# SYNTHESIS, CHARACTERIZATION AND APPLICATIONS OF CELLULOSE FROM DISCARDED CIGARETTE BUTTS

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**Keywords:**

Discarded cigarette butts (DCBs), Cellulose acetate (CA), Cellulose, Carboxymethyl Cellulose (CMC), Cyrene, β-D-glucopyranosyl, Cationic dye



**Introduction:**

Discarded cigarette butts (DCBs) pose a significant global environmental issue due to their inability to biodegrade and the presence of toxic agents in filters. Cigarettes consist of a filter, tobacco, additives, and wrapper, with filters made from cellulose acetate fibers (CA), which are poorly degradable. Tobacco leaves have various colors, tastes, burning properties, aromas, and nicotine content, which can cause addiction and be a strong insecticide. Tobacco additives, such as flavorings and humectants, are mixed with tobacco during manufacturing. The paper used to wrap tobacco is typically made of flax or linen fiber and contains various chemical substances to control or accelerate the burning rate. DCBs have evolved from plastic to cellulose acetate, which is resistant to microbial degradation, making them environmentally persistent. The estimated volume of DCBs produced worldwide and their persistence suggest the need for efficient disposal or recycling strategies. Cellulose, a linear homopolymer of repeating β-D-glucopyranosyl units, can be converted into water-soluble gums through substitution.

Cyrene synthesis is a promising green solvent derived from cellulose, offering numerous environmental and economic advantages over traditional solvent production methods. The synthesis of CMC from cellulose offers several advantages over traditional methods, including the utilization of renewable feedstocks, reduced environmental impact, and enhanced sustainability. Cyrene exhibits excellent biocompatibility, non-toxicity, and biodegradability, making it suitable for various applications in pharmaceutical formulations, food additives, personal care products, and industrial processes.

**Objectives:**

1. Separation of Cellulose acetate fibres from Discarded Cigarette butts.
2. Characterization studies of Cellulose Acetate

3. Separation of Cellulose from Cellulose Acetate
4. Characterization studies of Cellulose
5. Application - a) Preparation of Carboxymethyl Cellulose (CMC)

   b) Implementation of prepared CMC in removal of Cationic dye

   c) Preparation of Cyrene from Cellulose

**Methodology**:

***Obtaining high-quality cellulose acetate from cigarette butt***

The technique involves immersing discarded cigarette butts in hot water for 60 minutes, then rinsing three times in cold water to preserve the carbon fiber, twice-washing with 99% w/w ethanol to eliminate organic components, and drying the collected CA sample for 60 minutes.

***Separation of Cellulose from High Quality Cellulose Acetate***

Deacetylation of CA fibers, which produces cellulose, involves eliminating acetyl groups using aqueous or alcoholic alkali solutions. Factors like solvent type, alkali concentration, and liquid-to-fiber ratio influence the process. Deacetylation with 1M ethanolic NaOH is more effective and uniform than aqueous alkali. Fibers are treated for 180 minutes, washed, treated in 0.1N aqueous HCl, and rinsed before drying and collecting. CA is more hydrophobic than cellulose due to its hydroxyl functionalities being acetylated.

***Preparation of Carboxymethylcellulose from Cellulose***

The synthesis of carboxymethyl cellulose (CMC) involves adding amorphous cellulose to a solvent mixture of ethanol and water, stirring magnetically. After 50 minutes, NaOH is introduced to initiate an alkalization reaction at 30°C, activating the cellulose. Monochloroacetic acid (MCA) is added to the reaction mixture at 65°C, acting as a carboxymethylation agent. Stirring for 3 hours ensures thorough mixing and optimal carboxymethylation. The resulting solution is neutralized with hydrochloric acid (HCl) to adjust pH and stabilize the solution. The solution is then filtered to remove impurities and by-products, leaving the desired CMC product. The residue is dried to ensure purity and stability.

***Preparation of Cyrene from cellulose***

Cyrene is produced through two main stages: catalytic pyrolysis of cellulose to produce levoglucosanone (LGO) and catalytic hydrogenation of LGO to yield Cyrene. The pyrolysis process is complex, while the hydrogenation step typically achieves yields exceeding 90%. LGO production strategies are classified into three categories: direct LGO production from cellulose pyrolysis post-catalyst impregnation, catalytic pyrolysis in the gas phase using solid catalysts, and catalytic pyrolysis in the liquid phase using liquid catalysts. Sulfated zirconia, mesoporous catalysts, and P-Mo/SnO2 are used for fast pyrolysis of cellulose, while solid catalysts promote the catalytic pyrolysis of initial pyrolysis products. The pyrolysis-induced indirect production of LGO in the liquid phase involves hydrolysis with water, pyrolysis without water, and soaking cellulose in phosphoric or sulfuric acid. Cyrene, a solvent created by the Green Chemistry Centre of Excellence, is produced by hydrogenating LGO at both high and low pressures.

**Conclusion:**

1. Synthesis of High-quality Cellulose acetate fibres from Discarded Cigarette butts.
2. Separation of cellulose from High-quality cellulose acetate and its Characterization study
3. Preparation of Carboxymethyl cellulose from Cellulose, Characterization study and its application in dye absorption.
4. Preparation of Cyrene from Cellulose

Cigarette waste can be recycled into raw material for new products, with the main component being cellulose acetate. A methodology is proposed to purify this polymer using different solvents. Fourier-transform infrared spectroscopy and thermo gravimetric analysis were used to characterize the purified CA. The recovered CA has the same chemical and thermal properties as unused CA without altering material properties. The study suggests designing fibers with specific cellulose levels for specific applications.

The study demonstrates the potential of cellulose extracted from discarded cigarette waste to create high-value products like carboxymethylcellulose (CMC) and Cyrene. This research offers a holistic approach to waste management and resource utilization, addressing environmental concerns and economic opportunities. The development of scalable processes and ongoing efforts to explore additional product avenues demonstrate the commitment to a more sustainable future. The transformation of waste into valuable commodities holds promise for positive environmental, social, and economic outcomes.

**Scope for future work:**

1. Assessment of Toxic Agents in Discarded Cigarette Butts (DCBs)
2. Development of Environmentally Friendly Recycling Methods
3. Synthesis and Characterization of Carboxymethyl Cellulose (CMC) from DCBs
4. Application of CMC in Dye Adsorption
5. Economic and Environmental Impact Analysis