CHAPTER 9

Nanocellulose Derived from Agricultural Waste for Biomaterial Development

Aryanny Nasir, Siti Pauliena Mohd Bohari, Jamarosliza Jamaluddin, and Nadia Adrus

9.1 INTRODUCTION

A total of 998 million tonnes of agricultural waste are produced worldwide each year, and in Malaysia, agricultural waste produced in 2009 was approximately 0.122 kg/cap/day that is projected to reach 0.210 kg/cap/day by 2025 (Neh, 2020). This is so because the agriculture industry is crucial to meeting human needs and supporting our way of life. Agricultural wastes are a valuable source that can be converted into high-value-added products utilising a variety of chemical extraction processes. In underdeveloped countries, the burning of agricultural waste is a major cause of pollution. Agricultural waste like Rice Husk (RH) is a good source of lignocellulosic content and can indeed serve as great substrates for biomaterial development. Various characterizations of raw and treated waste materials may lead to appropriate applications of the waste materials.

Agricultural waste is made up of lignocellulosic components (Saini et al., 2015). Pre-treatment are employed to fractionate the recalcitrant lignocellulosic biomass. There are various type of pre-treatment methods including chemical, physical, physico-chemical, and biological pre-treatment. Chemical treatments are one of the most used procedures for treating agricultural fibres on the surface (Alemdar et al., 2008; Machaka et al., 2014). Acid and alkali treatments are the most popular chemical therapy procedures. By boosting hydrogen bonding and porosity, as well as removing lignin, both can increase the absorption properties of treated samples (Razali et al., 2022). Rice Husk (RH), have a high cellulose concentration (Shukla et al., 2013). It's interesting to note that while silica, a component of RH, has received the majority of attention in the literature and has a variety of uses, including as a drug delivery system, study on cellulose, which is present in large quantities in the same matrix, has lagged. Despite the numerous investigations and feasibility studies on the use of this agricultural wastes, this study requires greater attention. Previous studies on RH have focused on its usage in polymer composites, as a binder and in pollution treatment, particularly heavy metal removal. Hence, study on the biomedical applications of cellulose derived from RH proves necessary.

Cellulose, hemicelluloses, and lignin, among other minor components, make up lignocellulosic biomass (Das et al., 2016). Among these, cellulose is the most abundant renewable organic material created in the biosphere, found in higher plants, a variety of marine organisms, and to a lesser extent in algae, fungi, bacteria, invertebrates, and even amoeba (Habibi, et al., 2010). Cellulose is a polysaccharide made up of repeating unit of d-glucose molecules linked by 1,4-glycosidic bond. It's a promising raw material to produce essential compounds including cellulosic-ethanol, hydrocarbons, and polymer starting materials (Ragauskas et al., 2006; Hahn-Häegerdal et al., 2006). The potential applications of lignocellulosic biomass as a starting substrate for producing value-added materials such as biopolymers have been extensively studied, and several research studies have shown the potential applications of lignocellulosic waste as a starting substrate for producing value-added materials. Various methods for extracting cellulose, such as chemical treatment, as well as chlorine-free extraction from various plant materials are being used by researchers nowadays (Nazir et al., 2013).

To eliminate undesirable components and improve nano-cellulosic characteristics, cellulose can be pre-treated using a variety of techniques, including alkaline-acid pre-treatment, enzymatic pre-treatment, and ionic pre-treatment. The lignocellulosic substance is treated by alkali chemicals in the alkaline-acid treatment procedures (Gupta et al., 2020). These techniques generate fibrillation and alter the surface characteristics of native fibres, allowing hemicellulose, lignin, and waxes to escape (Phanthong et al., 2018). Alkali treatment is a typical extraction procedure used before or after bleaching to remove hemicellulose and other compounds from the fibre cell wall's exterior surface. The alkaline concentration, extraction duration, and temperature were found to have an impact on cellulose yield, -cellulose content, and whiteness index during cellulose extraction (Rodsamran & Sothornvit, 2015). Furthermore, alkaline treatments affect the structural behaviour of nanocellulose in terms of fibre swelling and shrinkage, agglomeration rate, and tensile strength disruption (Rambabu et al., 2016).

Wound dressing requires materials that act as scaffolds, directing tissue formation, allows oxygenation, as well as allowing the transport of biological nutrients. These materials require tailored porosity, surface chemistry, and suitable mechanical strength to be used in wound healing process. Electrospun nanofiber wound dressings have good healing properties. Their three-dimensional structure resembles the