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Development of Corn Cob-Derived Cellulose-Based Edible Coating for Enhancing the Physicochemical Properties of Pear Fruits during Storage

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Abstract

The utilization of edible coating is an efficient strategy for maintaining quality and reducing postharvest losses in fruits and vegetables. This study reports the extraction of cellulose from corn cob and the development of a cellulose-based edible coating. The efficiency of the prepared coating was evaluated using pear fruits as a model system. The novelty of this work lies in the use of corn cobs, an agricultural waste material, as a sustainable and low-cost source of cellulose extracted through a simple process. The extracted cellulose was quantified and characterized using Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy (SEM) and thermogravimetric analysis (TGA). The characterization results confirmed the presence of characteristic functional groups, including CH asymmetric stretching, –NCO groups, H–O–H bending, Hydrogen bonding, and β-glycosidic linkages. The cellulose exhibited a crystalline structure, structural rigidity, and a porous surface morphology. Cellulose-based edible coatings were prepared at 3 different concentrations and applied to pear fruits, which were stored at ambient temperature for 15 days. The coated fruits showed better retention of physicochemical properties, including pH, firmness, total acidity, and total soluble solids compared to uncoated fruits. The coating was applied to pear fruits and evaluated during 15 days of storage at 23°C. In addition, the cellulose-based coating significantly ($P<0.05$) reduced weight loss (3.41%) and preserved higher level of ascorbic acid (22.60 to 24.10 mg/100 g) during storage. Overall, the application of the cellulose-based edible coating effectively extended the shelf life of pear fruits. This finding suggests the potential of cellulose-based edible coatings derived from agricultural waste as a sustainable solution for preserving fruits and vegetables while maintaining nutritional quality.

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Introduction

Postharvest losses of perishable fruits such as pears (*Pyrus communis*), represent a major challenge within the fresh produce supply chain, primarily due to rapid physiological deterioration and microbial contamination. These factors significantly reduce shelf life, quality, and marketability, contributing to an estimated 20–30% loss of fruit freshness. Effective postharvest preservation strategies are therefore essential to mitigating these losses. Fresh *Pyrus communis* is a climacteric fruit with a relatively short postharvest shelf life, primarily attributed to its elevated respiration rate and pronounced sensitivity to ethylene (Ostek et al., 2020). Under ambient storage conditions, pears generally retain acceptable quality for only 5–10 days (Salvador et al., 2007), whereas refrigerated storage at 0–4°C can significantly prolong shelf life up to 2–4 months, depending on cultivar and storage conditions (Arias et al., 2007; Dong et al., 2018). Improper postharvest handling accelerates physiological and biochemical deterioration in pears, causing rapid quality loss. The loss of consumer acceptability is commonly associated with excessive softening, peel browning, moisture loss leading to shriveling, development of undesirable off-flavors, and increased susceptibility to microbial decay (Burger et al., 2005). These deteriorative processes are primarily driven by enhanced respiration and ethylene production, enzymatic disassembly of cell wall polysaccharides, and oxidative reactions involving phenolic compounds (Dong et al., 2023). Furthermore, prolonged storage and progressive deterioration adversely affect the nutritional profile of the fruit, leading to significant reductions in vitamin C content, antioxidant capacity, and overall phytochemical composition, thereby diminishing its nutritional and functional quality (Bentoulla et al., 2024). These quality deteriorations ultimately lead to consumer rejection, as the fruit becomes excessively soft, loses visual appeal due to browning and shriveling, and develops undesirable flavor characteristics. Consequently, the preservation of postharvest quality and the retardation of deterioration processes are of critical importance for extending shelf life and maintaining both the commercial value and nutritional integrity of pears (Pasquariello et al., 2013).

Cold storage is widely applied to delay ripening-related processes, including ethylene production, tissue softening, pigment degradation, and moisture loss (Salehi, 2020). Musacchi et al. (2021) highlighted that these technologies are energy-intensive and often inaccessible in small-scale or developing supply chains, emphasizing the need for alternative, cost-effective preservation strategies. In addition, microbial growth, enzymatic reactions, and physiological changes collectively accelerate spoilage, resulting in substantial postharvest wastage throughout the supply chain (Alegbeleye et al., 2022). Pear (*Pyrus communis*, L.) is one of the oldest cultivated fruit crops in Egypt and is among the most widely consumed fruits worldwide (Sultan et al., 2021). Pear fruits are highly valued by consumers for their sweetness, crisp texture, attractive appearance, and pleasant aroma. While many pear cultivars are consumed fresh due to their low stone cell content, others are processed upon reaching optimal ripeness. Pears are typically harvested in mid to late August at a maturity stage of approximately 10–12°Brix and require rapid postharvest cooling to remove field heat and maintain quality (Nath et al., 2012). Nutritionally, pears are rich in sugars, minerals, vitamin C, and antioxidant phenolic compounds, conferring high nutritional and functional value. Fruit quality is generally assessed based on physical attributes such as texture, size, color, and aroma, as well as chemical components including sugars, organic acids, vitamins, and minerals.

Various preservation, including modified atmosphere storage, cold storage, chemical dipping, and edible coatings, have been employed to maintain the freshness and extend the shelf life of fruits. The techniques help minimize the adverse effect of environmental factors during storage and distribution (Blancas-Benitez et al., 2022). Among them, edible coatings have gained considerable attention due to their ability to create a modified internal atmosphere and function as a protective barrier against moisture loss and gas exchange (Saleem et al., 2021). By limiting oxygen diffusion and carbon dioxide release, edible coating effectively delays physiological processes such as respiration, metabolic activity, and oxidative reactions, thereby prolonging fruit shelf life (Shen et al., 2022). A wide range of biopolymers has been utilized in the formulation of edible coatings, including Arabic gum (Murmu & Mishra, 2018), Xanthan gum (Sharma & Rao, 2015), Psyllium (Plantago) gum (Yousuf et al., 2015), chitosan (Taheri et al., 2020; Kumar et al, 2021), cellulose (Mousavi et al., 2021) and carboxymethyl cellulose (Bambalele et al., 2021). Previous studies have demonstrated that cellulose and its derivatives, particularly carboxymethyl cellulose, effectively reduce

moisture loss, delay softening, and maintain firmness and overall fruit quality during storage. Edible coatings have been successfully applied to improve the shelf life and quality of various fruits, including strawberry (Mousavi et al., 2021), blackberry (Isopencu et al., 2021), Cucumis metuliferus fruit (Arrieta et al., 2020), plum (Panahirad et al., 2019), guava (Kumar et al., 2021) and Pistacia vera (Hashemi et al., 2018).

Despite these advances, most studies have focused on commercially available or chemically modified cellulose-based coatings under controlled storage conditions, while the application of agricultural waste-derived cellulose, particularly from corn cob, for postharvest preservation of pear fruits under ambient storage conditions remains largely unexplored (Kossalbayev et al., 2025). Therefore, the novelty of this study lies in the development of a sustainable, low-cost edible coating based on corn cob-derived cellulose, combined with bioactive components, for enhancing the shelf life and quality of pear fruits under ambient storage conditions.

Corn cob is an abundant agricultural by-product generated in large quantities by agro-industrial activities and is commonly regarded as waste. Notably, corn cob contains a high cellulose content, ranging from approximately 36–46%, making it a promising raw material for the production of value-added bioproducts (Ng et al., 2024). Various extraction techniques, such as ultrasound-assisted extraction and acid hydrolysis, have been employed to isolate cellulose and nanocellulose crystals from corn cob biomass (Ditzel et al., 2017; Louis & Venkatachalam, 2020; Shao et al., 2020). Corn cob-derived cellulose was selected due to its abundance, low cost, and high cellulose content, making it a sustainable alternative to conventional commercial sources (Escamilla-García et al., 2022; Khalil et al., 2016). The incorporation of xanthan gum improves film-forming ability and coating stability (Sharma & Rao, 2015), while quercetin (Malvano et al., 2022) and Arthrospira platensis provide antioxidant and antimicrobial properties (Mohammadi et al., 2024; Nieto et al., 2009). This combination is expected to produce a synergistic effect by enhancing barrier properties, reducing oxidative damage, and inhibiting microbial growth, thereby improving postharvest preservation.

In the present study, cellulose was extract from corn cob and subsequently characterized. An edible coating based on the extracted corn cob cellulose was developed through a simple and cost-effective method. Furthermore, the effectiveness of the prepared edible coating in preserving quality and extending the storage life of pear fruits was systematically evaluated. The objective and novelty of this study was to develop and characterize an edible coating based on corn cob-derived cellulose and to evaluate its effectiveness in maintaining the physicochemical quality and extending the shelf life of *Pyrus communis* during storage. It is hypothesized that the developed coating will act as a semi-permeable barrier, reducing respiration rate, moisture loss, and microbial growth, thereby preserving fruit quality and prolonging shelf life.

Materials and methods

1. Collection and preparation of corn cob

Edible, food-grade corn cobs were collected from local farmers in the Theni District, Tamil Nadu, India. The collected corn cobs were thoroughly cleaned and sun-dried for three days to remove residual moisture. The dried corn cobs were initially ground using a hammer mill, followed by further pulverization using a mechanical pulverizer (MICRONEX 4U, Rieco Industries Ltd., India). The pulverization process was repeated approximately four times to obtain a fine powder. The final particle size was standardized by passing the powder through a sieve (No. 7≈2.80 mm) and the resulting corn cob powder was stored in airtight containers until further use.

2. Extraction and quantification of cellulose from corn cob

Cellulose was extracted from corn cob powder using a chemical extraction method adapted from Choque-Quispe et al. (2022) with minor modifications. Briefly, 75 g of corn cob powder was mixed with 3.5% (w/v) nitric acid and sodium nitrite solution and subjected to continuous stirring on a magnetic stirrer at 90°C for 2 h. After the reaction, the mixture was filtered, and the filtrate was washed with distilled water until neutral pH (pH 7) was achieved. The resulting residue was subsequently treated with 2% (w/v) sodium hydroxide at 50°C for 1 h to remove hemicellulose. This was followed by bleaching with 1.75% (w/v) of sodium hypochlorite at 70°C for 30 min. The sample then underwent a further alkali treatment with 17.5% (w/v) sodium hydroxide at 80°C for 30 min to enhance cellulose purity. Finally, the residue was treated with 10% (v/v) hydrogen peroxide at 60°C for 15 min to achieve

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additional delignification and whitening. After completion of the extraction process, the cellulose suspension was allowed to cool, filtered, and washed repeatedly with distilled water until neutral pH was achieved. The extracted cellulose was dried in a hot air oven (LSI-HOV-ML-250C, Lab Solution India Pvt. Ltd., India) at 60°C and stored in a sterile desiccator for further analyses. The cellulose content was quantified following the standard protocol described by Gupta et al. (2018), and the extraction yield was calculated. The total cellulose yield obtained was 26 g from 75 g of corn cob powder.

3. Characterization of corn cob-based cellulose

The functional groups present in the extracted corn cob-based cellulose were analyzed using Fourier transform infrared spectroscopy (FTIR-460 Plus, JASCO, Japan) over a wave number range of 4000–400 cm^{-1}. The crystalline structure and phase characteristics of the cellulose were determined using X-ray diffraction analysis (X'Pert PRO, PANalytical, Netherlands). The surface morphology of the cellulose fiber was examined using scanning electron microscopy (SEM) (MIRA3 XMU, TESCAN, Czech Republic). Thermal stability and decomposition behaviour of the extracted cellulose were evaluated using thermogravimetric analysis (EXSTAR 6300, Seiko Instruments Inc., Japan).

4. Preparation of edible coating using corn cob-based cellulose

The edible coating solution was prepared by dissolving 1 g of xanthan gum, 1% (w/v) citric acid, 1.75% (v/v) glycerol, 30 mg of *Arthrospira platensis*, and 50 mg of quercetin in 300 mL of distilled water. The mixture was heated at 85°C for 1 h in a water bath with continuous stirring to ensure complete dissolution and homogeneity. Corn cob-based cellulose was incorporated into the coating formulation at 3 different concentrations (1, 2, and 3% w/v). The resulting formulations were mixed thoroughly to obtain uniform edible coating solutions. The detailed composition of each edible coating formulation is presented in Table 1.

Table 1 Composition of the edible coating formulation

Compounds	Formulation-1 (300 mL)	Formulation-2 (300 mL)	Formulation-3 (300 mL)
Xanthan gum	1 g	1 g	1 g
Citric acid	1% (w/v)	1% (w/v)	1% (w/v)
Glycerol	1.75% (v/v)	1.75% (v/v)	1.75% (v/v)
Corn cob-based cellulose	1 %(w/v)	2% (w/v)	3% (w/v)
Arthrospira plantensis	30 mg	30 mg	30 mg
Quercetin	50 mg	50 mg	50 mg

The developed coating is a cellulose-based composite formulation, in which corn cob-derived cellulose serves as the primary structural matrix responsible for film formation and barrier properties. Xanthan gum was incorporated to improve viscosity, coating uniformity, and stability, while glycerol acts as a plasticizer to enhance flexibility. Quercetin and *Arthrospira platensis* were included as bioactive components to provide antioxidant functionality. The formulation was designed to achieve a synergistic effect between structural and functional components.

5. Assessment of edible coating efficiency on pear fruits

Kodaikanal Pear (*Pyrus communis* L.) fruits with uniform size, shape, and color, free from visible defected and mechanical damage, were purchased from a local fruit market in Kodaikanal, Dindigul District, Tamil Nadu, India. All pear fruits were initially washed with tap water and sanitized by immersion in a solution containing 10 mL/L hydrogen peroxide and 5 g/L citric acid for 10 min. The fruits were then rinsed with cold water for 5 min and air-dried at 27°C, following the method described by Sharma and Rao (2015).

The sanitized pears fruits were coated using the dipping method by immersing each pear fruit in the prepared edible coating solution for 2 min. After immersion, the fruits were air-dried at ambient temperature (23°C) for 15 min. The dipping and drying procedures were repeated twice to ensure uniform coating coverage on the fruit surface. After drying, the coated pear fruits were stored at room temperature (23°C) and their quality attributes were evaluated over a storage period of 15 days. Uncoated pear fruits stored under identical conditions served as the control (Kandhola et al., 2020).

6. Evaluation of quality attributes

The percentage of physiological weight loss (PWL) of coated and uncoated pear fruits was determined using the gravimetric method with an analytical balance (AUW220D, Shimadzu Corporation, Japan). Fruit firmness was measured using a texture analyser (TA Plus, Lloyd Instruments Ltd., UK) at regular storage intervals. Total titratable acidity (TA) was determined using the titration method described by Kumar et al. (2021). The pH of pear fruit juice was measured using a digital pH meter (PH-103, Brinkmann Instruments, Canada). Total soluble solids (TSS) were measured using a refractometer (MASTER-α, ATAGO Co., Ltd., Japan), and the results were expressed in °Brix (Kumar et al., 2021). Ascorbic

acid content was quantified following the method described by Dewhirst and Fry (2018). Change in fruit surface color during storage was evaluated using the method reported by Gao et al. (2019).

The storage quality of pear fruit storage was assessed using key physicochemical and sensory parameters as physiological weight loss, firmness, pH, total acidity (TA), total soluble solids (TSS), TSS/TA ratio, ascorbic acid content, and sensory qualities. The parameters were chosen as standard parameters of postharvest fruit quality that relates to moisture retention, texture, metabolism, ripening process, nutritional value, and consumer palatability. Reduced weight loss, increased firmness, constant acidity, maintained TSS change and retention of ascorbic acid were regarded as evidence of improved storage quality and prolonged shelf life.

7. Statistical analysis

All experiments were carried out with 3 replications. The experimental data were subjected to statistical analysis using analysis of variance (ANOVA) with the IBM SPSS Statistics software (version 24.0, IBM Corp., USA). Mean comparisons were performed using Duncan's multiple range tests (DMRT), and differences were considered statistically significant at $P<0.05$.

Results and discussion

1. Characterization of corn cob-based cellulose

1.1 Fourier transform infrared (FTIR) analysis

The FTIR spectrum of corn cob-based cellulose (Fig. 1) exhibited characteristic absorption peaks at 3352, 2889, 2229, 1647, 1028, 896, and 663 cm^{-1}, confirming the successful extraction of cellulose. The broad and intense band observed at 3352 cm^{-1} corresponds to O–H stretching vibrations associated with hydroxyl groups, which are characteristic of cellulose. The absorption peak at 2889 cm^{-1} is attributed to C–H asymmetric stretching vibrations of the cellulose backbone. A distinct peak at 2229 cm^{-1} was observed, indicating the presence of C≡C stretching (alkyne) functional groups. The C–H stretching vibrations at 2889 cm^{-1} contribute to weak van der Waals interactions, which support the structural organization of the polymer network and enhance surface mechanical stability. The band appearing at 1647 cm^{-1} is associated with H–O–H bending vibrations of absorbed moisture within the cellulose structure. The peak at 1028 cm^{-1} is attributed to C–O–C stretching vibrations and symmetric hydrogen bonding in the polysaccharide chains. Furthermore, the presence of characteristic β-glycosidic linkages between anhydroglucose units in cellulose was confirmed by the absorption peaks at 896 and 663 cm^{-1}. These hydrogen bonds enhance adhesion of the coating to the fruit surface by improving interfacial interactions, while also reducing molecular mobility within the polymer matrix, thereby improving barrier properties against moisture and gas transmission. The C–O–C stretching at 1028 cm^{-1} and β-glycosidic linkages (896 cm^{-1}) are responsible for the backbone structure of cellulose. These linkages provide rigidity and structural integrity to the coating matrix, resulting in improved mechanical strength and resistance to deformation. Additionally, the dense network formed by these linkages limits the diffusion of gases and water vapor, thereby enhancing barrier properties. These findings are consistent with previous studies reporting cellulose extraction from corn cob biomass. Ng et al. (2024) similarly reported the presence of β-glycosidic linkages in corn cob-derived cellulose. Escamilla-García et al. (2022) also observed characteristic FTIR peaks corresponding to $–CH_2$ snipping, O–H tension and –C–H tension in cellulose and cellulose nanocrystal films derived from corn cob.

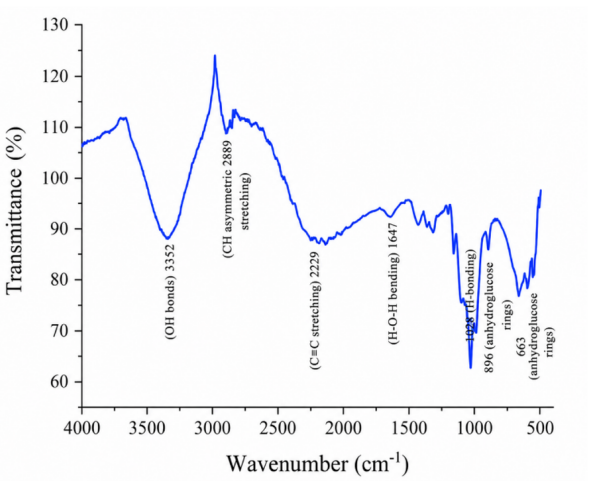


Fig. 1 FTIR spectra of cellulose extracted from corn cobs

1.2 Scanning electron microscopy (SEM) analysis

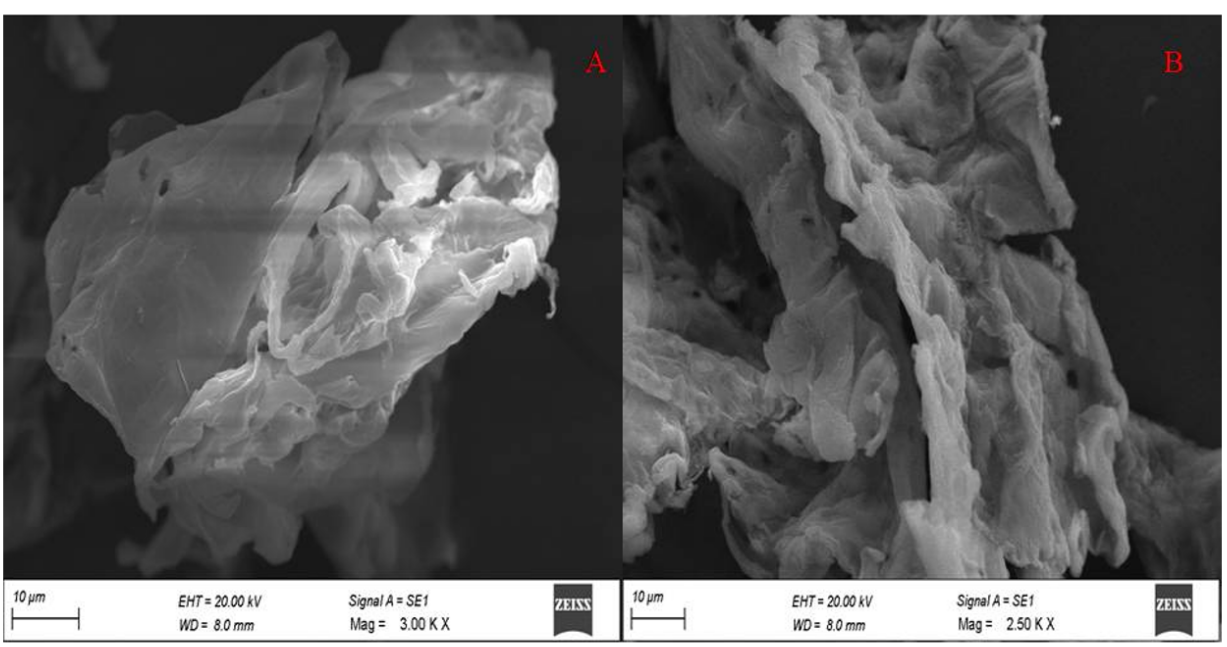
The surface morphology of corn cob-based cellulose is illustrated in Fig. 2a and Fig. 2b. The SEM micrographs revealed rough and irregular surface structure, which can be attributed to the alkaline treatment and bleaching processes employed during cellulose extraction. These chemical treatments effectively removed non-cellulosic components such as hemicelluloses,

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pectin and lignin, leading to the exposure of the cellulose fiber matrix. Additionally, the presence of pores on the cellulose surface was observed (Fig. 2b), indicating partial disruption of the fiber structure during chemical processing. Similar morphological features have been reported in previous research. Maigari et al. (2016) characterized nanocrystalline cellulose extracted from corncob using SEM, FTIR, XRD, and TGA, and reported a rigid cellulose surface with noticeable porosity. The observed porous and rough morphology in the present study suggests enhanced surface area, which may be advantageous for the application of corn cob-based cellulose in edible coating formulations. The rough and porous morphology of the cellulose provides a beneficial structural framework that enhances coating adhesion, mechanical stability, and barrier efficiency, ultimately contributing to improved preservation of fruit quality during storage.

1.3 X-ray diffraction (XRD) analysis

The crystalline structure of the extracted corn cob-based cellulose was investigated using X-ray diffraction analysis, and the resulting diffractogram is presented in Fig. 3. A prominent diffraction peak observed at 2θ=22° corresponds to the (002) crystallographic plane, which is characteristic of cellulose I and indicates the crystalline nature of the extracted cellulose. The average crystalline index was found to be 8.83 nm using Debye-Scherrer formula. The presence of the peak confirms the successful removal of amorphous components such as hemicellulose and lignin during the chemical extraction process. Likewise, with previous studies reporting cellulose extraction from corn cob residues. Wakudkar et al. (2025) similarly synthesized crystalline cellulose from corn cob biomass using chemical treatment methods and confirmed its crystalline structure through XRD analysis, supporting the results obtained in the present study. High crystallinity of corn cob-based cellulose significantly enhances film coating performance by improving stiffness, barrier properties, and structural integrity. The well-ordered crystalline regions restrict polymer chain mobility, resulting in increased stiffness and mechanical strength of the coating film. Moreover, high crystallinity reduces free volume within the matrix, thereby decreasing water vapor permeability (WVP) and limiting gas diffusion (such as oxygen and carbon dioxide). This leads to superior barrier properties, making the coating more effective for protective and packaging applications.



(a) (b)

Fig. 2 SEM analysis of cellulose derived from corn cobs a) Magnification 3000x and b) magnification 2500x

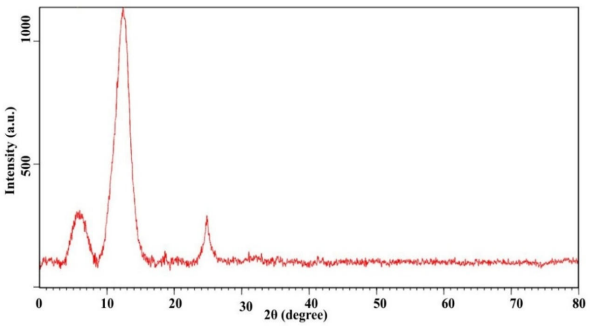


Fig. 3 X-ray diffraction (XRD) pattern of cellulose derived from corn cobs

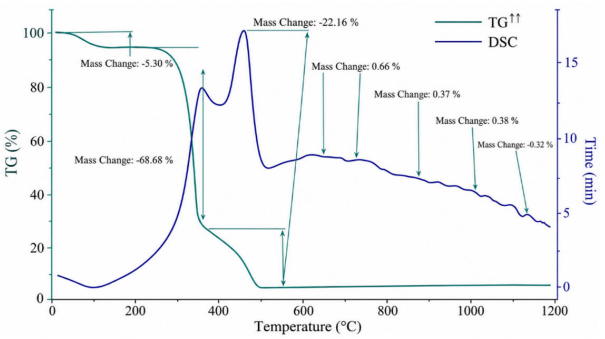


Fig. 4 Thermogravimetric analysis (TGA) thermogram of cellulose extracted from corn cobs

1.4 Thermogravimetric analysis

The thermal stability and degradation behavior of corn cob-based cellulose were evaluated using thermogravimetric analysis, and the corresponding thermogram is shown in Fig. 4. An initial weight loss of approximately 5.30% was observed in the temperature ranges of 100–200°C, which can be attributed to the evaporation of physically adsorbed moisture and the release of bound water molecules with in the cellulose structure. The TGA onset degradation temperature (Tonset) was observed at 280–300°C. A more drastic weight loss of approximately 68.68% occurred between 400 and 600°C, corresponding to the thermal decomposition of the cellulose polymer chains and the breakdown of carbonaceous components. This stage reflects the pyrolytic degradation of cellulose, leading to the formation of non-volatile carbonaceous residues. Similar thermal degradation behaviour of cellulose-based materials has been reported by Baker and Oguntoye (2023). High thermal resistance of corn cob–based cellulose offers significant advantages for product stability during storage. It helps maintain structural integrity of the coating under varying temperature conditions, preventing deformation, softening, or degradation. This stability reduces the risk of physicochemical changes such as moisture migration, oxidation, and loss of barrier properties. Consequently, it enhances shelf life, preserves product quality, and ensures consistent performance of the coated material during transportation and long-term storage.

2. Assessment of edible coating efficiency on pear fruits

2.1 Physiological weight loss

The physiological weight loss (PWL) percentages of uncoated and coated pear fruits during storage are presented in Table 2. After 15 days of storage, the lowest weight loss (3.41%) was observed in pear fruits coated with 3% corn cob-based cellulose, whereas the highest weight loss (10.88%) was recorded in uncoated pear fruits. Uncoated fruits exhibited significantly higher weight loss throughout the storage period, which can be attributed to rapid moisture evaporation and increased metabolic activity in the absence of a protective coating layer. In contrast, pear fruits coated with cellulose-coated edible coatings showed markedly reduce physiological weight loss. This reduction can be attributed to the formation of a semi-permeable barrier on the fruit surface, which limits water vapour transmission and gas exchange, thereby slowing respiration and transpiration rates. Similarly, results were reported by Dave et al. (2017), who observed minimal weight loss in pear fruits treated with composite edible coatings. Adiletta et al. (2018) also reported reduced physiological weight loss in chitosan-coated loquat fruit during cold storage, further supporting the effectiveness of edible coatings in minimizing postharvest moisture loss. The results can be confirmed based on respiratory metabolism principles. The cellulose coating acts as a semi-permeable barrier, which limits oxygen (O_2) diffusion into the fruit and reduces carbon dioxide (CO_2) exchange. This modified internal atmosphere slows down the respiration rate, thereby reducing the consumption of organic acids. As a result, the increase in pH is delayed in coated pear fruits compared to the uncoated control, confirming that the coating effectively regulates respiratory metabolism and helps maintain fruit quality during storage.

2.2 Firmness analysis

Changes in fruit firmness during storage for both uncoated and coated pear fruits are summarized in Table 2. A gradual reduction in firmness was observed in all samples over the storage period. However, uncoated pear fruits showed a pronounced decrease in firmness by the 15th day of storage compared to their initial firmness, indicating extensive tissue softening and a consequent

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decline in fruit quality. In contrast, cellulose-coated pear fruits exhibited significantly less reduction in firmness over the same storage period. The maintenance of firmness in coated fruits can be attributed to the protective effect of the edible coating, which slows down enzymatic activities related to cell wall degradation and reduced moisture loss, thereby delaying tissue softening. Our findings are similar to the previous reports by Resende et al. (2018), who observed firmness retention in strawberries coated with chitosan/cellulose nanofibril nanocomposites compared to uncoated fruits during storage.

2.3 pH changes

The variation in pH was noted in coated and uncoated pear fruits (Table 2). pH was high in uncoated pear fruits on the 15th day of storage due to consumption of organic acids during respiration. The cellulose coated pear fruits showed less pH on the 15th day storage periods, which proves the organic acid was not utilized for respiration. Carboxymethyl cellulose-based chickpea polysaccharides composite was used to coat the cherry tomatoes by Akhtar et al. (2021) for improving its quality and they reported coated cherry tomatoes exhibited less pH than uncoated cherry tomatoes.

Variations in pH values of coated and uncoated pear fruits during storage are presented in Table 2. A noticeable increase in pH was observed in uncoated pear fruits by the 15th day of storage, which can be attributed to the utilization of organic acids as substrates for respiration during ripening. In contrast, cellulose-coated pear fruits exhibited significantly lower pH values at the same storage period, indicating reduced consumption of organic acids.

The lower pH values observed in coated fruits suggest that the cellulose-based edible coating effectively slowed respiratory metabolism and delayed ripening processes. Similar findings were reported by Akhtar et al. (2021), who observed lower pH values in cherry tomatoes coated with carboxymethyl cellulose–chickpea polysaccharide composite films compared to uncoated samples, supporting the present observations.

2.4 Total acidity (TA), total soluble solids (TSS) and TSS/TA ratio

The changes in total acidity (TA), total soluble solids (TSS) and TSS/TA ratio of pear fruits during storage are summarized in Table 2. These parameters are critical indicators of sensory acceptability and overall eating quality of pear fruits during storage. The TA content of cellulose-coated pear fruits did not show a significant reduction throughout the storage, whereas a notable decrease in TA was observed in uncoated fruits after 15 days of storage. The reduction in total acidity in uncoated fruits is primarily due to the conversion of organic acids into sugar to support respiratory metabolism. The relatively stable TA levels in coated fruits indicate that the cellulose-based coating effectively slowed metabolic degradation of organic acids, thereby extending the shelf life of the fruits (Adiletta et al., 2018). Saleem et al. (2021) and Kumar et al. (2021) also reported that chitosan-based and carboxymethyl cellulose-based edible coatings significantly minimize acidity loss and improved the strawberry and guava fruits during storage.

The effect of cellulose-based edible coated on TSS content of pear fruits is also presented in Table 2. After 15 days of storage, coated pear fruits exhibited lower TSS values compared to uncoated fruits. The reduced TSS level in coated fruits can be attributed to the slowdown of metabolic activity and respiration rate induced by the semi-permeable coating barrier. These results are consistent with previous studies by Shaibani et al. (2022) and Hmmam et al. (2021), who reported a decline in TSS content of fruits during storage. During the storage period, the TSS/TA ratio was notably affected in coated pear fruits than uncoated fruits. Furthermore, the TSS/TA ratio, an indicator of ripening progression and flavor balance, was significantly higher in uncoated pear fruits on the 15th day of storage, reflecting a faster ripening rate. In contrast, cellulose-coated fruits exhibited a lower TSS/TA ratio, indicating delayed ripening. Similar trends were reported by Ali et al. (2022), who observed a lower ripening index in carboxymethyl cellulose-coated banana fruit.

2.5 Ascorbic acid content

Changes in ascorbic acid content of coated and uncoated pear fruits during storage are shown in Table 2. Initially, pear fruits contained 27.50 mg/100 g of ascorbic acid. A gradual decline in ascorbic acid content was observed in all samples over the 15-day storage period. However, cellulose-coated pear fruits retained significantly higher level of ascorbic acid, ranging from 22.60 to 24.10 mg/100 g compared to uncoated fruits. The enhanced retention of ascorbic acid in coated pear fruits indicates the effectiveness of the cellulose-based edible coating in reducing oxidative degradation and preserving the nutritional quality of pear fruits during storage. This protective effect may be attributed to reduced oxygen permeability and delayed ethylene production (Ballesteros et al., 2022). The results of the present study demonstrate that cellulose-based edible coatings effectively maintain the nutritional attributes of pear fruits during postharvest storage.

The effectiveness of the cellulose-based edible coating can be described by its ability to form semi-porous barriers on the surface of the fruit and thus alters the internal gaseous environment. The coating limits diffusion of oxygen and carbon dioxide, which causes a low respiration rate and slow ripening process. The low permeability to gases of cellulose is further contributed by its crystalline structure and high density of hydrogen-bonding network, which restricts oxidative reactions in the metabolism of cells. Also, the composite matrix, which is developed around Xanthan gum and glycerol, increases the integrity of the film and is lower in the passage of water vapor hence reducing loss of moisture and keeping fruit firm. The combination of these barrier properties is important in maintaining the physicochemical quality and life of pear fruits in storage time. This modified atmosphere effect is analogous to passive modified atmosphere packaging (MAP), where gas exchange is regulated through semi-permeable barriers.

Table 2 Evaluation of quality attributes of coated and uncoated pear fruits during storage

Weight loss (%)				
Treatments	**Initial day**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	0.00	3.63±0.10^{a}	7.26±0.22^{a}	10.883±0.17^{a}
1% CBEC	0.00	2.04±0.13^{b}	4.09±0.33^{b}	6.1327±0.19^{b}
2% CBEC	0.00	1.95±0.12^{b}	3.90±0.43^{c}	5.8504±0.44^{c}
3% CBEC	0.00	1.14±0.11^{c}	2.28±0.19^{d}	3.4135±0.38^{d}
Firmness (N)				
Treatments	**Initial day^{ns}**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	40.0	32.5±1.69^{c}	25.0±2.32^{c}	17.5±1.53^{d}
1% CBEC	40.0	34.8±2.37^{b}	29.5±1.86^{b}	24.2±2.32^{c}
2% CBEC	40.0	35.5±1.27^{b}	30.8±1.37^{b}	26.0±1.43^{b}
3% CBEC	40.0	36.2±2.69^{a}	32.5±2.66^{a}	28.7±1.96^{a}
pH				
Treatments	**Initial day^{ns}**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	3.80	3.97±0.14^{a}	4.18±0. 73^{a}	4.40±0.49^{a}
1% CBEC	3.80	3.87±0.67^{b}	4.00±0. 45^{b}	4.13±0.24^{b}
2% CBEC	3.80	3.87±0.28^{b}	3.93±0. 35^{c}	4.00±0.15^{b}
3% CBEC	3.80	3.85±0.45^{c}	3.90±0.29^{c}	3.94±0. 35^{c}
Total acidity (%)				
Treatments	**Initial day^{ns}**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	0.62	0.544±0.2^{d}	0.467±0.3^{d}	0.39±0.02^{d}
1% CBEC	0.62	0.561±0.1^{c}	0.500±0.2^{c}	0.44±0.06^{c}
2% CBEC	0.62	0.573±0.6^{b}	0.527±0.9^{b}	0.48±0.03^{b}
3% CBEC	0.62	0.587±0.5^{a}	0.573±0.7^{a}	0.54±0.01^{a}
Total soluble solids (° Brix)				
Treatments	**Initial day^{ns}**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	11.5	12.27±1.03^{c}	13.03±1.43^{a}	13.8±1.64^{a}
1% CBEC	11.5	11.83±2.23^{b}	12.17±2. 45^{c}	12.8±2.49^{b}
2% CBEC	11.5	11.87±1.34^{a}	12.20±2.85^{b}	12.6±1.03^{c}
3% CBEC	11.5	11.83±1.27^{b}	12.17±1.33^{c}	12.5±2.16^{d}
Total soluble solid/Total Acidity (TSS/TA)				
Treatments	**Initial day^{ns}**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	18.55	24.16±2.03^{a}	29.77±1.34^{a}	35.38±2.67^{a}
1% CBEC	18.55	22.73±1.12^{b}	26.00±1.29^{b}	29.09±1.45^{b}
2% CBEC	18.55	21.78±2.86^{c}	24.01±2.04^{c}	26.25±2.82^{c}
3% CBEC	18.55	20.08±1.36^{c}	21.61±1.65^{d}	23.15±1.03^{c}
Ascorbic acid content (mg/g)				
Treatments	**Initial day^{ns}**	**5 Days**	**10 Days**	**15 Days**
Uncoated (Control)	27.50	22.70±1.23^{b}	18.40±2.33^{c}	14.10±1.06^{d}
1% CBEC	27.50	25.87±1.67^{a}	24.23±1.36^{b}	22.60±2.64^{c}
2% CBEC	27.50	25.57±2.87^{a}	24.63±0.28^{b}	23.70±1.74^{b}
3% CBEC	27.50	25.90±1.03^{a}	25.00±2.11^{a}	24.10±2.39^{a}

Remark: Corn cob-based cellulose (CBEC), Different letters in the same column indicate significant differences according to Duncan's test at $P<0.05$. ns is not significant difference.

Conclusion

This study demonstrated the successful extraction of cellulose from corn cob biomass and its application as a component of an edible coating system for pear (*Pyrus communis* L.). The developed cellulose-based composite coating effectively preserved fruit quality by reducing weight loss, maintaining firmness and color, and retaining higher ascorbic acid content during 2 weeks of ambient storage compared to uncoated fruits. These effects may be attributed to the formation of a semi-permeable barrier that delays respiration and ripening processes. Although the results indicate promising potential, it is important to note that the coating represents a composite formulation, and the individual contributions of each component require further investigation. Additionally, while corn cob-derived cellulose provides a value-added use of agricultural waste, the chemical extraction process may limit sustainability unless optimized using greener approaches. Future research should focus on evaluating barrier properties (such as water vapor and gas permeability), coating thickness, and respiration rate to better understand the coating mechanism. In addition, microbial analysis and sensory evaluation are needed to assess antimicrobial effectiveness and consumer acceptability. Further studies on process optimization, large-scale production, and environmentally friendly extraction methods are also required to improve practical application and sustainability.

Conflict of interest

The authors declare that they have no conflict of interest.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the author(s) used Turnitin and Grammarly for similarity checking and enhancing language clarity and improving grammar. The final content was reviewed and edited by the author(s), who take full responsibility for the accuracy and integrity of the publication.

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