

CHAPTER

3

THERMAL PROPERTIES OF OPEFB NANOCELLULOSE IN COMPOSITES

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3.1 ISSUES ASSOCIATED WITH OPEFB NANOCELLULOSE IN COMPOSITES

Empty fruit bunches (as shown in Figure 3.1) from oil palm plantations account for approximately two-fifths of the total weight of fresh fruit bunches. An oil mill operating at a capacity of sixty tonnes per hour can generate nearly 54 thousand tonnes of oil palm empty fruit bunch (OPEFB) annually (Reneta Nafu et al., 2015). This makes OPEFB the most significant waste product from the palm oil industry. Its commercial viability is limited, and its dense structure causes disposal difficulties. Traditionally, this waste has been either incinerated, buried in landfills, or processed through composting to produce natural fertilisers (Asyraf et al., 2022; Rafidah et al., 2023). However, incineration of OPEFB is no longer recommended due to its contribution to air pollution (Khairil et al., 2018). Therefore, optimising the use of OPEFB is essential to address these challenges and enhance its potential as a valuable resource.

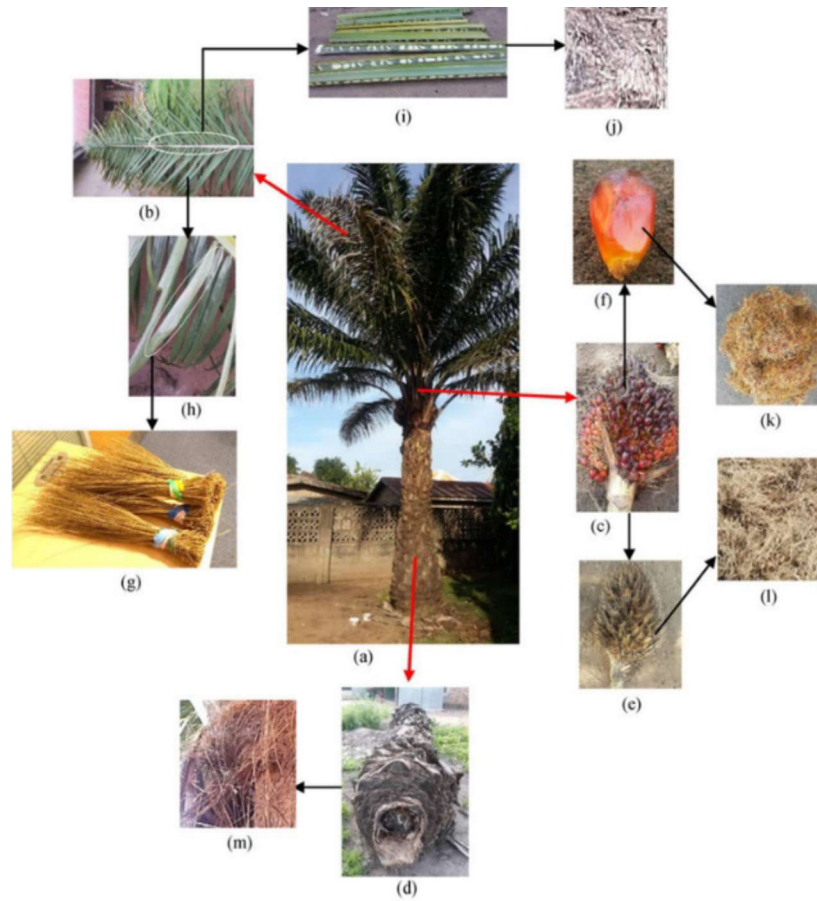


Figure 3.1 Various types of oil palm fibres (OPFs), including (a) Oil palm tree, (b) Leaf, (c) Fruit, (d) Trunk, (e) Empty fruit bunch, (f) Dissected fruit, (g) Broom fibres, (h) Leaflet, (i) Oil palm frond, (j) Frond fibres, (k) Mesocarp fibres, (l) Empty fruit bunch fibres, and (m) Trunk fibres (Source: Momoh & Osofero, 2020)

OPEFB is a fibrous and mineral-rich material constituting a large portion of the solid waste produced by oil mills. It consists mainly of stalks, which form the major stem, and spikelets visible on the surface of the bunch. The cellulose content in the stalks is considerably high, ranging from 27–29%, while the lignin content remains relatively low, between 11–13%, especially compared to the spikelets (Yunos et al., 2015).

Nanocrystalline cellulose (NCC) is a versatile and sustainable nanomaterial derived from cellulose isolated from various types of biomass waste. These nanoparticles have attracted significant attention across multiple industries due to their unique properties, including high strength, lightweight nature, biodegradability, and high surface area (Balakrishnan et al., 2018; Ilyas et al., 2020; Ng et al., 2024). These attributes make NCC highly desirable for applications in biomedical fields, food packaging, biocomposites, and electronics because of their exceptional mechanical properties, renewable nature, and eco-friendliness (Norrrahim et al., 2021; Poulouse et al., 2022; Shruthy et al., 2021), as shown in Figure 3.2. However, to fully exploit the potential of NCC, understanding their thermal stability and colloidal stability is critical.

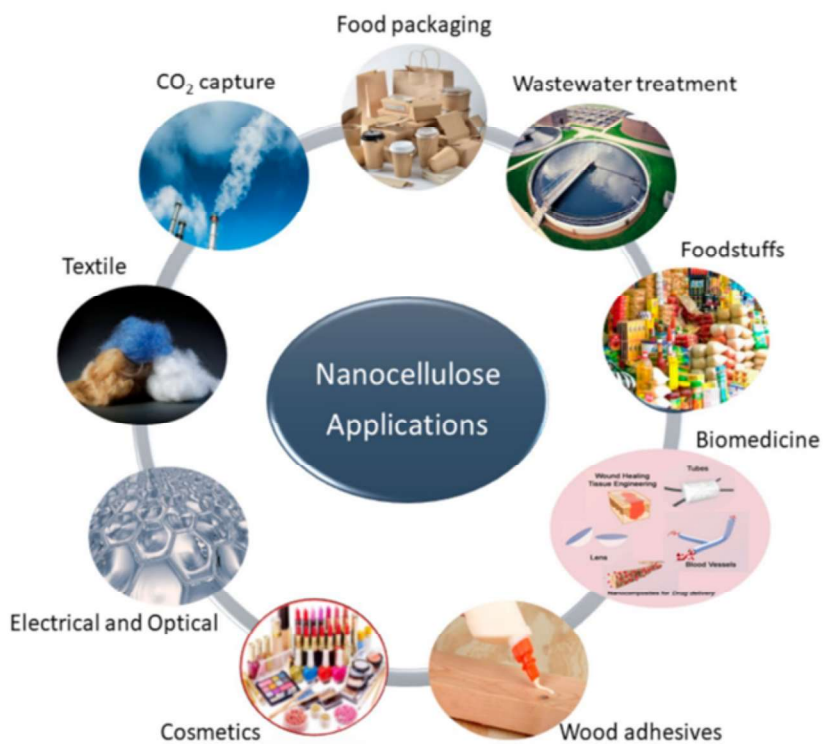


Figure 3.2 Applications of nanocellulose (Source: Poulouse et al., 2022)