MASTER OF SCIENCE (BIOTECHNOLOGY) [JYOTI SHARMA] 2023

ISOLATION, TREATMENT, AND CHARACTERIZATION OF MICRO CELLULOSE PRODUCTION FROM ORGANIC WASTE

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE AWARD OF THE DEGREE

OF

Master of Science

In

Biotechnology

Submitted by:

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CANDIDATE'S DECLARATION

I **Jyoti Sharma**, Roll Number: **2K21/MSCBIO/17** student of M.Sc. Biotechnology, hereby declare that the project dissertation titled - **"Isolation, Treatment, and Characterization Of Micro Cellulose Production From Organic Waste"** which is submitted by me to the department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Science, is original and not copied from any source with proper citation. This work has not previously formed the basis for the award of any degree, Diploma Associateship, fellowship or other similar title or recognition.

The details of the conference paper are given below:

Title of Conference Paper: Utilizing agricultural waste derived nanoparticles for wastewater treatment: A synergistic step toward circularity and sustainability

Name of Authors: Jyoti Sharma, Tanya Srivastava and Jai Gopal Sharma

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CERTIFICATE

I hereby certify that the Project Dissertation titled "**Isolation, Treatment, and Characterization Of Micro Cellulose Production From Organic Waste**" which is submitted by **Jyoti Sharma** , Roll No.: **2K21/MSCBIO/17**, Department of Biotechnology, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Science, is a record of the project work carried out by the student under my supervision. To the best of my knowledge, this work has not been submitted in part or full for any Degree or Diploma to the University or elsewhere.

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ABSTRACT:

Micro cellulose, the versatile biopolymer derived from cellulose, which is flexible and numerous, has a lot of potential for use in a variety of industrial applications. The isolation, treatment and cellulose characterization produced from organic waste sources are the main topics of this study. Establishing a sustainable and effective process for extracting micro cellulose from waste materials will help protect the environment and open up new waste management opportunities. The research methodology has a number of steps. Initially, organic waste products (Apple peels, Potato peels) are collected and processed. Advanced analytical methods, such as Fourier transform infrared spectroscopy (FTIR), Particle Size Distribution are used to characterize the resultant micro cellulose. The produced micro cellulose can be used in a variety of industries, including the textile industry, biomedical equipment, packaging materials and the creation of renewable energy. Overall, this research helps to provide a sustainable method for harvesting micro cellulose from organic waste sources. It encourages waste management procedures while lowering reliance on non-renewable resources by turning garbage into a useful resource. The final results of the micro cellulose characterization will enable the production process to be optimized and new uses to be investigated, promoting circular economy and more sustainable.

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I would like to use this time to offer my sincere gratitude and appreciation to my supervisor **Prof. Jai Gopal Sharma** who has helped me along the way. I am extremely appreciative of the possibilities and experiences I have had as a consequence of your unfailing support, advice, and encouragement. I appreciate your confidence in me and your unwavering support in my research.

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CHAPTER 1. INTRODUCTION

Recent years have seen a rise in creative waste management tactics due to rising environmental sustainability concerns around the world and the rapid accumulation of organic garbage. The need for sustainable materials has increased at the same time and for a variety of uses. Micro cellulose, a biopolymer made of microscopic cellulose, has become known as a viable solution to both problems. Micro cellulose may be extracted, measured, and characterized from organic waste, which has enormous promise for resource efficiency, waste valorization, and the creation of environmentally benign materials.

1.1 Organic Waste Accumulation

The global waste stream is significantly made up of organic waste, such as agricultural waste, food waste, and biomass. Organic waste management and disposal done improperly can result in health risks, greenhouse gas emissions, and environmental damage. In order to turn organic waste into useful resources, there is an increasing demand for efficient waste management techniques.

1.2 Cellulose and Micro cellulose

Plant cell walls mostly consist of cellulose, a linear polymer made of glucose units. It is a desirable material for many applications due to its exceptional mechanical qualities, biocompatibility, and biodegradability. Micro cellulose is a term used to describe cellulose fibers or particles with diameters in the nanometer range that are typically produced through mechanical or chemical processes. Micro cellulose has special qualities like high surface area, crystallinity, and aspect ratio that make it excellent for a variety of uses, including scaffolds in tissue engineering, additives in coatings, and reinforcing agents in composites.[1]

1.3 Isolation of Micro cellulose from organic waste

The choice of appropriate waste sources is essential in order to extract micro cellulose from organic waste. The cellulose content, chemical makeup, and accessibility of various organic waste materials, such as agricultural residues (such as rice straw, sugarcane bagasse, or other lignocellulosic biomass), food waste, or other waste products, may differ. These elements affect the viability and effectiveness of micro cellulose extraction. In this thesis we took Apple peels and Potato peels as our organic waste.

A series of pretreatment processes are taken during the isolation process to clean up contaminants, increase cellulose accessibility, and boost the effectiveness of subsequent processing. Pretreatment techniques like washing, drying, grinding, and size reduction are frequently used. These procedures enhance the release of cellulose fibers by helping to remove non-cellulosic elements like lignin and hemicellulose.[2]

After pretreatment, micro cellulose is separated from the cellulose-rich fraction using purification procedures. There are numerous approaches, including chemical and enzymatic processes. Purified micro cellulose is produced via chemical processes that require the use of acids, alkalis, or solvents to dissolve or alter non-cellulosic components. Cellulase enzymes are used in enzymatic methods to preferentially hydrolyze non-cellulosic materials and isolate micro cellulose with high purity.[3]

1.4 Quantification step

To evaluate how effective the isolation procedure is, the micro cellulose yield must be quantified. Commonly used methods include gravimetric analysis, which measures the weight of separated micro cellulose after drying and purification. Quantitative analysis can also be done using other techniques, such as spectrophotometric analysis based on the response of cellulose with certain dyes or enzyme assays. We used spectrophotometric analysis which was performed after an anthrone test that was carried out for confirmation of cellulose.[4]

1.6 Characterization

Micro cellulose's morphology, which includes particle size, shape, and surface structure, has a big impact on its characteristics and uses. The morphology of micro cellulose particles can be seen and examined using the techniques of scanning electron microscopy (SEM) and atomic force microscopy (AFM). Micro cellulose's mechanical durability, enzymatic digestibility, and chemical reactivity are all influenced by its crystalline structure. A common method for determining the crystallinity index and crystalline structure of micro cellulose samples is X-ray diffraction (XRD).

Micro cellulose's chemical makeup is regularly identified and studied using Fourier-transform infrared spectroscopy (FTIR). It enables for the characterization of chemical changes or impurities and offers information about the functional groups that are present in the substance. For many uses of micro cellulose, thermal stability is a crucial quality. Micro cellulose's thermal stability, decomposition temperature, and heat flow characteristics are evaluated using methods including thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). We specifically used FTIR and Particle Size Distribution for characterization.[5]

A possible path to waste valorization, sustainable material creation, and resource efficiency is the extraction, measurement, and characterization of micro cellulose from organic waste. Utilizing organic waste as a renewable resource for micro cellulose manufacturing helps with waste management, has a smaller negative impact on the environment, and encourages the circular economy. Micro cellulose can also have its characteristics and capabilities customized by different treatments and alterations, making it suitable for a variety of industrial applications. Environmental issues can be addressed and the transition to a more sustainable future can be facilitated with continued study and development in this area.[6]

CHAPTER. 2 REVIEW OF LITERATURE

2.1 Cellulose and its applications

2.1.1 Introduction of cellulose and its structure

A complex carbohydrate named cellulose acted as the primary structural element of cell walls of plants. It is one among the most prevalent organic substances on earth and is essential to the ecological systems. Glucose monomers are repeated units that make up the polymer cellulose. Long linear chains are created when these monomers are joined together by -1,4-glycosidic linkages. These chains are arranged in a very organized manner, with neighboring chains establishing hydrogen bonds to form sturdy, fibrous structures. This structure provides cellulose with its strength and extraordinary rigidity.

2.1.2 Properties of cellulose

Numerous distinctive characteristics of cellulose contribute to its diverse variety of uses. First off, it is highly resistant to deterioration because it is not soluble in water and the majority of organic solvents. Second, cellulose is highly affine to water due to its hydrophilic nature. This characteristic enables cellulose to absorb and hold onto water, which contributes to its use as a natural fiber and in plant cells. The great tensile strength of cellulose makes it an advantageous material for a variety of industrial applications.[7]

2.1.3 Functions of cellulose

I. Function of cellulose in plants: Cellulose is an essential structural element found in plants. It gives plant cell walls rigidity and strength, enabling them to tolerate mechanical pressures and preserve their shape. Layers of cellulose fibers provide the tissues of the plant their structural integrity. Additionally, cellulose aids in cell-to-cell adhesion, which facilitates the movement of nutrients and water throughout the plant and the development of tissues.

II. Digestion and Utilization of cellulose: Although cellulose helps support the structural integrity of plants, most mammals lack the enzymes required to breakdown it. However, some creatures, including termites and ruminants (cattle, sheep, etc.), have symbiotic microbes that can break down cellulose in their digestive tracts. Cellulases, which are produced by these bacteria, hydrolyze cellulose generating units of glucose which can be used as an energy source.

III. Industrial and Commercial applications of cellulose: There are multiple uses for cellulose across numerous industries. The manufacture of paper and paper products is one of its most notable applications. To extract cellulose fibers from a source of cellulose, pulp from wood, which are then used to produce paper. Due of their durability and absorption capabilities, cellulose-based polymers are also used in textiles like cotton and rayon. In the creation of coatings, adhesives, films and composites, cellulose derivatives are used. For instance, the production of films for photography and the coating of textiles both employ cellulose acetate. The pharmaceutical and food sectors frequently use cellulose ethers, such as methylcellulose and hydroxy ethyl cellulose, as emulsifiers, stabilizers, and thickeners.[8]

IV. Cellulose in Biomedical and Pharmaceutical industries: For use in medical and pharmaceutical applications, cellulose is ideal due to its biocompatibility and biodegradability. Nanocellulose and other cellulose-based materials can be utilized to make tissue engineering scaffolds, medication delivery systems, and bandages for cuts and scrapes. These materials provide benefits include the ability to sustain cell development, regulated medication release, and excellent water-holding capacity.

2.2 Micro cellulose and it’s applications

Microcrystalline cellulose (MCC), also known as micro cellulose, is a flexible highly used material made from cellulose, a naturally occurring polymer that exists in the cell walls of plants. It is mostly made up of tiny, thin cellulose particles, or microcrystals.

I. Pharmaceutical: Due to its special qualities, micro cellulose is frequently used in the pharmaceutical business. It aids in enhancing powder flowability, tablet dissolving and disintegration, and mechanical strength of tablets. Additionally, it is utilized as filler material in capsules and as a direct compressing binder.

II. Food and Beverage industries: Micro cellulose is used as an additive to food in the food business with a variety of functions. It can serve as a fat substitution, giving low-fat food products a creamy feel. The taste of processed foods is enhanced and phase separation is prevented by using it as a stabilizer in dairy products.[9]

III. Cosmetics: Many cosmetic and personal care items, such as creams, lotions, sunscreen products, and cosmetics, include micro cellulose. It improves the product's stability and sensory qualities by acting as a texturizer, absorbent, and bulking agent.

2.3 Why Organic Waste?

There are many advantages of using organic waste to produce Micro cellulose:

I. Resource efficiency and waste reduction: Utilizing organic waste to make micro cellulose enhances resource efficiency and reduces waste. Materials that would otherwise be disposed of in landfills can instead be reused and made into useful items.

II. Sustainability of Environment: If organic garbage is not processed, it may produce dangerous greenhouse gases. We can decrease the impact on environment and promote sustainability by turning it into micro cellulose. It lessens the need for virgin resources like wood pulp and minimizes the carbon footprint linked to trash disposal.[10]

III. Economical benefit: The ideals of a circular economy are supported by the use of organic waste in the production of micro cellulose. It reduces the need for additional raw materials and promotes a more regenerative system and sustainable by closing the loop and recycling waste materials.

IV. Public health and waste management: For the maintenance of public health and hygiene, proper handling of organic waste is essential. We address waste management issues and lower the danger of disease transmission, pollution, contamination linked to untreated trash by using it to produce micro cellulose.[11]

V. Versatility: Organic waste-derived cellulose can be used in a variety of goods and industries. It can be used to make a variety of products, including textiles, paper, packaging supplies, biofuels, and bioplastics. By broadening the uses for cellulose, we can encourage a greater economically sustainable and minimize our reliance on goods made from fossil fuels.

2.4 Anthrone Test

Anthrone test is a group test for measuring the amount of carbohydrates that are either free or bound to any lipids or proteins. It is a quick and practical approach.

2.4.1 Objectives of Anthrone Test

A chemical assay called the Anthrone test is used to find the presence of carbohydrates, especially monosaccharides and some disaccharides. The Anthrone test's goal is to establish the presence or concentration of carbohydrates in a particular sample. In a variety of disciplines, such as biochemistry, food science, and pharmaceutical analysis, this test is frequently used.

The Anthrone test uses a combination of Anthrone (1,5-dihydroxynaphthalene) mixed in sulfuric acid as the Anthrone reagent, which reacts with carbohydrates to produce the desired results. When the Anthrone reagent is heated with carbohydrates, a complex is created that absorbs visible light, changing the colour from pale yellow to a strong green-blue. The amount of carbs in the sample directly relates to how intense the colour is.

The Anthrone reagent is normally added to the sample, and the combination is then heated to conduct the test. After cooling, a spectrophotometer is used to determine the absorbance of the coloured solution that results. The carbohydrate concentration in the sample can then be determined by comparing the absorbance value to a standard curve created using known concentrations of a carbohydrate. In complicated mixtures, such biological samples or food products, where carbs may be present in different amounts, the Anthrone test gives a quantitative determination of carbohydrates and is very helpful in these situations.[12]

In conclusion, the Anthrone test's goals are to identify and measure the concentration of carbohydrates in a sample. Researchers and analysts can use this test to determine whether certain compounds contain carbs or not, which helps with product characterisation and quality control in a variety of industries, from biochemistry to food science.

2.4.2 Principle of Anthrone Test

Furfural is created when carbohydrate reacts with concentrated H2SO4. When this furfural and anthrone interact, a bluish-green colored complex results.

2.5 UV-Visible Spectroscopy

The amount of different wavelengths of UV or visible light that are absorbed or transmitted through a sample cuvette in contrast to a reference or blank sample is measured by the analytical technique known as UV-Vis spectroscopy. [13]

According to the Beer-Lambert equation, the concentration of the absorbing species in the solution and the length of the path are exactly proportional to the absorbance of a solution.

$$A= Ecl$$

where, A - absorption

E - molar extinction coefficient

L – pathlength

The absorption or transmission of light in the ultraviolet and visible portions of the electromagnetic spectrum is measured using the widely used analytical approach known as ultraviolet-visible (UV-Vis) spectrophotometry. It is frequently used in many disciplines, including chemistry, biology, pharmacology, environmental research, and materials science, and it gives useful information on the concentration of absorbing species in a sample.

A spectrophotometer is used in UV-Vis spectrophotometry to measure the light's intensity both before and after it passes through a sample. A light source that emits a wide spectrum of light, a mono chromator that chooses a particular wavelength of light, a cuvette or sample holder to hold the sample, and a detector that gauges light intensity make up the instrument.[13]

The amount of light absorbed or transmitted is measured after the light passes through the sample in the spectrophotometer. The chemical makeup and concentration of the sample affects the absorption or transmission of light. In order to account for any background absorption, measurements are also made using a blank solution made up of the same solvent as the sample.

Because it is quick, non-destructive, and capable of providing quantitative data about a variety of analytes, UV-Vis spectrophotometry is a potent approach. It permits quick and precise measurements of sample concentration and is frequently used in routine analysis and quality control. Additionally, the electronic structure and chemical bonds of molecules can be revealed by UV-Vis spectroscopy, which is helpful for identifying compounds and researching reaction kinetics. All things considered, UV-Vis spectrophotometry is a flexible and trustworthy method for determining the concentration and composition of materials in a variety of scientific fields. (1)

2.6 FTIR (Fourier Transform Infrared) Spectroscopy

2.6.1 Principle

This technique is used to identify unknown material, even a fine difference can be detected. It’s principle is that Some of the infrared (IR) light is absorbed when it travels through a sample. It is noted which radiation enters the sample. [14]

2.6.2 Advantages

First off, the non-destructive nature of FTIR spectroscopy is one of the method's key benefits. The originality of the original material is preserved by FTIR because it doesn't require sample preparation or manipulation, unlike certain other analytical techniques. With the help of this non-destructive function, precious or small samples can be analyzed without sacrificing their suitability for use in subsequent tests or applications. Additionally, it makes it possible to examine fragile or sensitive samples that could degrade or change.

Second, FTIR spectroscopy offers useful insights into the make-up and structure of molecules. The method enables the identification and characterization of diverse compounds because to its high sensitivity to chemical bonds and functional groups. The determination of molecular structure, the identification of unidentified compounds, and the evaluation of sample purity are all made possible by FTIR by analysing the absorption peaks in the infrared spectrum to reveal information about the kinds of chemical bonds that are present.

The far-infrared, mid-infrared, and near-infrared spectrums are all covered by FTIR spectroscopy, which also offers a broad spectral range. This wide range enables the study of a variety of materials, including polymers, liquids, gases, solids, and organic and inorganic substances. Because of its adaptability, FTIR spectroscopy is used in a variety of industries, including materials science, forensics, environmental analysis, and pharmaceuticals.

FTIR spectroscopy also provides quick data collection and analysis. The approach uses interferometry to simultaneously analyse the full infrared spectrum, leading to quicker analysis times than traditional infrared spectroscopy techniques. When working with time-sensitive samples or when high-throughput analysis is necessary, this benefit is especially helpful. Furthermore, the accessibility of cutting-edge databases and software enables effective spectrum interpretation and comparison with reference spectra, enabling accurate and trustworthy results.

FTIR spectroscopy has several benefits, including its non-destructive nature, capacity to provide information about the structure and composition of molecules, wide spectral range, and speedy data collecting. Because of these benefits, FTIR spectroscopy is a useful tool for a variety of applications, including basic research, quality control, and process monitoring in a variety of industries. [14]

2.7 Particle Size Distribution

The description of particles in a sample based on their sizes is known as particle size distribution. It offers useful data on particle size distribution, which is essential for comprehending the physical and chemical characteristics of materials in a variety of sectors.[15]

The importance of particle size in affecting the behavior and performance of materials is first highlighted in the introduction to particle size distribution. Important characteristics like solubility, reactivity, flow ability, stability, and bioavailability are impacted by particle size. For processes to be optimized, products to be of the highest quality, and required performance attributes to be achieved, particle size distribution must be understood and controlled.

The many methods utilized for particle size analysis could be highlighted in the second paragraph. Sieving, sedimentation, laser diffraction, dynamic light scattering, and microscopy are a few of the techniques that can be used to measure and examine particle size distribution. The choice of approach depends on elements such the particle size range, sample type, desired accuracy, and sample number. Each technique has advantages and drawbacks.

The significance of precisely assessing particle size distribution for certain applications can be covered in the third paragraph. Particle size is important for product development, formulation optimization, quality control, and process effectiveness in sectors like medicines, food and beverage, cosmetics, chemicals, and minerals. For instance, in the pharmaceutical industry, particle size distribution has an impact on the bioavailability, stability, and rates of drug dissolution. It affects the texture, mouthfeel, and sensory qualities of food. The creation of nanoparticles, filtration, and particle separation processes all require an understanding of the particle size distribution.[15]

The complications and difficulties involved with particle size analysis may be highlighted in the final paragraph. Sample heterogeneity, agglomeration, irregular particle morphologies, and the presence of tiny or coarse particles can all have an impact on particle size distribution. To achieve trustworthy and meaningful results, accurate and representative sample, appropriate dispersion procedures, and correct data interpretation are essential. Additionally, effective summarization and communication of the particle size distribution information is aided by data analysis and reporting techniques like cumulative distribution plots, mean particle size, and span indices.

In conclusion, particle size distribution is an important factor that affects how materials behave and function across a range of sectors. Particle size distribution may be accurately measured and analyzed to reveal important information that is useful for process improvement, quality assurance, and product development. In order to ensure accurate and significant results for sound decision-making, it is essential to comprehend the difficulties posed by particle size analysis.22

2.7.1 Definition

The size and range of the particles that are indicating given substance are identified and reported using a Particle Size Distribution Analysis (PSD).

2.7.2 Principle

Based on the intensity and angle of light that scatters from the particles, this principle states that light scatters from larger particles at a smaller angle and with a higher intensity than light scatters from smaller ones.

CHAPTER 3. METHODOLOGY

3.1 Sample Preparation

I. The fresh Apples and Potatoes were washed and peeled separately.

II. The peels were put on newspaper and let it dry under the sun for 4 days.

Fig.3.1 Apple peels drying

III. A fine powder sample was obtained by mortar pestle as well as grinder.

3.2 Pretreatment

I. Pulping process: 100 gm of biomass with 1L of 10% NAOH is mixed.

II. The mixture was set for heating up to 160°C for 2 hours.

Fig.3.2 Apple peel pulp after heating

III. After this, it was kept for filtering, after the filtration process the potato peel sample was not filtered out and some jelly like texture appeared.

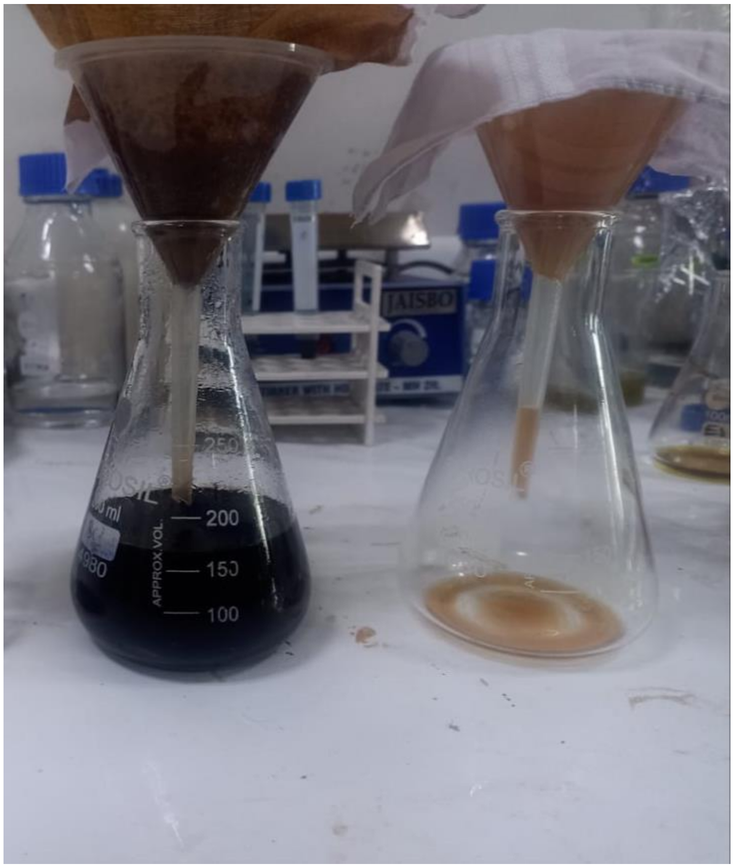

Fig.3.3 Filtration of apple and potato sample

Fig.3.4 Failed filtration of potato sample

IV. The fibers were kept for drying in air

Fig.3.5 Air Drying of sample (apple)

V. Those fibers were subjected to acidic hydrolysis (10 gm of sample plus 200 ml of 20% H_2SO_4 and was heated at 120°C for 30 min with constant stirring).

VI. A paste like texture appeared then 1500 ml frozen distilled water was added to quench the reaction.

VII. After that the suspension was kept for filtration for 24 hours.

VIII. Next day, the neutralization step was performed by adding 5% $NaHCO_3$ until the pH of 7-8 was achieved.

IX. After that, the suspension was centrifuged at 6000 rpm for 15 min.

Fig.3.6 Sample after centrifugation

X. Supernatant was decanted and washed with distilled water.

XI. The last 2 steps were performed 2 times until the pH 7 was attained.

3.3 Quantification of Micro cellulose

I. For quantification of cellulose, an anthrone test was carried out.

II. Reagents used for anthrone test: Anthrone, concentrated H_2SO_4, Glucose stock solution.

III. Anthrone reagent was prepared by adding 0.2 gm of anthrone in 100 ml of H_2SO_4.

IV. A stock solution of glucose was prepared by mixing 0.01 gm in 10 ml of water.

V. 11 test tubes were taken and glucose solutions of different concentrations were prepared using the stock solution in concentration of 10µg, 20µg, 40µg, 60µg, 80µg, 100µg, 120µg, 140µg, 160µg, 180µg and 200µg.

VI. 4 test tubes of our sample (with unknown concentrations) was taken of different pH.

VII. 5ml of anthrone reagent was added to all 15 test tubes and vortex.

VIII. All the tubes were covered and incubated in water bath for 15 min.

IX. After that the tubes were cool at room temperature and optical densities were measured of all the test tubes at 620 nm.
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X. Anthrone was taken as blank and after getting all the readings, a standard curve was prepared of absorbance against glucose concentrations.

XI. The unknown concentration of our samples was calculated by the standard curve of glucose.

XII. 1 more optical density was also measured of original apple powder (without pretreatment) for comparison.

3.4 Characterization

For characterization step two techniques were used FTIR (Fourier Transform Infrared) Spectroscopy and Particle Size Distribution.

CHAPTER 4. RESULTS

4.1 Quantification Of Micro cellulose

- For quantification, Anthrone test was carried out and after this the optical densities at 620 nm were measured.

Table 4.1 Optical densities of glucose at different concentration

S.no.	**Concentration**	**Glucose (V)**	**D.H2O**	**Anthrone**	**Absorbance**
1	10 µg	10 µl	990	5 ml	0.093
2	20 µg	20 µl	980	5 ml	0.205
3	40 µg	40 µl	960	5 ml	0.244
4	60 µg	60 µl	940	5 ml	0.264
5	80 µg	80 µl	920	5 ml	0.408
6	100 µg	100 µl	900	5 ml	0.522
7	120 µg	120 µl	880	5 ml	0.622
8	140 µg	140 µl	860	5 ml	0.766
9	160 µg	160 µl	840	5 ml	0.863
10	180 µg	180 µl	820	5 ml	0.992
11	200 µg	200 µl	800	5 ml	1.360

- The unknown concentrations were calculated with the help of a standard plot of the original sample (before pretreatment) and after pretreatment.

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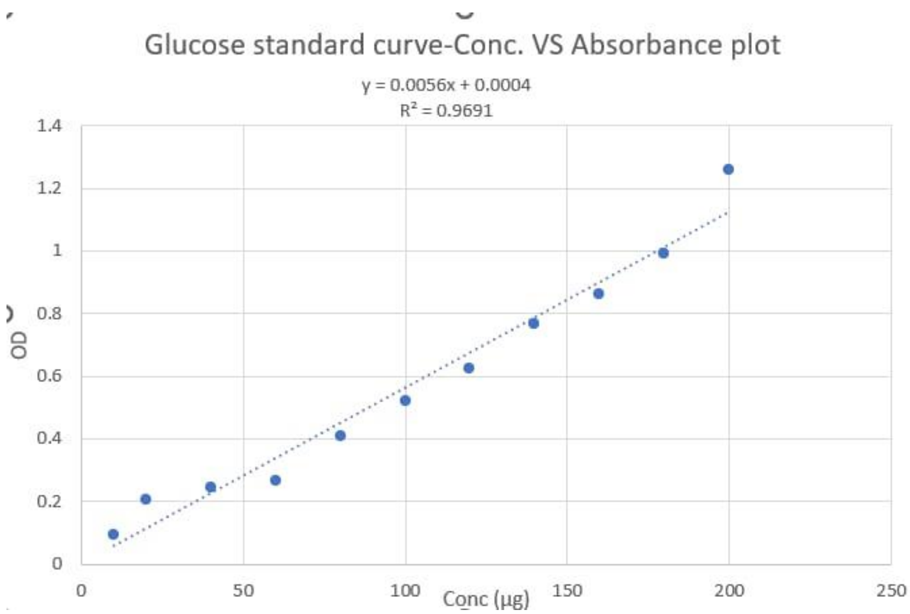

Fig. 4.1 Glucose Standard curve- Concertation v/s absorbance plot

Table 4.2 Concentration and absorbance before treatment

Sample	**Concentration**	**Absorbance**
AP (0.01)	4.559322 µg	0.026
AP (0.1)	101.765 µg	0.909

Table 4.3 Concentration and absorbance after treatment

Sample	**Concentration**	**Absorbance**
AP 01	13.30505	0.074
AP 02	438.4327	2.463

AP 03	15.2414	0.086
AP 04	193.8114	1.089

4.2 Characterization Of Micro cellulose

4.2.1 FTIR (Fourier Transform Infrared) Spectroscopy

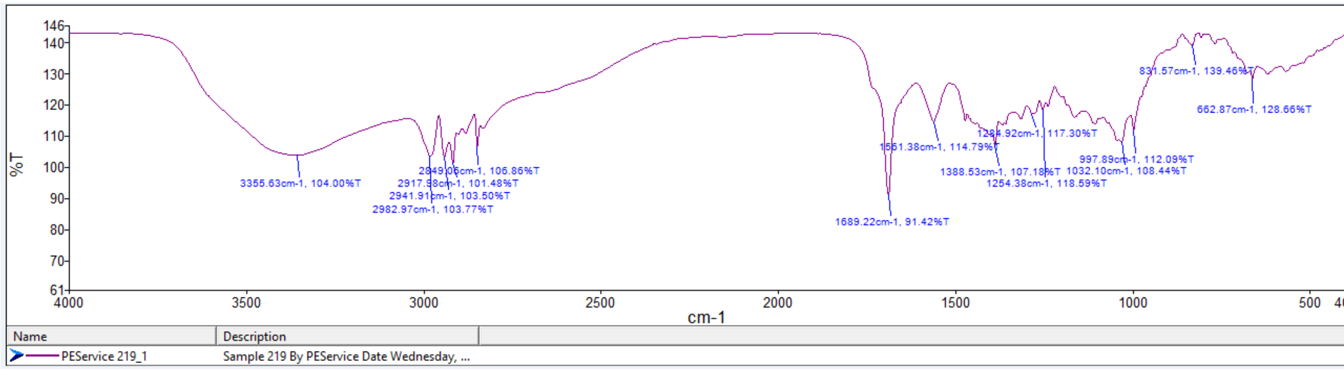

Fig.4.2- Graph showing FTIR spectroscopy result

Table 4.4 Absorption bands for cellulose

Fiber Component	**Wave number (cm_1)**
Cellulose	4000-2995
	2890
	1640
	1270-1232
	1170-1082

4.2.2 Particle Size Distribution

Sample Details

Sample Name:	3
SOP Name:	mansettings.nano
General Notes:	

File Name:	Sachin.dts	**Dispersant Name:**	Water
Record Number:	1741	**Dispersant RI:**	1.330
Material RI:	1.54	**Viscosity (cP):**	0.8872
Material Absorbtion:	0.010	**Measurement Date and Time:**	26 May 2023 13:03:38

Fig.4.3- Sample details

System

Temperature (°C):	25.0	**Duration Used (s):**	20
Count Rate (kcps):	175.0	**Measurement Position (mm):**	4.65
Cell Description:	Disposable sizing cuvette	**Attenuator:**	7

Results

			Size (d.n...	% Intensity:	St Dev (d.n...
Z-Average (d.nm):	5358	**Peak 1:**	4989	100.0	534.3
PdI:	0.147	**Peak 2:**	0.000	0.0	0.000
Intercept:	0.970	**Peak 3:**	0.000	0.0	0.000
Result quality	**Refer to quality report**				

Fig.4.4- System details and Results

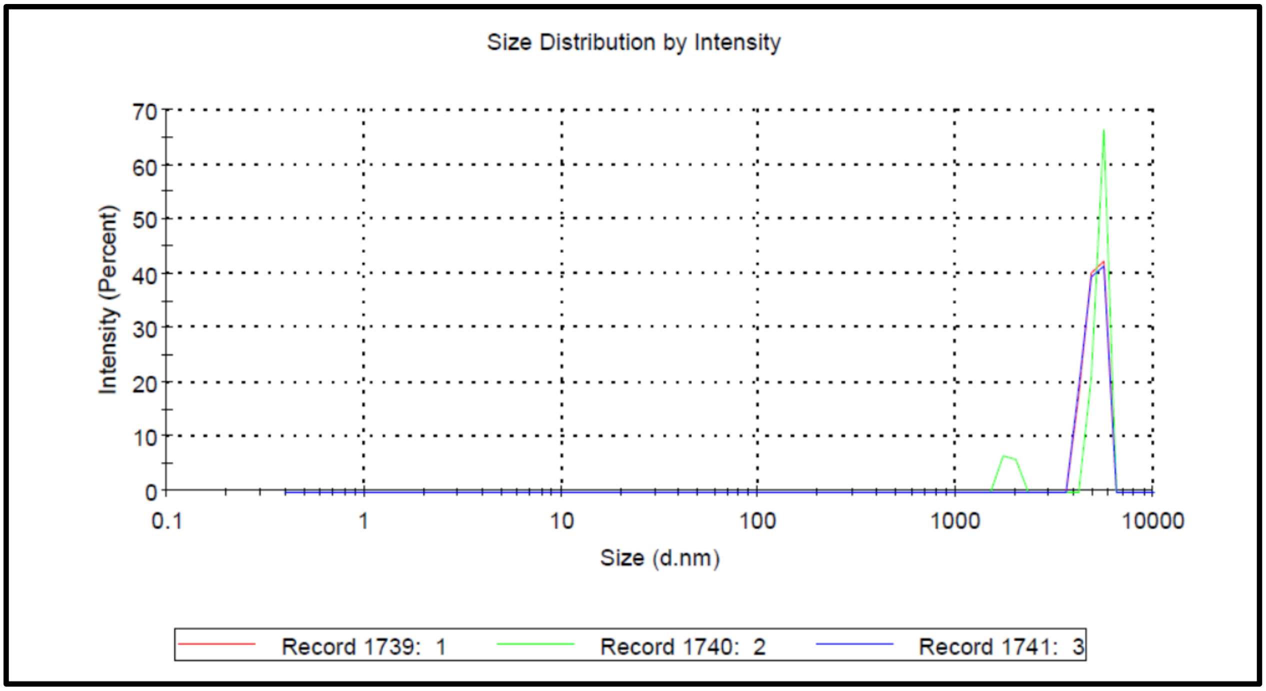

Fig.4.5- Particle Size Distribution Plot

4.3 Discussion

Micro cellulose is often thought to be safe for use in food and other applications. It is categorized as a food additive by regulatory organizations including the US Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA). The human body tolerates it well and it has a long history of safe use. Micro cellulose is made from renewable, plant-based materials, usually cotton and wood pulp. It is environmentally friendly compared to synthetic substitutes because it is biodegradable. Since the production process may involve chemical treatments, efficient waste management is necessary to minimize any potential environmental effects. Compared to ordinary cellulose, micro cellulose is more crystalline and has smaller particle sizes. As a result, functional characteristics are enhanced, including surface area, water absorption ability, and flow characteristics. These qualities make micro cellulose an important component in a variety of products, such as medications, foods, cosmetics, and coatings. Using Organic waste for producing micro cellulose will have many advantages like waste reduction, resource efficiency, circular economy, cost- effectiveness, environmental sustainability. The produced micro cellulose displayed favorable characteristics that made it appropriate for use in a variety of industries, including packaging, textiles, composites, and biomedical materials. Micro cellulose created from organic waste is sustainable and offers an eco-friendly substitute for traditional materials, helping to reduce waste generation.

4.4 Conclusion

The results show the presence of micro cellulose in apple peels. The difference between the amount of micro cellulose before treatment and after treatment proved the importance and need of treatment. The result from the anthrone test confirms the presence of cellulose in the sample. The optical densities that are measured by spectrophotometer helps to calculate the concentration of cellulose before and after the treatment. The FTIR result shows peaks at 2849 cm_1 and 2917 cm_1 which confirms the presence and show functional groups. The Particle Size Distribution result confirms the size 5358 nm which is equal to 5.358 µm. In summary, this work shows how to separate, prepare, and characterize micro cellulose from sources of organic waste. The results show how waste materials can be used as a valuable resource for the production of sustainable materials. The widespread use of micro cellulose-based goods may result from additional research and development in this field, opening the way for a future that is greener and more sustainable.

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