The use of modest doses of gamma radiation to produce Bacterial Nano Cellulose has reached a tipping point

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ABSTRACT

Due to its wonderful qualities and wide range of uses, enormous efforts have been made in recent years to devise a cost-effective production procedure for Bacterial Nano cellulose (BNC). The influence of gamma irradiation on BNC yield was investigated using a new bacterial strain, Komagataeibacter hansenii KO28, which was treated to various irradiation doses using a devised scheme, and the productivity and structural features of the BNC were examined. After 240 hours of incubation, the culture treated twice with 0.5 kGy had the greatest BNC yield, which was 47.5% greater than the control cu--lture. Furthermore, the first six days produced about 92 percent of the BNC yield. SEM, Thermogravimetric Analysis (TGA), X-Ray Diffraction (XRD), and Fourier transform infrared spectroscopy were used to evaluate the physicochemical properties of BNCs (FTIR). For the BNC formed from the control and irradiation cultures, the water retention capacity, water release rate, surface area (BET), and mechanical characteristics were also adjusted. Overall, there were no significant differences in the characteristics of the BNC generated by the irradiated cultures compared to the control, suggesting that strain irradiation might be a useful, simple, and inexpensive way to increase BNC output.

Key Words: *Bacterial Nano cellulose (BNC), Gamma radiation, Biotechnology*

INTRODUCTION

Because of its amazing physical properties, including as high tensile strengths, crystallinity, thermal stability, and biocompatibility, Bacterial Nano cellulose (BNC) has piqued the interest of academic and industry researchers in the recent decade. Despite having the same chemical structure as plant cellulose $(C_6H_{10}O_5)$ n, BNC is manufactured in a 3D network of nanofibers, is naturally pure and devoid of hemicellulose or lignin, and has significantly better surface area, water holding capacity, and polymerization qualities. The BNC's unusual properties allowed it to be employed in a variety of applications, including biomedical and pharmaceutical areas, electro-conductive composites, the food industry, waste-water treatment, food packaging, textiles, and even building. Komagataeibacter, Agrobacterium, Aerobacterium, Rhizobium, Salmonella, Sarcina, Azotobacter, and Achromobacter, among others, have been shown to synthesis BNC, however the yield varies greatly. The most efficient BNC producers were found to be members of the genus Komagataeibacter (formerly known as Acetobacter), with Komagataeibacter xylinus acting as the role model bacterial strain for BNC production. Despite the growing relevance of BNC across the world, the manufacturing process still faces a number of obstacles, including long propagation times, low yields, and restricted cellulose layer thickness, all of which are major impediments to BNC mass production and use.

Whether it's the medium composition, the manufacturing circumstances, or the strain efficiency, research organizations have put in a lot of effort to improve the BNC yield. Agro-industrial wastes, food remnants, paper industry effluents, and textile wastes account for more than 30% of total production costs, with recent developments focusing on experimenting with less expensive carbon and nitrogen sources such as agro-industrial wastes, food remnants, paper industry effluents, and textile wastes. Another technique for enhancing BNC yield is to improve production parameters, which entailed experimenting with a variety of bioreactors to determine the ideal production conditions for the bacteria used, whether static or agitated. Selecting a high-efficiency bacterial strain for BNC manufacture, on the other hand, is an important step in the BNC mass-production process. The utilized strain may be genetically modified to generate substantially more BNC under the same production conditions. The genetic alteration of bacteria can be accomplished by genetic recombination or mutation in response to an external chemical or physical stimuli (termed mutagen). Genetic recombination is a technique for enhancing the potential of wild-type strains by injecting genetic components into them. Because of its importance in genetic modification for either greater product output or better qualities, gamma rays have aroused the interest of biotechnologists. Despite its reputation as a universal sterilizing agent, tiny dosages of gamma irradiation have been shown to cause i-

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-ntriguing alterations in living cells. Furthermore, gamma ray irradiation is inexpensive and feasible in most study fields. The goal of this study was to see how different dosages of gamma irradiation affected the BNC productivity of the Komagataeibacter hansenii KO28 strain, as well as the physical and chemical attributes of the synthesized BNCs from the irradiated cultures compared to the control product. To the best of our knowledge, this is the first study to look at whether gamma ray-assisted mutagenesis of BNC-producing bacteria is a viable option for optimizing BNC production.

Year after year, worldwide worries about growing environmental risks have grown.

It has become a major priority to develop sustainable and green materials to replace non-eco-friendly synthetic polymers and fossil oil derivatives. Cellulose is the most prevalent natural polymer, accounting for over 30% of all plant matter on the planet. The global cellulose output is projected to be 1010–1011 tons per year, with around 6 109 tons going to the paper, textile, materials, and chemical sectors. Bacterial Nano cellulose (BNC) marks a paradigm change toward more sustainable procedures, since it can be made from a wide range of wastes and with clean effluents, resulting in a high-value-added and environmentally friendly product. Furthermore, unlike plant cellulose, BNC is cellulose in its purest form, requiring no time, money, or energy-intensive extraction processes.

CONCLUSION

Komagataeibacter hansenii KO28 was discovered as a new BNC-producing strain. The isolated strain was given several gamma ray doses (0.5, 1, 2, 3, single and double doses) to see how they affected the BNC productivities. In terms of BNC yield and hereditary stability, as well as BNC physical qualities, the four cultures with positive BNC yield impact (treated with 0.5, dual 0.5, 1, and dual 1 kGy) were compared to the wild-type (control) culture. In terms of fiber diameter or outspreading pattern, FESEM indicated no significant differences, whereas surface area values showed a modest variance. The BNC-1 had the most surface area and ductility of the five BNC artefacts studied, while the BNC-05D had the best water holding capacity, best water retention, highest tensile strength, and highest Young's modulus. The thermo-decay profiles of the BNCs studied were comparable, but their crystalline characteristics differed, suggesting that the multiple irradiation doses had additional effect on the cellular crystallization systems. Eventually, the BNC products had comparable IR spectra, with the BNC films from irradiation cultures having denser hydroxyl peaks.