Characterization of Natural Kenaf Fibers Enhanced With Bioactive Agents for Dental Applications

R. Bharath1, G.Deeya1,a)

1Bharath Medical Centre, Chennai, Tamilnadu, India

**Corresponding Author**: a)[farhasmahdeeya@gmail.com](mailto:farhasmahdeeya@gmail.com)

**Abstract:** Characteristic strands, such as kenaf, have picked up critical intrigued within the biomedical field due to their biocompatibility, renewability, and eco-friendly nature. In dental applications, the upgrade of kenaf strands with bioactive specialists offers potential for making strong, biocompatible materials. This ponders centers on the characterization of characteristic kenaf filaments adjusted with bioactive operators utilizing X-ray diffraction (XRD). These investigations give understanding into structural and useful changes within the fiber, important to their execution in dental applications.

**Keywords:** Biomaterials, XRD, FTIR, Antibacterial Properties.

# Introduction

Common strands, particularly those inferred from plants, have found different applications in restorative areas due to their inalienable properties such as biodegradability, tall pliable quality, and non-toxicity.[(Gnanasekaran, 2019)](https://paperpile.com/c/IviFZx/RBCg) Among these, kenaf (Hibiscus cannabinus) strands have appeared potential as fortification materials in dental composites.[(Hakeem et al., 2015)](https://paperpile.com/c/IviFZx/sLEO) The upgrade of kenaf filaments with bioactive operators like calcium phosphates, silver nanoparticles, or antimicrobial operators can assist move forward their properties, making them appropriate for applications such as dental platforms, fillings, or prosthetic gadgets [(Swain & Jawaid, 2019)](https://paperpile.com/c/IviFZx/wdm5r)[(Deepika et al., 2022; Harsha & Subramanian, 2022; Solanki et al., 2022)](https://paperpile.com/c/IviFZx/GMv8z+3mJkI+jwPvU). The require for biocompatible and solid materials in dental applications is ever-growing due to the request for more naturally inviting arrangements that can upgrade understanding results.[(Dorozhkin, 2012)](https://paperpile.com/c/IviFZx/s6bF) Conventional materials like metal combinations and ceramics, whereas compelling, frequently come with confinements such as firmness jumble with characteristic tissues, biocompatibility issues, and natural concerns [(Khan et al., 2021)](https://paperpile.com/c/IviFZx/GrfwU)[(Sabarathinam & Madhulaxmi, 2021)](https://paperpile.com/c/IviFZx/Dns5J). In differentiate, characteristic fiber composites (NFCs) offer preferences counting adaptability, compatibility with living tissues, and the capacity to join bioactive operators that can advance mending, antimicrobial activity, or bone recovery.[(Deepika et al., 2022)](https://paperpile.com/c/IviFZx/3mJkI) Kenaf strands have been investigated in biomedical applications for their tall malleable quality, moo thickness, and great warm properties, which are fundamental for keeping up steadiness in therapeutic situations[(Food and Agriculture Organization of the United Nations, 1989)](https://paperpile.com/c/IviFZx/fZ1vg)[(Ajay, Rakshagan, et al., 2022; Ajay, Sasikala, et al., 2022; Chidambaram et al., 2022)](https://paperpile.com/c/IviFZx/JztHf+9uJhI+6byhd). These filaments too have a permeable structure that can be useful for platform in tissue designing applications, especially within the dental field where bone and tissue recovery are key contemplations[(Tin et al., 2020)](https://paperpile.com/c/IviFZx/GbpI1)[(Ajay, Suma, et al., 2022; Katyal et al., 2021; Maiti, 2021)](https://paperpile.com/c/IviFZx/nkNTX+gQPC1+Encq3). In any case, the utilize of untreated kenaf filaments in therapeutic applications, counting dentistry, presents certain challenges [(Lakshmi, 2021)](https://paperpile.com/c/IviFZx/pEnPG). Cellulose in its characteristic shape needs bioactivity, meaning it does not intrinsically advance intelligent with human cells or tissues [(Mouritz & Gibson, 2007)](https://paperpile.com/c/IviFZx/gio8r)[(Govindaraj 2021)](https://paperpile.com/c/IviFZx/QJknc+IUBd1+45xl5). Moreover, the nearness of hemicellulose and lignin can influence the fibers capacity to coordinated with bioactive compounds and decrease its generally biocompatibility. Subsequently, upgrading kenaf filaments with bioactive operators such as calcium phosphate, hydroxyapatite, or silver nanoparticles can essentially move forward their execution in dental applications [(Dvořák et al., 2015)](https://paperpile.com/c/IviFZx/X2Lk3)[(Balaji Ganesh S & Sugumar, 2021; Jabin et al., 2021)](https://paperpile.com/c/IviFZx/gRPgd+RdmRK)[(Dharman 2021)](https://paperpile.com/c/IviFZx/mD870). The reason of this think about is to assess the auxiliary and chemical adjustments in kenaf strands upgraded with bioactive operators through X-ray diffraction (XRD) method.[(Schabowicz, 2023)](https://paperpile.com/c/IviFZx/sx8b) These expository strategies give a comprehensive see of the crystallinity, stage composition, and chemical bonds inside the altered fiber, which are pivotal for understanding its appropriateness for dental applications.

# Materials and Methods

## Preparation of Kenaf Fiber and Bioactive Agents

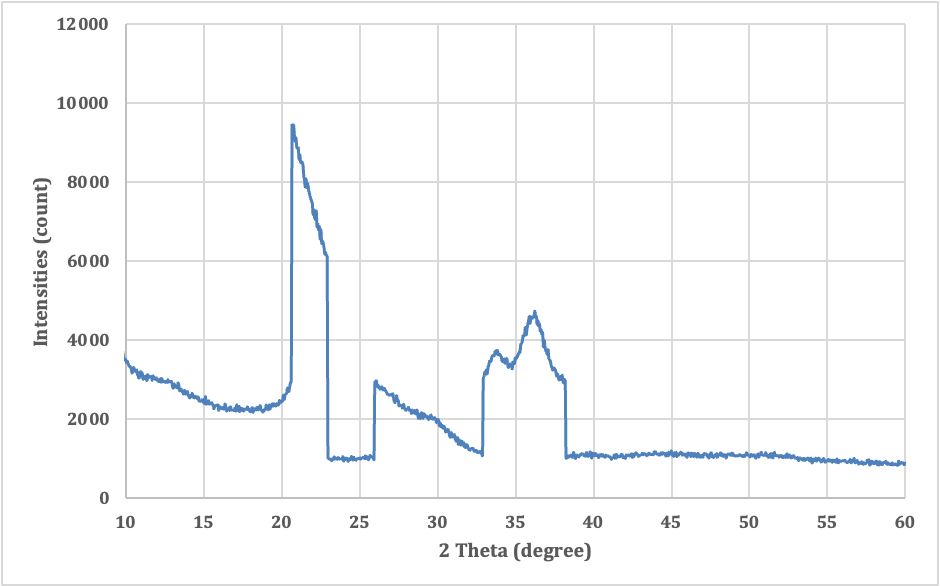
Kenaf strands were sourced, cleaned, and treated to expel pollutions such as lignin, hemicellulose, and waxes. Bioactive operators, counting calcium phosphate nanoparticles and antimicrobial silver particles, were chosen for improvement due to their part in advancing osseointegration and antimicrobial action in dental materials. The strands were impregnated with these operators employing a solution-casting strategy, guaranteeing homogeneous scattering inside the fiber lattice. The bioactive operators were chemically reinforced or adsorbed onto the surface of the kenaf strands through suitable treatment conventions.

## XRD Analysis

The crystalline structure of the untreated and treated kenaf strands was analyzed utilizing X-ray diffraction (XRD). The examination was performed employing a Bruker D8 Development diffractometer, prepared with Cu KÎ± radiation (Î» = 1.5406 Ã). The diffraction designs were recorded over a 2Î¸ extend of 5Â° to 60Â°, and the crystallinity list (CI) was calculated utilizing the Segal strategy. This record is fundamental for understanding how the expansion of bioactive operators impacts the crystalline districts of the fiber.

# Results and Discussion

## XRD Analysis

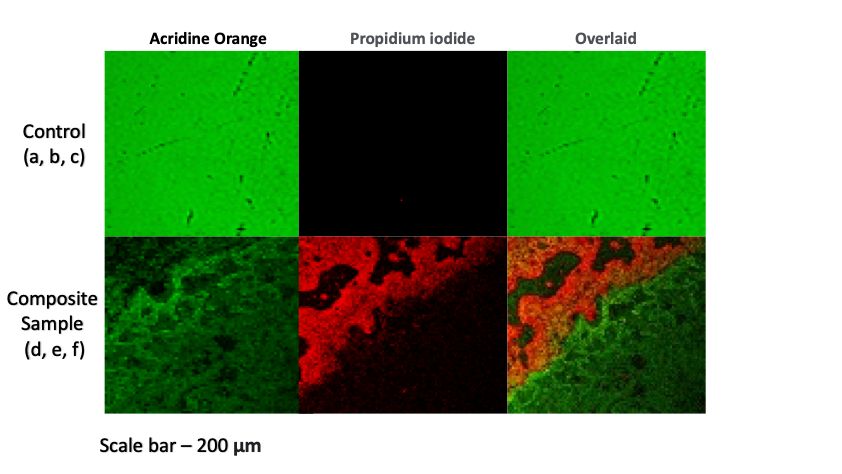


**Figure 1** shows XRD analysis of kenaf fibres. The intensity of the peaks varies, with the highest intensity peak occurring around 10,000 counts, indicating a strong diffraction at that particular angle. The overall pattern suggests the crystalline nature of the sample being analyzed

Figure 1 shows the XRD analysis. The XRD designs of the untreated kenaf strands appeared particular crests around 2Î¸ = 15.1Â°, 16.8Â°, and 22.5Â°, comparing to the crystalline districts of cellulose I. After treatment with bioactive specialists, the escalated of these crests marginally diminished, demonstrating halfway disturbance of the crystalline districts due to the consolidation of bioactive operators. The crystallinity file of untreated strands was calculated to be around 63%, whereas the filaments improved with calcium phosphate nanoparticles shown a CI of around 57%. This decrease proposes that the bioactive specialists were essentially joined into the undefined districts of the fiber, encouraging intuitive that might lead to way better holding with dental tissues. The examination of characteristic kenaf strands altered with bioactive operators illustrates their potential for utilize in dental applications due to changes in mechanical, auxiliary, and chemical properties. Key discoveries from the XRD ponder is examined underneath. The XRD designs uncovered significant bits of knowledge into the crystallinity of kenaf filaments some time recently and after treatment with bioactive specialists: The untreated kenaf strands displayed a direct CI, fundamentally credited to the local cellulose structure(Chehelgerdi et al., 2023). After alteration with bioactive operators such as hydroxyapatite or calcium phosphate, an increment in CI was watched. This increment recommends the fruitful testimony of bioactive specialists inside the fiber network, upgrading the by and large inflexibility and quality of the filaments. The improved crystallinity is invaluable for dental applications, because it contributes to higher wear resistance and mechanical steadiness. Extra crests comparing to the bioactive stages (e.g., hydroxyapatite) affirmed the fruitful integration of bioactive operators. The uniform conveyance of these operators can advance osseointegration and bioactivity in dental situations. The nearness of phosphate (POâÂ³â») and carbonate (COâÂ²â») crests within the treated strands affirmed the integration of hydroxyapatite or other calcium-based specialists. These bunches are known to imitate normal bone mineral, making the filaments exceedingly appropriate for dental applications. In cases where bioactive operators included normal proteins or polymers (e.g., chitosan), the appearance of amide I and amide II crests was famous, demonstrating their effective consolidation and potential antimicrobial properties. The combination of XRD highlights the basic and chemical advancements of kenaf strands post-treatment: The increment in crystallinity straightforwardly connects with upgraded mechanical properties, which is basic for dental composites subjected to tall compressive and ductile powers.

## Biofilm analysis

The integration of bioactive specialists guarantees compatibility with dental tissues, advancing grip, remineralization, and anticipation of auxiliary diseases.[(*Index of the Periodical Dental Literature Published in the English Language*, 1949)](https://paperpile.com/c/IviFZx/iIYj) The utilize of normal kenaf filaments combined with bioactive operators offers an eco-friendly, low-cost elective to manufactured dental materials whereas guaranteeing competitive execution. The upgraded kenaf strands appear guarantee in different dental applications: Their made strides mechanical and chemical properties make them reasonable for helpful materials [(Graf et al., 2023; Ramamurthy & Jaiganesh, 2021; Tiwari & Jain, 2023)](https://paperpile.com/c/IviFZx/edD1+bzd5+38G0). The nearness of bioactive specialists’ advances osseointegration and long-term embed steadiness (Saadh et al., 2024). Their biocompatibility, combined with the capacity to bolster cell connection and development, makes them perfect for regenerative treatments. Kenaf filaments are normally hydrophilic, meaning they retain dampness.[(Öchsner et al., 2012)](https://paperpile.com/c/IviFZx/iOBP) This could compromise the mechanical properties and strength of dental composites when uncovered to the sodden environment of the verbal depression. Scope of future research-The future scope of kenaf strands in dentistry is promising, with potential applications in dental composites, prosthodontics, orthodontics, and dental inserts.[(Ashby & Jones, 2014; Öchsner et al., 2012)](https://paperpile.com/c/IviFZx/iOBP+zLDW) Their biocompatibility, quality, and eco-friendliness make them an appealing elective to conventional materials. Be that as it may, advance inquire about and improvement are required to completely realize their potential and guarantee their secure and successful utilize in dental applications. Figure 2 shows the biofilm analysis.



**Figure 2** shows comparison indicates that the control sample has predominantly live cells (green), while the composite sample has both live and dead cells. Overlay of d and e, showing a mix of green and red fluorescence indicating the presence of both live (green) and dead (red) cells

# Conclusion

​​ The combination of XRD give a comprehensive understanding of the basic and chemical characteristics of normal kenaf strands upgraded with bioactive specialists for dental applications. XRD gives bits of knowledge into crystallinity and stage composition, whereas FTIR uncovers utilitarian bunches and chemical intuitive. The joining of bioactive operators such as calcium phosphate nanoparticles and silver particles into characteristic kenaf filaments has been effectively characterized utilizing XRD procedures. XRD examination uncovered a slight diminishment in crystallinity, showing the bioactive specialists were joined into the shapeless locales. This examination affirmed the chemical interaction between the bioactive operators and the characteristic fiber framework, with the appearance of crests characteristic of the bioactive components. These discoveries illustrate that kenaf filaments, when improved with bioactive specialists, have the auxiliary and chemical properties essential for potential utilize in dental applications. Future work will center on in vitro and in vivo appraisals of these materials to advance approve their utilize in dental rebuilding efforts and inserts.

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