may develop and led to the formation of voids or gaps between the fiber and polystyrene. A similar type of findings in decrease of density of the composites owing to rising fiber content was reported for fique fiber reinforced LDPE-Al composites by Miguel et al. [35].

3.2. Water uptake of the composites

The consequence of various wt% of fiber loading on water uptake behavior of the short DPM fiber reinforced polystyrene composites is presented in Fig. 2. The graph shows that the amount of water uptake of the composites gradually rises with rising fiber loading. Among the tested samples, the composite with 5 % fiber content exhibits lowest absorption while the composite with 25 % fiber content exhibits highest amount of water absorption. The highest water uptake value was for C6 composites. Having a lot of hydroxyl groups and forming hydrogen bonds with water, natural fibers are hydrophilic by nature [36]. In the case of natural fiber composites, water molecules are absorbed through three mechanisms: diffusion of water into the polymer chain micro-gaps, water absorbed by the capillary phenomenon into the micro-gaps, and voids or defects in the fiber and matrix interfaces [37]. Das et al. reported that the water absorption of the coir fiber reinforced epoxy composites raised as fiber length and fiber content increased [38]. Kumari et al. prepared polyester and poly lactic acid composites with sisal fiber where they also found an increased water absorption capacity of the composites when the amount of fiber was increased [39]. Similar findings were found for the prepared polystyrene based short DPM fiber composites.

3.3. Mechanical properties

Fig. 3(a) displays the consequence of the variation of fiber content on the tensile strength of the composites. It is noticed from the graph that the tensile strength declines firstly 22.97 % from 0 to 5 % fiber content. Then, when the fiber loading increases from 5 to 10 %, the tensile strength improves as well. Among the DPM fiber reinforced polystyrene composites, the highest tensile strength is around 39.07 MPa which is obtained for the composites with 10 % fiber content. The change in tensile strength between 5 and 10 % of DPM fiber reinforced composites was 12.36 %.When the fiber content exceeded 10 %, the tensile strength of the composite reduced with increased fiber content. The homogeneous stress distribution and fiber content of composites affect their mechanical characteristics. The fiber-matrix bonds break down at low fiber content because of the lack of sufficient fiber reinforcement in the matrix. When fiber content is high, the matrix is unable to adequately moisten the fibers, which causes agglomeration of fiber and a blockage of stress transfer resulted lower tensile strength. The stress is transferred uniformly from matrix to the fiber and the strength of the

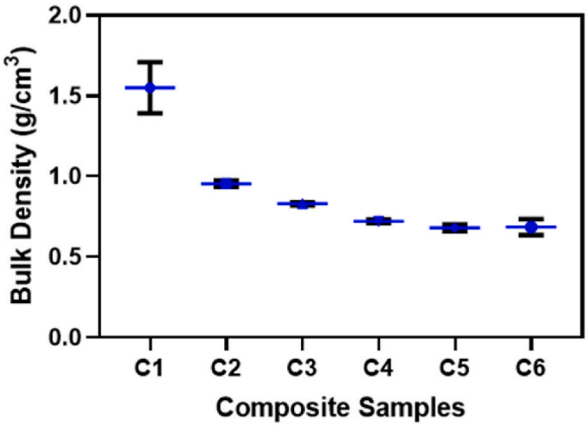

Fig. 1. Bulk density of the composites at various fiber contents.

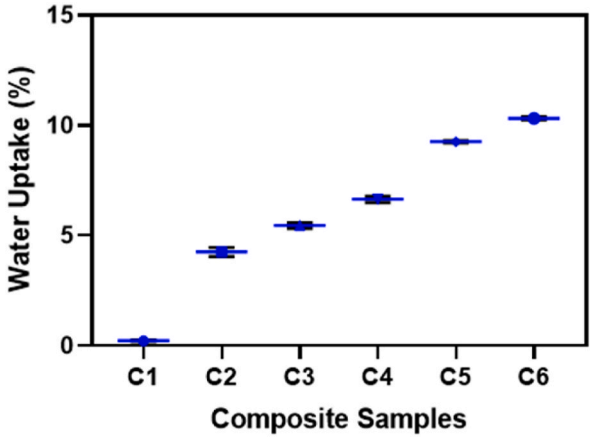

Fig. 2. Water uptake of the composites at various fiber contents.

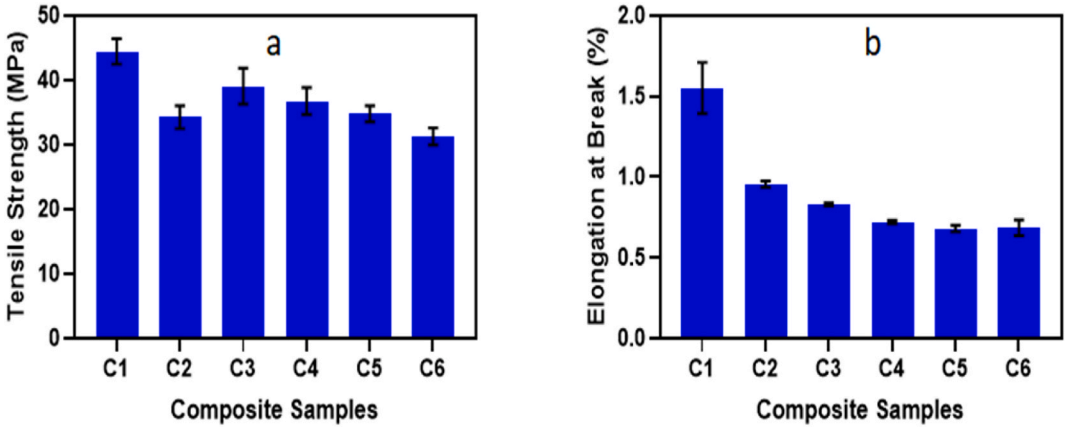

Fig. 3. (a) Tensile strength and (b) Elongation at break of the composites at various fiber contents.

composites rises for moderate fiber content [40]. The increase in tensile strength in the case of 10 % fiber loading may be as a result of good fiber-matrix adhesion which causing uniform stress transfer from the matrix to the reinforcing fiber [18]. This decrease in tensile strength with rising fiber loading may be owing to weak fiber-matrix adhesion, and debonding took place during tensile strength measurement. Voids may develop through fiber - matrix debonding, which causes defects to spread easily through the void containing regions. Moreover, the unequal dispersion of fibers into the composites also affected the tensile strength of the composites [41]. The tensile strength of the composites is also diminished by fiber aggregation that takes place in the matrix. The tensile strength of the composites are caused by the non-uniform stress transfer resulted by irregular orientation of the fibers inside the matrix [42]. Zadeh et al. reported that the improved tensile strength for 10 % date palm leaf fiber reinforced recycled blend of LDPE, HDPE and PP [18]. The findings from our experiments are in agreement with their results.

The elongation at break indicates the toughness of the composites. The elongation at break of different wt% of fiber loading composites is presented in Fig. 3(b). It is concluded that the incorporation of 5–25 % by weight of short DPM fiber has slightly lessened the elongation at break of short DPM fiber reinforced composites compared to 100 % polystyrene (0 % fiber content). As fiber content is increased, elongation at break decreases because the fibers existing in the composites do not show elasticity or flexibility. In addition, the rigidity and toughness of the composites increases on the other hand ductility reduces [43]. Rahman et al. used jute fiber as reinforcement for the preparation of polypropylene and linear low density composites [44]. The fiber loading of the composites was 10, 20 and 30 %. They reported that the elongation at break of the composites diminished with increased fiber amount. Huq et al. prepared short jute fiber (5–30 %) reinforced polypropylene composite [45]. In their study, the elongation at break of those composites decreased steadily as the amount of fiber increased. Similar findings were observed for the prepared short DPM fiber reinforced polystyrene composites.

The bending strength for various wt% of fiber loading is displayed in Fig. 4. The bending strength of the short DPM fiber reinforced polystyrene composites decreased with the rising of fiber content. From the graph it can be concluded that bending strength reduced with 5 % fiber content. Then bending strength improved for 10 % fiber content and again reduced for 15–25 % short DPM fiber reinforced composites. For 100 % polystyrene sample the bending strength is 54.82 MPa and for 5 %, 10 %, 15 %, 20 % and 25 % fiber

content in composites is 42.74, 47.38, 43.38, 41.26 and 39.45 MPa respectively. The reduction in bending strength indicates the poor fiber-matrix interaction. The composite C3 shows comparatively higher bending strength. The probable reason for higher bending strength of the composite C3 may be attributed to good interaction between fiber and matrix [40].

3.4. FTIR study

The FTIR spectra of the polystyrene (C1) and 10 % short DPM fiber reinforced polystyrene (C3) composites are shown in Fig. 5. The main FTIR peaks are listed in Table 2. In the case of polystyrene, the peak at 2923 cm^{-1} relates to H–C–H asymmetric stretch signifying the presence of alkane group [3]. The peak at around 1700-1500 cm^{-1}, indicates C═C aromatic stretching [30]. The peak 1470 cm^{-1} directs to aromatic C–C stretching and the peaks between 1000 cm^{-1} to 650 cm^{-1} attribute to the aromatic C–H bending vibrations [31]. For short date palm mat fiber reinforced composites, the peak at 3331 cm^{-1} may relate to hydrogen-bonded O–H stretching vibrations [32] which is absent in the 100 % polystyrene. The peaks at 1250 cm^{-1} and 1027 cm^{-1} resemble to the C–O stretch of the acetyl group, existing in lignin and hemicellulose [3]. Besides, the characteristic peaks of polystyrene matrix also found for the composites.

3.5. Thermal analysis

Thermal analysis of C1 (polystyrene) and C3 (10 % DPM fiber reinforced polystyrene) composites were conducted to investigate their thermal stability. The TGA and DSC curves are presented in Fig. 6(a , b) and Fig. 7 (a ,b) respectively. The TGA gives information about the mass change of composite samples as a function of temperature. The mass change in composites happens as a result of the breakdown of cellulose, hemicellulose, and lignin constituents throughout heating. Greater decomposition temperatures indicate more thermal stability. From the figure it is clear that C1 started to degrade at 353.7 °C with about 94.0 % of mass change whereas C3 composite began to degrade at 363.0 °C. The percentage of residual mass provides the thermal stability of the composites. The higher the percentage of residual mass is the indication of improved thermal stability of the composites [46]. The percentage of the residual mass at the end of the heating process about 6.0 and 8.0 was found for the composites C1 and C3 respectively. It can be concluded from the TGA curves that C3 composite is more thermally stable than C1. In case of DSC curve (Fig. 7), a sharp endothermic peak was observed at 418.3 °C for C1 and at 414.7 °C for C3 composites. These endothermic peaks are corresponded to the melting process of the composite samples. In fact, the presence of the peak in the DSC curve of polystyrene was reported at almost same temperature [47].

3.6. Morphological analysis

Scanning Electron Microscope (SEM) investigation is an effective method to examine the surface morphology of natural fiber reinforced polymeric composites. The surface morphology of the tensile fracture surfaces of the C1, C3 and C6 composite were observed and the SEM micrographs in different magnitude are shown in Fig. 8(a , b), Fig. 9 (a,b) and Fig. 10 (a,b) respectively. A rough fracture surface was observed for the composite C1. In the micrographs, fibers are more bonded with the polystyrene matrices suggested the superior fiber-matrix adhesion causing uniform stress transfer and the tensile strength increases for the composite formulation C3. On the contrary, gaps, loosely bonded fibers with the matrices and fiber pull outs are observed for composite C6 indicating poor fiber-matrix adhesion. Easy fiber pullouts take place due to this weak fiber-matrix adhesion resulting in lesser tensile strength for the C6 composite as compared to C3 composite. The tensile characteristics outcome of the composites, which was detailed in the previous section, is supported by SEM observation. Sapuan et al. produced short sugar palm fiber loaded high impact polystyrene composites. From the SEM image analysis, they concluded that the 40 % and 50 % sugar palm fiber loaded composites exhibited compacted arrangement between the fiber and matrix that caused the enhancement of strength [48]. Similar compacted arrangement

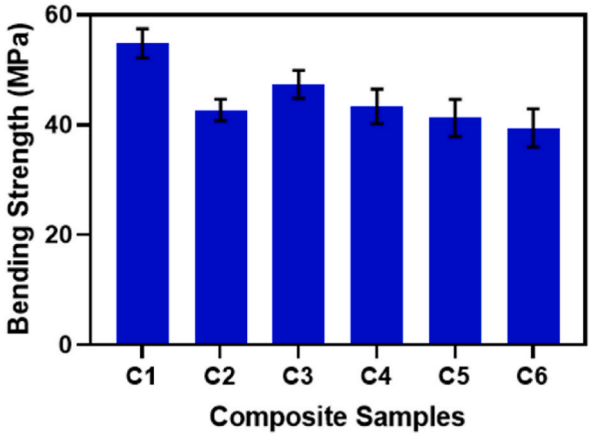

Fig. 4. Bending strength of the composites at various fiber contents.

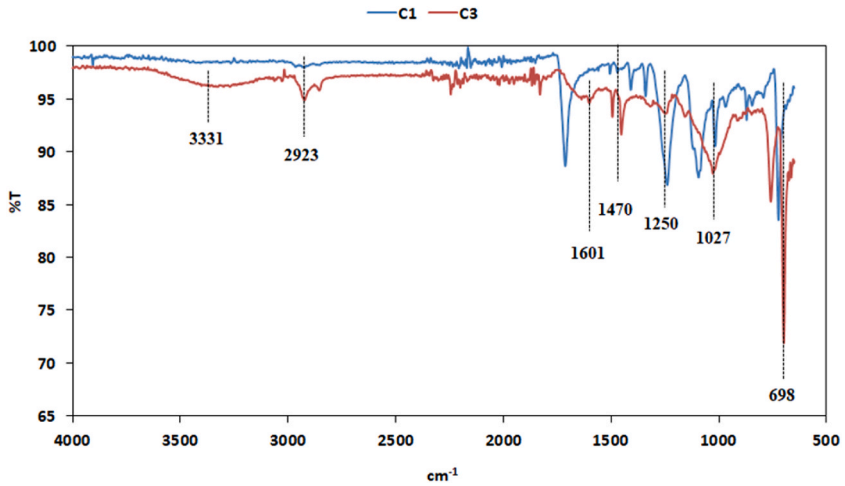

Fig. 5. FTIR spectra of C1 and C3.

Table 2
FTIR spectral bands of C1 and C3 composites.

Wave number (cm^{-1}) of the composites		Probable assignments	Reference
C1	C3		
–	3331	O–H stretching vibrations	[3,30–32]
2932	2923	H–C–H asymmetric stretching	
1713	1601	C═C aromatic stretching	
1470	1494	C–C stretching	
_	1250	C–O stretch	
_	1027	C–O stretch	
1016	–	C–H stretch vibrations	
846	759	C–H bending vibrations	
723	698	C–H bending vibrations	

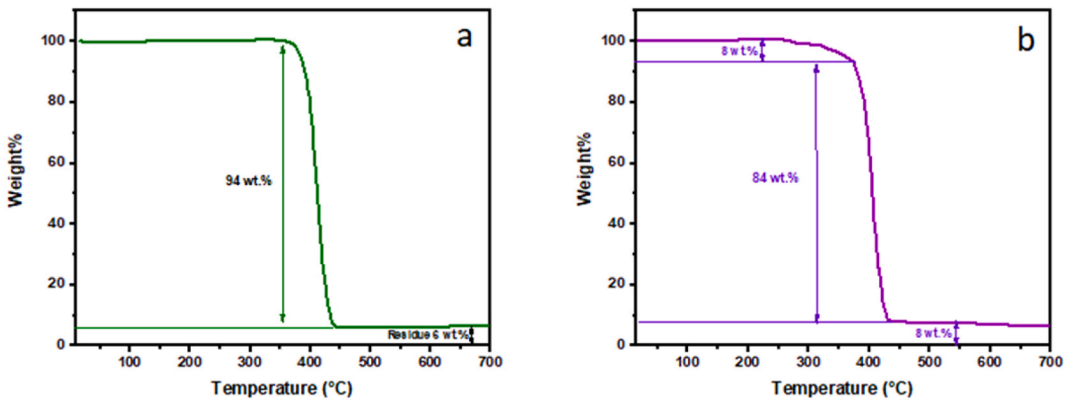

Fig. 6. TGA of (a) C1 and (b) C3.

between DPM fiber and polystyrene was observed for C3 composites.

3.7. Effect of gamma radiation on mechanical properties

The optimized composites (10 % DPM fiber reinforced polystyrene) were subjected to gamma radiation at various doses (2.5–7.5 kGy). The consequence of gamma radiation on the tensile strength of the composites is depicted in Fig. 11(a). It is clear that gamma radiation significantly raises the tensile strength up to a certain dose. At the radiation dose of 5.0 kGy, the maximum tensile strength of the composites was 43.81 MPa. At 5.0 kGy, the tensile strength of the composites improved to 12.13 %, when compared to the non-

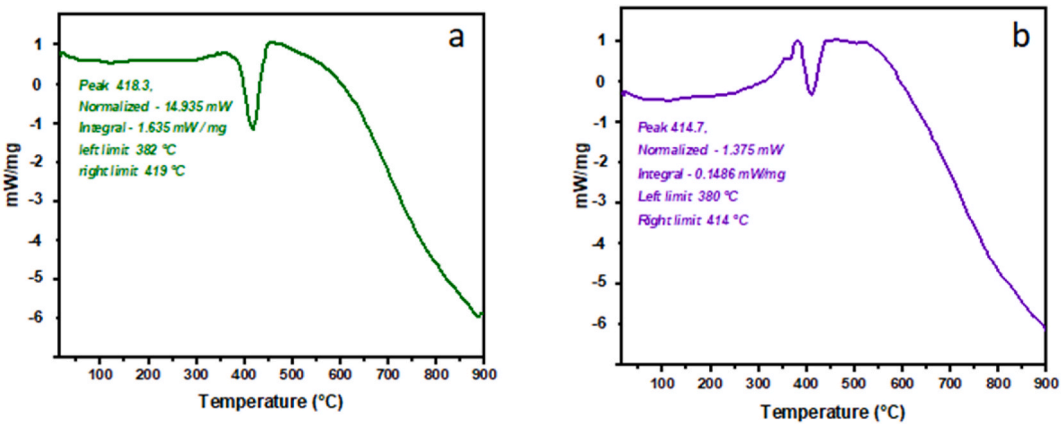

Fig. 7. DSC of (a) C1 and (b) C3.

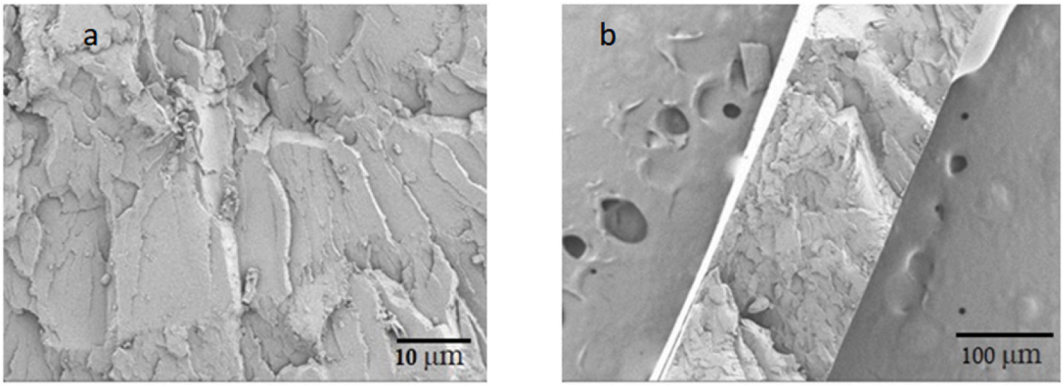

Fig. 8. SEM micrographs of C1 composites (a) 500× magnification and (b) 100× magnification.

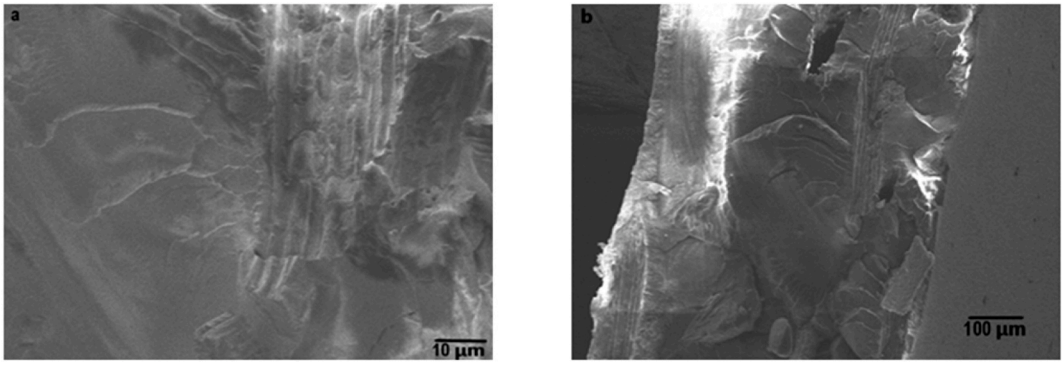

Fig. 9. SEM micrographs of C3 composites (a) 500× magnification and (b) 100× magnification.

irradiated composites. Nevertheless, the tensile strength of the composites decreases as the dose is increased beyond 5.0 kGy. The tensile strength of the composites dropped 8.13 % from its maximum with a dose of 7.5 kGy of gamma radiation. The graph clearly indicate that the bending strength of the composites show an enhancement trend from 2.5 to 5.0 kGy, followed by a decline in values up to 7.5 kGy dosage. The highest tensile strength was determined 54.33 MPa for 5.0 kGy. 14.67 % increase in bending strength of the composites was observed for 5 kGy radiation dose compared to non-irradiated composites (Fig. 12).

On exposure to gamma radiation photo cross-linking and photo degradation are the two opposite phenomena happen concurrently [49]. This increment in tensile strength may be caused by the cross-linking of neighboring chains and, consequently, improved adhesion between the fiber and matrix on exposure to the gamma radiation causing the composites' more ordered polymeric structure [50]. The moisture content, which can be reduced by gamma radiation and raise the tensile strength, is one of the key barriers to

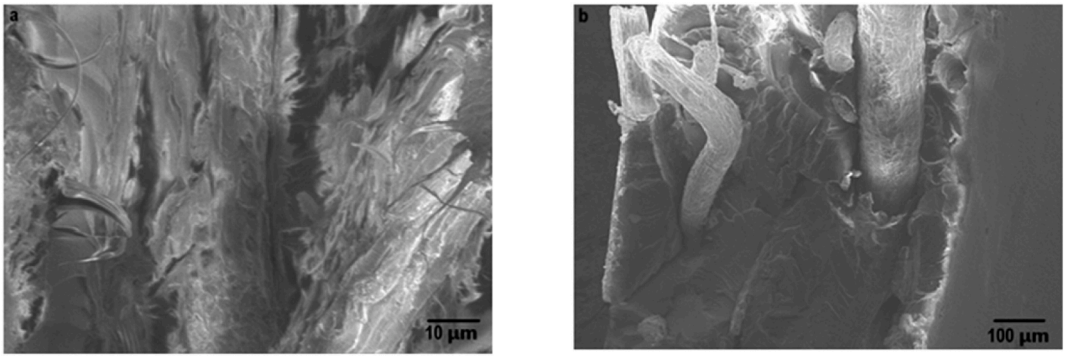

Fig. 10. SEM micrographs of C6 composites (a) 500× magnification and (b) 100× magnification.

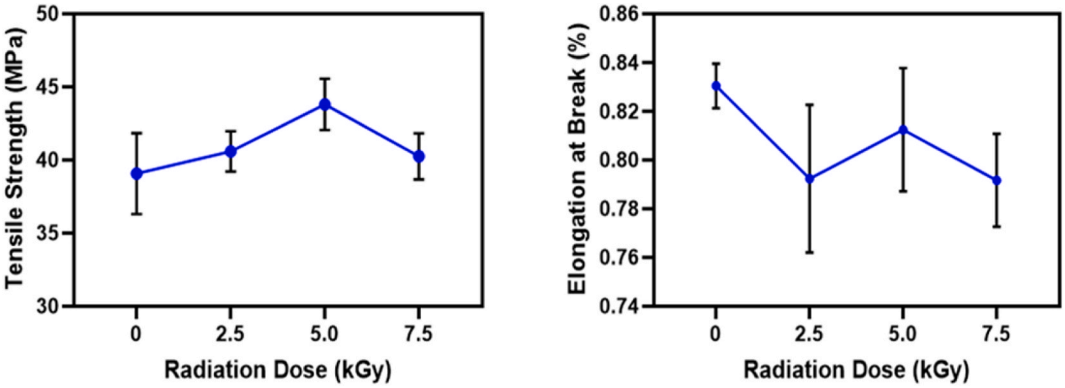

Fig. 11. Effect of gamma radiation on the (a) tensile strength and (b) elongation at break of the composites.

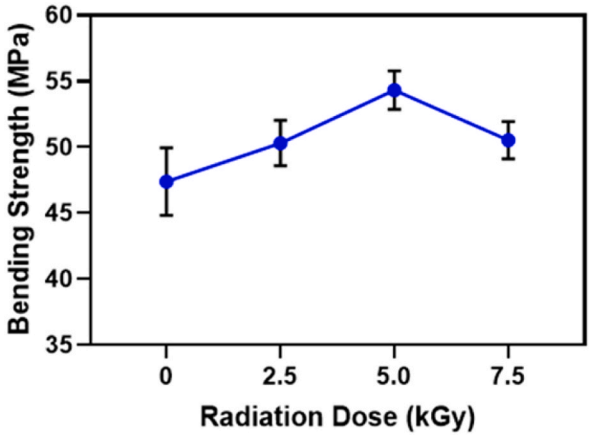

Fig. 12. Effect of gamma radiation on the bending strength of the composites.

improve the mechanical characteristics of the composites [51]. The degradation of the cellulose backbone caused by gamma radiation may be the cause of decreasing tensile properties of the composites. Azim et al. examined mechanical properties of jute fiber reinforced polyester composites and noticed that under gamma radiation the tensile and bending strength of the composites raised from 2.5 to 5.0 kGy, whereas increasing radiation dose up to 9 kGy showed a decreased trend [25].

Fig. 11(b) represents the impact of gamma radiation on the elongation at break of the composites. The graph shows that the elongation at break of the composites initially dropped and subsequently slightly increased. At the radiation dose of 5.0 kGy, the elongation at break decreases 2.17 % than the non-irradiated composite. The increased crosslinking between the molecules may result in increased crystallinity, which would then limit the segmental movement of the polymeric chains, causing lower elongation at break

value of the composites [49].

3.8. Degradation behavior of the composites

Degradation of the composites was conducted in four different media such as water, acid, base, and brine for 60 days.

3.8.1. Degradation in water

The degradation behavior of the composites in water was observed for 60 days and the outcomes are represented in Fig. 13. Degradation of the composites showed an increasing trend with time. The composites at radiation dose 2.5 kGy showed maximum value of 1.79 % weight loss while minimum value of 1.67 % weight loss was found for the composites at radiation dose 7.5 kGy after 60 days. During degradation tests in water, the fibers in the composite absorbed water and started to degrade causing weight loss of the composites.

3.8.2. Degradation in acid

Degradation of the composites was conducted by dipping the samples in 5 % H_2SO_4 and the average results are shown in Fig. 14. Results revealed that the composites at radiation dose 2.5 kGy lost 3.33 % whereas the composites at radiation dose 5.0 kGy lost 1.46 % of their weight after 60 days. This may be due to the deterioration of fibers in the composites.

3.8.3. Degradation in base

Degradation of the composites in base was done by dipping the samples in 5 % NaOH and the average values are displayed in Fig. 15. It can be observed that the maximum percentage of weight loss was found 2.15 %. Alkaline hydrolysis and fiber mineralization may be the primary factors that cause the degradation of the fiber present in the matrix.

3.8.4. Degradation in brine

Degradation of the composites in brine was done by dipping the samples in 5 % NaCl. Fig. 16 presents the average results. The greatest amount of weight loss was 3.28 % while the lowest weight loss was 1.47 %. Throughout the entire experiment, the weight dropped by a tiny, this suggested that the composites were degrading slowly in brine solution. The composites did not lose any noticeable percentage of weight loss after 60 days.

For the investigation of degradation properties, a variety of circumstances including water, acid, base, and brine were taken into account. The produced composites demonstrated an acceptable commencement of deterioration within the specified duration in all mediums. The acid and brine solution were comparatively efficient than other degrading conditions. The highest degradation of the composites was observed in acid media. In contrast, water medium displayed the least degradation of the composites.

4. Conclusion

In this work, polystyrene as matrix and date palm mat fiber as reinforcement was used for the creation of composites by compression moulding technique. The composite samples were characterized with the help of various instrumental techniques. It can be concluded that 10 % date palm mat fiber reinforced polystyrene composite displays better mechanical properties than 5, 15, 20 and 25 % of date palm mat fiber reinforced polystyrene composites. The FTIR spectra of the composites were examined and its findings were contrasted with the literature. Morphological analysis of tensile fractured surfaces of 10 % date palm mat fiber reinforced polystyrene composite shown good fiber-matrix interfacial adhesion. Thermal analysis of the composites revealed that the incorporation of 10 % fiber in the polystyrene composites exhibits slightly higher thermal stability. After the composite samples were exposed to ionizing radiation at a dose of 5.0 kGy, the tensile and bending characteristics showed notable improvements. However, the degradation behavior in four different media was assessed for 60 days, the composites exhibited slight degradation. In acidic media, the composites revealed the highest rate of degradation. It has been displayed that the mechanical characteristics of the composites formed from date palm mat fiber show that they may be a possible choice for diversified applications.

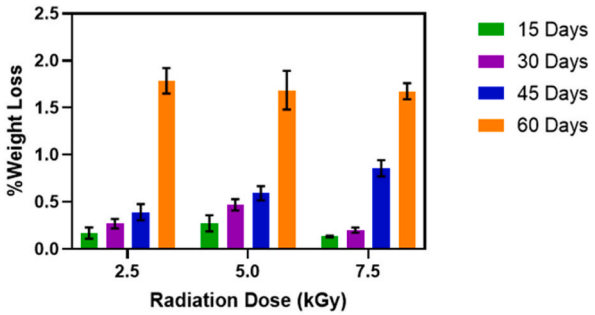

Fig. 13. Degradation behavior of composite samples in water.

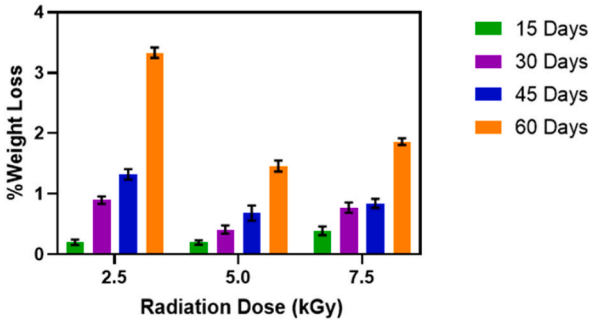

Fig. 14. Degradation behavior of composite samples in acid.

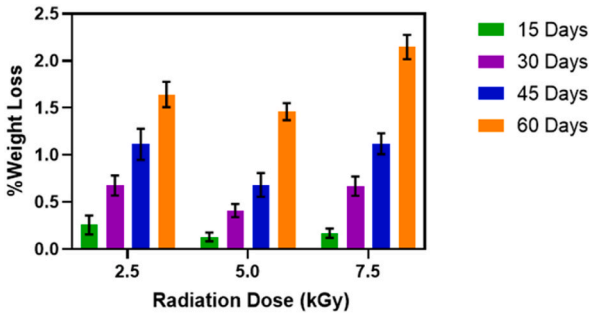

Fig. 15. Degradation behavior of composite samples in base.

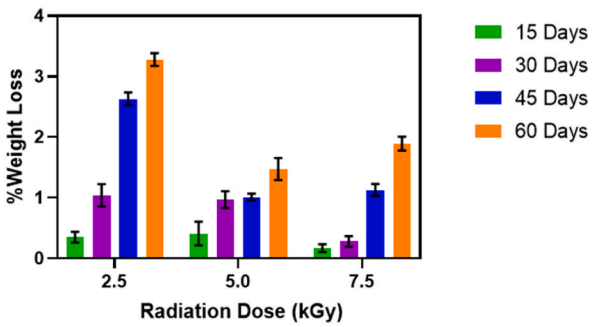

Fig. 16. Degradation behavior of composite samples in brine.

CRediT authorship contribution statement

Most Afroza Khatun: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. **Shahin Sultana:** Software, Writing – review & editing. **Mohammad Shahriar Kabir:** Formal analysis. **Md Sahadat Hossain:** Conceptualization. **Husna Parvin Nur:** Formal analysis, Supervision. **A.M Sarwaruddin Chowdhury:** Conceptualization, Formal analysis, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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