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ORIGINAL RESEARCH ARTICLE

Isolation and Identification of α-Cellulose from Longan (*Dimocarpus longan* L.) Peel Using Chemical Delignification Method

Yulianita Pratiwi Indah Lestari[1,*], Abdul Aziz Setiawan[2], Nita Triadisti[1], Tuty Mulyani[1]

[1]*Fakultas Farmasi, Universitas Muhammadiyah Banjarmasin, Banjarmasin, Indonesia*

[2]*Fakultas Farmasi, Universitas Muhammadiyah A.R. Fachruddin, Tangerang, Indonesia*

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* Corresponding author.
E-mail address: yulianita.pratiwi@umbjm.ac.id

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ABSTRACT

This study aims to isolate and characterize α-cellulose from longan (*Dimocarpus longan* L.) peel using a chemical delignification method. Longan peel, as an agricultural waste, is known to contain significant amounts of cellulose and thus has potential as a sustainable raw material. The dried longan peel (simplicia) was subjected to alkaline treatment using sodium hydroxide (NaOH), followed by a bleaching process with sodium hypochlorite (NaOCl) to remove lignin and non-cellulosic components. The resulting α-cellulose was collected, washed, and dried. From 150 grams of dried simplicia, 28.28 grams of α-cellulose was obtained, resulting in a yield of 18.85%. The isolated material appeared as a fibrous, white solid in unground form. The chemical delignification method was proven effective in separating cellulose from the lignocellulosic matrix of the longan peel. These findings suggest that longan peel can serve as a promising alternative source of α-cellulose for various pharmaceutical and industrial applications.

Keywords: α-cellulose, cellulose, lignocellulose, longan peel, chemical delignification.

1. Introduction

The increasing concern over environmental degradation due to non-biodegradable materials such as Styrofoam has prompted the search for sustainable alternatives. Biodegradable foam (biofoam), derived from natural sources like starch, has been widely studied as a potential eco-friendly packaging material. However, biofoam made solely from starch is known to have limitations, including high water absorption and low structural flexibility. These deficiencies can be addressed by incorporating reinforcing agents such as α-cellulose, which improves mechanical properties and reduces water permeability (Akmala & Supriyo, 2022).

α-cellulose, a purified form of cellulose, is widely recognized as a precursor for microcrystalline cellulose (MCC), a valuable biopolymer extensively applied in pharmaceutical and material sciences. The isolation of α-cellulose generally involves delignification processes, including alkaline and oxidative treatments to remove lignin and hemicellulose. Various agricultural residues such as pineapple leaves (Sumiati et al., 2023), areca nut peel (Zulnazri et al., 2022), and limpasu fruit peel (Yuspa et al., 2023) have been identified as promising sources for α-cellulose, promoting the valorization of local biomass waste.

In Indonesia, non-wood biomass like seludang jantung pisang—a banana flower sheath waste—contains high α-cellulose content (63.47%) and has shown potential as a sustainable source for MCC production (Fernianti & Hastuti, 2019). Similarly, longan (Dimocarpus longan L.) peel, abundant locally, not only provides cellulose but also exhibits antioxidant and antibacterial activities, positioning it as a dual-purpose candidate for pharmaceutical use (Thursina et al., 2022; Tobaq et al., 2023). Prior research has demonstrated that MCC isolated from tropical biomass such as pineapple fruit has comparable physicochemical properties to commercial MCC (Agustin & Abdassah, 2021), supporting the feasibility of utilizing local resources.

In the pharmaceutical industry, MCC is widely used as an excipient in directly compressed tablets due to its excellent binding, disintegrating, and filler properties. Agustin and Abdassah (2021) successfully isolated MCC from pineapple fruit and reported that its physicochemical characteristics—including moisture content, pH, particle size, and morphology—were comparable to commercial MCC (Avicel PH-102). This demonstrates the feasibility of tropical biomass for high-quality MCC production.

Among the less-explored but highly promising materials is the limpasu fruit (Baccaurea lanceolata), endemic to Kalimantan. Research has shown that its fruit peel can be utilized not only as a source of α-cellulose but also for the preparation of MCC with desirable pharmaceutical-grade characteristics (Yuspa et al., 2023). Additionally, Prigita et al. (2023) highlighted the importance of exploring the bioactivity of longan seed extracts, further supporting the integration of ethnobotanical resources in pharmaceutical applications.

Therefore, the objective of this study is to evaluate and characterize microcrystalline cellulose (MCC) derived from longan (Dimocarpus longan L.) as a potential pharmaceutical excipient. The findings are expected to support the development of MCC from underutilized local biomass, promote sustainable excipient sourcing, and contribute to the advancement of environmentally friendly pharmaceutical practices in Indonesia.

2. Material and Methods

2.1. Material

The tools used in this study included laboratory glassware, an oven, a melting point apparatus, pH paper, and a digital balance. The natural material used was powdered simplicia of longan peel (*Dimocarpus longan* L.). The chemical reagents used included distilled water, hydrochloric acid (HCl), acetic acid (CH_3COOH), sodium hydroxide (NaOH), sodium hypochlorite (NaOCl), zinc chloride ($ZnCl_2$), potassium iodide (KI), iodine (I_2), and 70% ethanol.

2.2. Methods

2.2.1. Preparation and extraction of Longan Peel Simplicia

Longan peels were sorted to remove dirt or foreign materials, then thoroughly washed under running water and drained. The material was cut into small pieces and dried in a shaded area protected from direct sunlight. Once dried, the simplicia was ground using a blender and sieved through a 60-mesh sieve to obtain a uniform powder size for further processing (Yuspa et al., 2025).

Longan peel simplicia powder was extracted using the maceration method with 70% ethanol as the solvent in a 1:10 ratio. The extraction process was carried out for 3 × 24 hours with occasional stirring. The resulting filtrate was filtered, and the solvent was evaporated using a dehydrator at 50 °C until a thick extract was obtained. This extract was stored in a tightly closed container at 4 °C until further use, while the residue from the extracted simplicia powder was used for α-cellulose isolation (Yuspa et al., 2025).

2.2.2. Isolation of α-Cellulose of Longan Peel

Using the Kraft cooking method, the material was boiled in a 10% NaOH solution for 1 hour. After cooking, it was soaked in 1 liter of cold water for 24 hours to optimize the removal of residual cooking solution. Subsequently, a 3.5% NaOCl solution was added to produce a whiter and cleaner powder. The material was then washed until free from alkali and ground to obtain powder with a particle size of 30–40 mesh (Lestari et al., 2025).

2.2.3. Identification of α-Cellulose using zinc chloride-iodine solution

A zinc chloride–iodine solution was prepared by dissolving 20 g of $ZnCl_2$ and 6.5 g of KI in 10.5 mL of water, followed by the addition of 0.5 g of iodine. The mixture was stirred for 15 minutes. Approximately 10 mg of α-Cellulose was placed on a spot plate, and 2 mL of the zinc chloride–iodine solution was added. The compound was considered positive if a blue-violet color was produced (Lestari et al., 2025).

3. Result and Discussion

This study successfully isolated α-cellulose from longan (*Dimocarpus longan* L.) peel through chemical delignification, followed by conversion into microcrystalline cellulose (MCC). The results presented include yield calculations from each stage of processing, visual observations of material transformation, and qualitative identification outcomes. These findings are discussed in relation to their implications for optimizing production efficiency, material purity, and potential applications as pharmaceutical excipients. The discussion also compares the physicochemical characteristics obtained with relevant literature to assess the quality and feasibility of longan peel–derived MCC.

3.1. Preparation of Longan Peel Simplicia

The preparation of simplicia is the initial step to ensure the raw material is clean, uniform, and suitable for subsequent chemical processing. In this study, dried longan peel simplicia was obtained after careful sorting, washing, cutting, drying, grinding, and sieving. This process produced a fine powder with a uniform particle size, which is essential for maximizing extraction efficiency in the next stage.

A) **B)**

Figure 1. The process of preparing longan peel simplicia.

The powdered simplicia served as the starting material for α-cellulose isolation, where chemical delignification was employed to remove lignin and hemicellulose, thereby enriching the cellulose content.

The preparation of longan peel simplicia is a critical step to ensure material cleanliness and uniformity before chemical processing. In this study, the process involved sorting to remove impurities, washing under running water, cutting into small pieces, drying in a shaded area to prevent degradation of active compounds, grinding, and sieving through a 60-mesh sieve. This method produced a fine powder with a consistent particle size, which is essential for maximizing the efficiency of the subsequent delignification process.

Similar preparation methods have been reported for other lignocellulosic materials, such as ketapang leaves (Yuspa et al., 2025) and limpasu fruit peel (Yuspa et al., 2023), where proper drying and particle size reduction significantly improved the penetration of alkaline and bleaching agents during cellulose isolation. The shaded drying technique also helps preserve the structural integrity of cellulose fibers, thereby supporting higher yields and better quality of α-cellulose in later stages.

3.2. Preparation of α-Cellulose

The chemical delignification process using the Kraft method effectively removed lignin and hemicellulose from the lignocellulosic matrix of longan peel. The combined alkaline cooking with 10% NaOH and bleaching with 3.5% NaOCl produced a white, fibrous α-cellulose material with a yield of 18.85% from 150 g of dried simplicia. This yield is higher than the 12.45% reported for α-cellulose derived from ketapang (Terminalia catappa L.) leaves using a similar

NaOH–NaOCl treatment (Yuspa et al., 2025), but comparable to yields obtained from limpasu (Baccaurea lanceolata) fruit peel, which ranged from 17–19% (Yuspa et al., 2023). Sumiati et al. (2023) also reported a similar approach for pineapple leaf lignocellulose, where alkaline delignification followed by oxidative bleaching resulted in high-purity α-cellulose with good physical appearance. Variations in yield between sources are influenced by cellulose content, lignin composition, and fiber structure of the raw material.

Table 1.
Yield of α-cellulose isolated from longan peel simplicia.

Plant part	Simplicia weight (gram)	α-cellulose weight (gram)	Yield (%)
Longan peel	150	28,28	18,85%

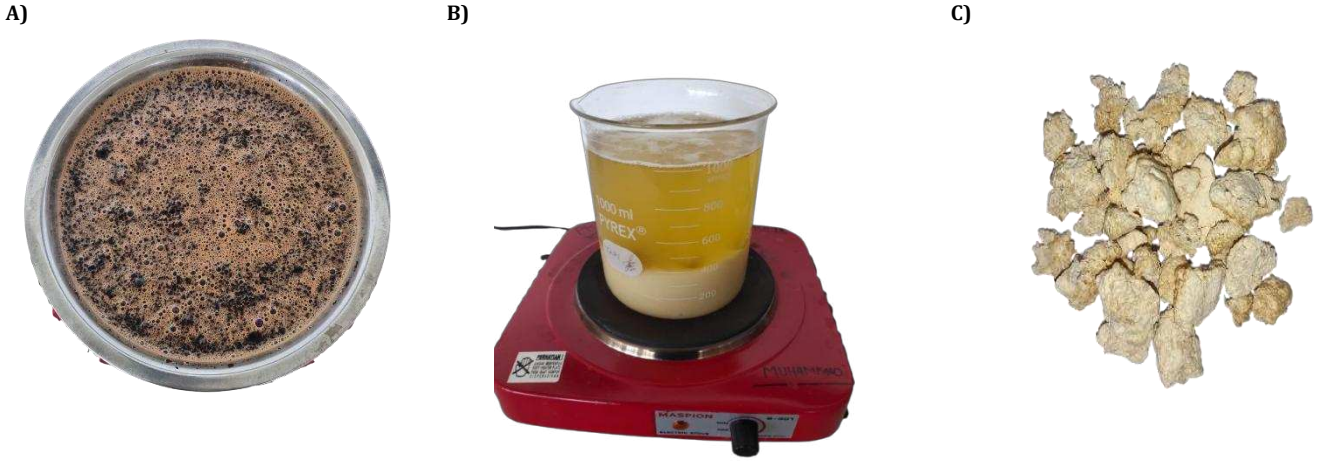

Figure 2. The isolation process of α-cellulose from longan peel: **A)** chemical delignification using NaOH solution, **B)** bleaching using NaOCl solution, **C)** the resulting α-cellulose in unground form.

The bleaching step was effective in producing a whiter product, indicating efficient removal of residual lignin, consistent with results from pineapple leaf (Sumiati et al., 2023) and areca nut peel cellulose production (Zulnazri et al., 2022).

Qualitative testing using zinc chloride–iodine solution produced a distinct blue-violet coloration, confirming the presence of cellulose. This colorimetric response is consistent with previous findings in α-cellulose from various plant materials (Lestari et al., 2025; Yuspa et al., 2025), indicating that the method is a reliable and rapid technique for verifying cellulose content before further processing into microcrystalline cellulose (MCC).

To confirm the identity of the isolated material, qualitative testing was performed using zinc chloride–iodine solution, which is a standard method for cellulose identification.

3.3. Identification of α-Cellulose

Qualitative identification of the isolated α-cellulose was carried out using the zinc chloride–iodine test, a standard method for confirming the presence of cellulose. In this test, α-cellulose produced a characteristic blue-violet coloration upon contact with the reagent, indicating a positive result. The coloration occurs due to the formation of a cellulose–iodine complex in the presence of zinc chloride, which swells the cellulose fibers and facilitates iodine penetration (Mi'rajunnisa & Lestari, 2022).

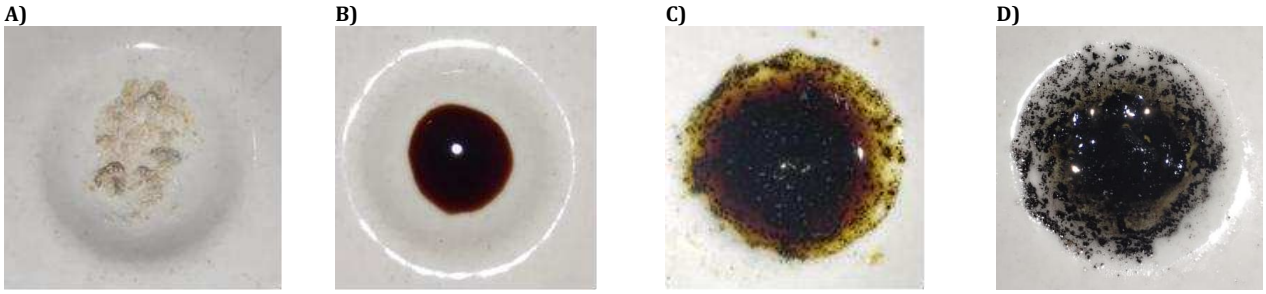

Figure 3. Identification of α-cellulose using $ZnCl_2$–I_2 solution: **A)** isolated sample; **B)** reagent; **C)** immediate color change; **D)** color after 12 h.

This reaction is consistent with the description by Ruppersberg et al. (2022), who explained that Schultze's reagent produces a blue to brown-violet coloration depending on cellulose concentration and fiber structure, as zinc and chloride ions promote fiber swelling, allowing iodine to bind effectively to cellulose chains. While this method is valued for its simplicity and sensitivity, it contains zinc chloride, which is classified as hazardous (GHS 05, GHS 07, GHS 09). Ruppersberg et al. (2022) proposed an iodine–calcium chloride solution as a safer alternative, maintaining detection performance while reducing reagent hazards—an option worth considering for future cellulose identification studies.

According to Hubbe et al. (2019), the zinc chloride–iodine test is one of the most effective classical staining methods for cellulose because $ZnCl_2$ acts as a strong fiber-swelling agent, disrupting crystalline regions and enabling iodine to penetrate deeply into the cellulose microfibrils. This structural change makes the coloration both rapid and highly specific to cellulose, with no comparable staining for lignin or hemicellulose.

Mechanistically, Cao et al. (1994) demonstrated that $ZnCl_2$ forms a zinc–cellulose complex with reduced crystallinity, making the cellulose more reactive toward hydrolysis and iodine binding. Their iodine absorption experiments confirmed that zinc-treated cellulose exhibits faster and more intense coloration due to increased accessibility of hydroxyl groups at the C-5 position.

Furthermore, Li Feng Jia et al. (2015) showed that the intensity and clarity of the blue-violet color in iodine-based cellulose staining are strongly influenced by reaction conditions such as temperature, iodide concentration, and fiber swelling agents. Optimized swelling significantly enhances the staining contrast, supporting the importance of adequate $ZnCl_2$ concentration in ensuring accurate cellulose identification.

Similar observations were reported in α-cellulose derived from kapok pericarp (Ceiba pentandra L.), which exhibited the same blue-violet color response comparable to commercial microcrystalline cellulose (Avicel PH-101) (Mi'rajunnisa & Lestari, 2022). This color change is attributed to iodine binding with the hydroxyl groups at the C-5 position of cellulose, while zinc chloride promotes fiber swelling and enhances the reaction. $ZnCl_2$ has also been shown to accelerate cellulose dissolution and hydrolysis into glucose, increasing its reactivity toward iodine. Similar blue-violet responses have also been reported in α-cellulose derived from ketapang leaves (Terminalia catappa L.) (Yuspa et al., 2025) and tigarun leaf fibers (Crateva magna DC.) (Lestari et al., 2025), confirming the reliability of this test across various plant-derived cellulose sources. The use of this rapid qualitative method at the α-cellulose stage ensures that subsequent processing, such as conversion into microcrystalline cellulose, is performed on a verified cellulose-rich material, thereby reducing the risk of impurities affecting product quality.

The characteristic blue-violet color that appears during the identification of α-cellulose using zinc chloride–iodine solution does not appear immediately but develops over time. This occurs because $ZnCl_2$ acts as a fiber swelling agent that disrupts the crystalline structure of cellulose, allowing iodine to penetrate and bind effectively to the cellulose chains (Hubbe et al., 2019). Additionally, $ZnCl_2$ accelerates the hydrolysis of cellulose into glucose, increasing its reactivity toward iodine and enhancing the color intensity (Cao et al., 1994). Reaction conditions such as iodide concentration and temperature also influence the intensity and rate of color development (Jia et al., 2015). Therefore, sufficient time is required for the characteristic color to fully develop as a positive indicator of α-cellulose presence.

4. Conclusions

α-cellulose was successfully isolated from longan (*Dimocarpus longan* L.) peel through a chemical delignification method involving alkaline treatment and bleaching. The final yield obtained was 18.85%, and the product appeared as white, fibrous material in unground form. This study demonstrated that longan peel, an agricultural waste, has potential as an alternative natural source of α-cellulose for further applications in pharmaceutical and biomaterial fields. The identified α-cellulose is a suitable precursor for MCC, highlighting its potential for pharmaceutical excipient development.

Author contribution

Y.P.I.L. conducted the research and prepared the initial manuscript draft. A.A.S., N.T., and T.M. contributed to the manuscript refinement and final editing. Both authors read and approved the final version of the manuscript.

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Conflict of Interest

The authors declare that they have no conflict of interest regarding this research or its funding.

References

Akmala, A. & Supriyo, E., 2022. Optimasi konsentrasi selulosa pada pembuatan biodegradable foam dari selulosa dan tepung singkong. PENTANA, 1(1), pp.27–40. https://ejournal2.undip.ac.id/index.php/pentana/article/view/11597

Agustin, N. & Abdassah, M., 2021. Isolasi dan karakterisasi selulosa mikrokristal dari nanas (Ananas comosus (L.) Merr). PHARMACY: Jurnal Farmasi Indonesia, 18(1), pp.111–121. https://doi.org/10.30595/pharmacy.v18i1.10277

Cao, N. J., Xu, Q., Chen, C. S., Gong, C. S., & Chen, L. F. (1994). Cellulose hydrolysis using zinc chloride as a solvent and catalyst. Applied Biochemistry and Biotechnology, 45, 521–530. https://doi.org/10.1007/BF02941827

Fernianti, D., & Hastuti, D., 2019. Analisa α-Selulosa dan Bilangan Kappa pada Proses Pembuatan Pulp (Pulping) Menggunakan Seludang Jantung Pisang sebagai Bahan Baku. Prosiding Nasional Rekayasa Teknologi Industri dan Informasi XIV (ReTII), November 2019, 376-379.

Hubbe, M. A., Chandra, R. P., Dogu, D., & van Velzen, S. T. J. (2019). Analytical staining of cellulosic materials: A review. BioResources, 14(3), 7387–7464.

Jia, L. F., Yang, M., Liu, Y., & Sun, L. (2015). Automatic identification of ramie and cotton fibers based on iodine blue reaction, Part I: the optimum conditions for the iodine blue reaction of cellulose. Textile Research Journal, 86(8), 848–855. https://doi.org/10.1177/0040517515596970

Lestari, Y.P.I., Kamalia, N., Maulidah, N. & Luthfia, R., 2025. Pembuatan Selulosa Mikrokristal pada Serat Daun Tigarun (Crateva magna DC.). Healthy-Mu Journal, 9(1), pp.42–47. doi: 10.35747/hmj.v9i1.1322.

Mi'rajnunisa, M., & Lestari, Y. P. I. (2022). Biodelignifikasi kulit buah kapuk (Ceiba pentandra (L.) Gaertn) menggunakan Trametes versicolor. Jurnal Inovasi Penelitian, 3(1), 4547–4554. https://doi.org/10.47492/jip.v3i1.1657

Prigita, A. E., Azhari, Mulyawan, R., Nasrul, Z. A., & Meriatna, M., 2023. Pengaruh perbedaan metode ekstraksi biji kelengkeng (Dimocarpus longan.) terhadap aktivitas antioksidan. Chemical Engineering Journal Storage, 3(5), 652–662. https://doi.org/10.29103/cejs.v3i5.11991

Ruppersberg, S., Zeiger, B., Koeber, R., & Klein, K. (2022). Know thy carbs 2: Reagents for cellulose detection. Biochemistry and Molecular Biology Education, 50(6), 573–584. https://www.pedocs.de/volltexte/2024/29733/pdf/Ruppersberg_et_al_2022_Know_thy_carbs_2.pdf

Sumiati, T., Yuningtyas, S. & Haloho, L.E.B.R., 2023. Delignifikasi lignoselulosa daun nanas (Ananas comosus (L.)) untuk produksi alfa selulosa. Jurnal Pharmamedica, 8(2), pp.130–137.

Thursina, C. S., Bakri, T. K., & Mahmudi, M., 2022. Uji aktivitas antioksidan ekstrak etanol daging buah kelengkeng (Dimocarpus longan Lour.) menggunakan metode DPPH. Jurnal Serambi Konstruktivis, 4(2), 388–393. https://doi.org/10.32672/konstruktivis.v4i2.5120

Tobaq, F. R., Mandalas, H. Y. & Sugiaman, V. K., 2023. Efek antibakteri ekstrak kulit kelengkeng (Dimocarpus longan L.) terhadap Porphyromonas gingivalis. E-GiGi, 12(1), pp.60–66. https://doi.org/10.35790/eg.v12i1.48012

Yuspa, R., Hafifah, R., Mursyidah, S., Aldeina, S., Muhammad & Lestari, Y.P.I., 2023. Isolasi alfa selulosa dan pembuatan serta karakterisasi mikrokristalin selulosa dari kulit buah limpasu (Baccaurea lanceolata Muell). Jurnal Ilmiah Ibnu Sina, 8(3), pp.71–81. https://doi.org/10.36387/jiis.v8i3.1676

Yuspa, Muhammad, Fatimah, Nur Maulidah, Raidah Luthfia & Lestari, Y.P.I., 2025. Isolation, Manufacture and Qualitative Test of Cellulose Microcrystallization Powder from Ketapang Leaves (Terminalia catappa L.) Using Chemical Delignification and Hydrolysis Methods. International Journal of Applied Pharmaceutics, 17(4), pp.159–165. doi: 10.22159/ijap.2025v17i4.54021.

Zulnazri, D., Lestari, D., Hakim, L., Dewi, R., & Sulhatun, S., 2022. Kajian ekstraksi selulosa dari kulit pinang dengan menggunakan larutan NaOH. Jurnal Teknologi Kimia Unimal, 11(2), pp.193–206. https://doi.org/10.29103/jtku.v11i2.7846