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Nanocellulose Composite Films in Food Packaging Materials

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Food packaging plays an indispensable role in the food industry chain, serving food storage and transport by preventing chemical contamination and enhancing shelf life to ensure food security. Cellulose is a linear biopolymer and the most abundant organic material on earth. It is widely presented in higher plants, and can be acquired from marine animals, agricultural residues, industrial waste bacteria, and algae. Chickpea (*Cicer arietinum*) is one of the major legumes that are globally consumed after processing by suitable unit operations. The proportion of husk generated from chickpea is approximately 12 % which is mostly used as poultry feed or is improperly dumped on the land resulting in environmental degradation. The use of this valuable bio-waste for developing industrially relevant products is of paramount importance and needs to be taken up by the concerned industrial sectors. Fortunately, chickpea husk has rich reserves of cellulose; however, limited investigations have considered the utilization of legume husk for cellulose extraction and its potential applications. Some researchers reported that legume husk contains more cellulose than other crops used for broiler feed which makes chickpea husk an attractive alternative for cellulose production.

Preparation of Nanocellulose Composite Films

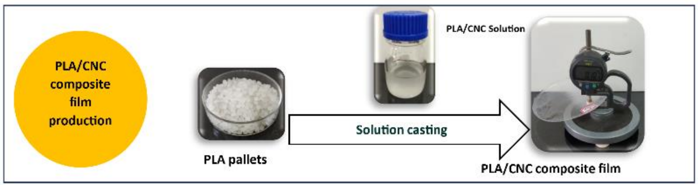

Fig. 1 Preparation of composite film from Chickpea husk

Nanocellulose offers high specific surface area, strength, biocompatibility, biodegradability, and easy modification, making it suitable for various applications such as drug carriers, cosmetics, optoelectronic materials, and food packaging. Researchers are increasingly focusing on developing new materials and enhancing conventional material properties using nanocellulose. It can be combined with other polymers as a reinforcing filler to improve material performance. Nanocellulose composite films for food packaging are prepared using wet processes, melt processing, and coating.

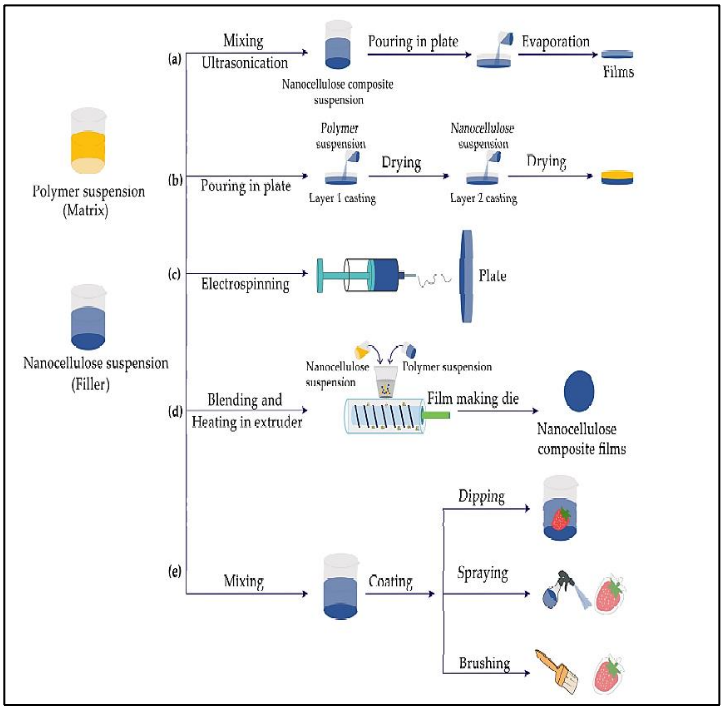

Fig. 2 Preparation methods of nanocellulose composite films: (a) solvent casting method, (b) layer by-layer assembly, (c) electrospinning, (d) melt process, (e) coating

Advantages

- High specific surface area
- High strength, good biocompatibility
- Natural biodegradability
- Easy modification

Conclusions

Traditional petroleum-based packaging materials can no longer meet the needs of sustainable development. Nanocellulose could replace petroleum-based materials due to its promising advantages, including rich sources, biodegradability, excellent mechanical properties, biocompatibility, etc. Different types of nanocellulose (CNCs, CNFs, and BNC) can be extracted from different sources to obtain desirable characteristics for the preservation of specific products. Nanocellulose composite films and coatings can extend shelf life and maintain the quality of diverse food products such as fruits, vegetables, and meats, as has already been reported by some relevant studies.

Table 1. Types and characteristics of nanocellulose

Types	Micromorphology	Typical sources	Average size	Preparation method
Cellulose nanocrystals (CNCs)	Whiskers, rod-shaped	Plants (wood, cotton, hemp, flax, etc.)	Diameter: 5–70 nm Length: 100–250 nm	Acid hydrolysis
Cellulose nanofibrils (CNFs)	Twisted filamentous	Plants (wood, beet, cotton, hemp, flax, etc.)	Diameter: 5–60 nm Length: several micrometres	Mechanical treatment
Bacterial nanocellulose (BNC)	Gel-like, ribbon-like	Acetobacter, xylinum, pasteurii, etc.	Diameter: 20–100 nm Length: unfixed	Bacterial synthesis

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