Synthesis of CNPs from beetroots and carrot Pomaces and Application in reduction of Color from waste water

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Abstract

Food sector produces million tons of waste. Out of which some is discarded as animal feed, as fertilizer or mostly treated as waste which further creates environmental hazards. The present study was done to utilize the waste pomace from vegetables – carrot and beetroot after juice extraction in the formation of Cellulose Nano Particles (CNPs). Pomaces of carrot and beetroot were treated with alkali treatment and bleaching treatment separately. So formed CNPs have shown good adsorption behavior and have shown good reduction in polluting parameters, specially colour was reduced upto 80% in waste water.

Key words: Cellulose nanoparticles, Green synthesis, Nano composite, Carrot.

Introduction

In recent years, nanocomposites have been a subject of increasing interest due of their significant properties. Nano-cellulose fiber materials are used for bio-nanocomposites production due to their abundance, high strength and stiffness, low weight, and biodegradability. Isolation, characterization, and search for applications of novel forms of cellulose—variously termed crystallites, nanocrystals, whiskers, nanofibrils, and nanofibers—are currently generating much activity[1-2]. Nanotechnology is engaged in preparing Nano Particles (NPs) with different sizes ranging from 1 to 100 nm. NPs have wide ranges of application in numerous areas such as: chemical industries, electrical industries, biomedical science, space industries, drug delivery, cosmetic industries, catalytic areas and other fields [3].

The cell wall is a composite of cellulose, hemicellulose and pectin, with the addition of other, non-polysaccharide components like proteins, lipids, enzymes and aromatic compounds. Generally, the primary cell wall is composed of approximately 25% cellulose, 25% hemicellulose and 35% pectins, with up to 8% structural proteins (on a dry-weight basis). Cellulose is a polycarbohydrate composed of glucose units linked by chemical β-1, 4-glycosidic bonds[4-5].

The food sector generates about million tons of by-products and waste every year which is left over after processing of fruits and vegetables, mainly after juice extraction. The pomaces sometimes are used as animal feed, as fertilizer, but still a part of pomaces is treated as waste and are discarded causing environmental problems like bad smell, air pollution. Coming to minimal or no environmental risk, fruits and vegetables waste can be used for making useful final products. The main residue after fruit and vegetable processing is pomaces containing pulp, peel, seeds, and stem [6-8]. Carrot (Daucus carota) is a highly nutritious root vegetable. On a dry weight basis, carrot pomace...
contains 28% cellulose, 2.1% pectin, 6.7% hemicellulose, and 17.5% lignin. Beetroot (Beta vulgaris) is a great source of fiber and vitamins. The waste from beetroot extraction is mainly used as animal feed. Beetroot pomace consists of approximately 40% cellulose, 30% pectin, and 30% hemicellulose based on the dry weight [9-10].

Cellulose is the most widely distributed natural polymer and it can be synthesized by using various biomasses. The development of cellulose nanoparticles is one of the most promising areas of research as the cellulose nanoparticle has very wide field of applications [11]. The cellulose nanoparticles have improved physical and chemical properties such as high specific area, high tensile strength, stiffness, low density [12]. Due to improved physical and chemical properties the use of cellulose nanoparticles was increasing tremendously. In the last few years there are so many researches were carried out to develop new methods for the synthesis of cellulose nanoparticles. A cellulose nanoparticle was generally synthesized by the degradation of raw cellulose materials [13-14]. The synthesis of cellulose nanoparticles by using waste cellulose material was one of the best alternative eco-friendly method. Hence in the present report we proposed the biosynthesis of cellulose nanoparticles by using waste material of carrot and beet root.

Materials and Method
Preparation of pomace

Carrot and beetroot were collected from local market. Juice was extracted from both carrot and beetroot separately by using juicer and pomace were collected. Separately pomace of carrot and beetroot were dried under sunlight and crushed into powdered form by using grinder.

Extraction Process

Alkali treatment was given to both pomaces by treating 5g of pomace sample with 100ml 2% NaOH solution and kept for stirring at 75°C at 800 rpm for continuously 90 minutes. Excess of alkali was washed off by vacuum filtration and bleaching treatment was given after drying the samples. Bleaching was done by using 100ml bleaching solution of 1:1 sodium hypochlorite and glacial acetic acid. The sample were kept on magnetic stirrer for 90 minutes at 70°C at 800 rpm and then filtered and dried in an air oven for 6 hours at 50°C and CNPs from carrot and beetroot pomace were collected as shown in following figures (1-2).

Application study

So formed Cellulose nano-particles (CNPs) were added in 100 ml of synthetic waste water prepared in lab and stirred and then filtered with whatman filter paper No.1. Polluting parameters like, Total suspended solids, TDS, BOD, COD, Color were determined in waste water before and after treatment

Result and Discussion

The green synthesis of cellulose nanoparticles by using Separately pomace of carrot and beetroot is good alternative method. The synthesized nanoparticles are structurally characterized by using various analytical techniques.

SEM Analysis

SEM analysis was done by using Perkin Elmer SEM instrument. Its image is in given in figure-3. Shows morphological structure of cellulose nano particles of beetroot and carrot pomace composites. It confirms the
formation of nano-composites and nanoparticles obtained in the range of 90-110 nm.

**Fig-3:** CNP of Beetroot-carrot

**Application of Cellulose Nanoparticles in reduction of polluting parameters**

So formed CNPs were used for reduction of polluting parameters (TSS, BOD, COD and Colour) from waste water. When we added about 1 g of CNPs in to 100 ml of synthetic waste water, stirring for 2 mins and then 1hr time was allowed for adsorption and then parameters were analysed then it was observed that all polluting parameters were reduced. Specially when observed for color with different dosage of CNPs then color was reduced upto 80% successfully. Results are shown in table -1.

**Table 1:** Reduction in Parameters of waste water with adsorption nano particles

| Parameters | Original waste water (No CNP) | CNP Conc (1g/l) | CNP Conc (2g/l) | CNP Conc (5g/l) | Max reduction % |
|------------|-------------------------------|-----------------|-----------------|-----------------|-----------------|
| BOD        | 60                            | 56              | 50              | 36              | 40              |
| COD        | 320                           | 300             | 260             | 150             | 53.1            |
| TDS        | 480                           | 430             | 400             | 300             | 37.5            |
| Colour     | 320                           | 250             | 160             | 60              | 81              |

There are many applications of nanocomposites, which have been applied by different researchers. Biological Applications: The nano cellulose has very wide application due to its low cost of production high biodegradability, high hydrophilicity and high surface area. It is generally used as filler in the synthesis of nanocomposite [15].

**Antimicrobial activity:** The cellulose nanoparticles itself does not show any antimicrobial activity but along with any other agents like chitin, silver and iron they produce promising antimicrobial activity [16].

Nano cellulose as Coating Material: Cellulose nanoparticles are used as coating materials in the paper industries and the use of cellulose nanoparticles as coating materials improved the mechanical strength of the prepared paper [17].

Nano cellulose in Energy Storage Devices: There is a tremendous increase in the demand of low cost green energy storage device. To achieve this goal biodegradable polymer such as cellulose nano crystal has been used as an electrode binder. The cellulose nano crystal was also used in the manufacturing of batteries body and electrolyte materials. The material which is used as electrode binder must be electro chemically stable and bind to the materials used in the synthesis of electrode. Polyvinylidene difluoride was the most commonly used electrode binder but the use of Polyvinylidene difluoride as an electrode binder produces some critical problem as it was only soluble in non polar solvent, very expensive, flammable and toxic. The use cellulose nanoparticles as electrode binder provide good alternative of Polyvinylidene difluoride [18].

**Adhesion in Nanocellulose:** Self adhesion of cellulose material is the key factor of the strength of the synthesized paper. The self adhesion is basically depending upon the strength of the hydrogen bond between the adjacent cellulose materials. The use of nanocellulose material in paper making increase the compatibility of cellulosic materials to other material which comes in contact hence increase the stability of paper [19].

**Conclusion**

The proposed method of the synthesis of cellulose nanoparticles was a good eco-friendly method. This method was a good alternate of conventional method as in this method there was no use of any harsh chemicals and also it is a very cost effective method. The synthesized nanoparticles were analyzed by various analytical tools. The SEM image of synthesized nanoparticles was established that the prepared nanoparticles were almost spherical in shape with average size of 90-110 nm. So formed CNPs can be used in reduction of polluting parameters from waste water, specially colour can be reduced by adsorption.

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