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Review

Antioxidant and antimicrobial applications of biopolymers: A review

Subajiny Sivakanthan[a], Sarathadevi Rajendran[a], Ashoka Gamage[b], Terrence Madhujith[c,d,*], Sudhagar Mani[e]

[a] Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna, Sri Lanka
[b] Department of Chemical and Process Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka
[c] Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Sri Lanka
[d] College of Engineering, University of Guelph, ON N1G 4W1, Canada
[e] School of Chemical, Materials and Biomedical Engineering, University of Georgia, Athens, GA 30602, United States

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ABSTRACT

Biopolymers have generated mounting interest among researchers and industrialists over the recent past. Rising consciousness on the use of eco-friendly materials as green alternatives for fossil-based biopolymers has shifted the research focus towards biopolymers. Advances in technologies have opened up new windows of opportunities to explore the potential of biopolymers. In this context, this review presents a critique on applications of biopolymers in relation to antioxidant and antimicrobial activities. Some biopolymers are reported to contain inherent antioxidant and antimicrobial properties, whereas, some biopolymers, which do not possess such inherent properties, are used as carriers for other biopolymers or additives having these properties. Modifications are often performed in order to improve the properties of biopolymers to suit them for different applications. This review aims at presenting an overview on recent advances in the use of biopolymers with special reference to their antioxidant and antimicrobial applications in various fields.

1. Introduction

Polymers are compounds composed of monomeric units covalently bound to form large molecules. There are numerous polymers which are used in daily life and most of them are conventionally synthesized from fossil fuels including crude oil, coal and natural gases. Despite many advantages, the use of the traditional fossil-based polymers is discouraged as they are not biodegradable. The growing environmental consciousness has necessitated the discovery of alternative renewable resources for sustainable production of polymers (Özçimen, İnan, Morkoç, & Efe, 2017).

A wide array of biologically derived sources is available as promising alternatives for fossil fuels. Biopolymers can be defined as natural polymers synthesized by plants, animals and microorganisms. However, the term biopolymer is not clearly defined in the literature. There is some ambiguity in terms such as biopolymers, bio-based polymers, bioplastics and biodegradable polymers. Biopolymers show biodegradability, however, they do not include artificially synthesized biodegradable polymers. Biodegradable polymers, also known as bioabsorbable polymers include both naturally derived and artificially synthesized polymers (Nakajima, Dijkstra, & Loos, 2017). Bio-based polymers are materials which are produced from renewable resources and these polymers can be either biodegradable or non-degradable (Babu, O'Connor, & Seeram, 2013). Bioplastics may be biodegradable, however, they are not necessarily derived from biological sources. As some of the petroleum based polymers can also be biodegradable such as polycaprolactone (PCL) and polybutylenesuccinate (PBS), whereas some bio-based polymers can also be non-biodegradable (Özçimen et al., 2017). This review focuses only on polymers that are obtained from renewable sources.

Compared to polymers obtained from fossil fuels, biopolymers offer several advantages such as biodegradability, nontoxicity and biocompatibility, which make the biopolymers excellent candidates for a wide range of applications in medicine, pharmacology and in industries including packaging, cosmetics, absorbents, electronics, agriculture, water treatment, clothing fabrics, plastics and biosensors (Niaounakis, 2015; Rebelo, Fernandes, & Fangueiro, 2017).

During the past 5 years, a number of reviews analyzing various topics related to biopolymers have been published (Banu et al., 2019; Bernaerts, Gheysen, Foubert, Hendrickx, & Van Loey, 2019; Crini, 2019; Kashirina, Yao, Liu, & Leng, 2019; Moradali & Rehm, 2020). Reviews are available in the literature related to applications of biopolymers in biomedicine, however, most are limited to particular biopolymers or particular applications (Banerjee & Ganguly, 2019; Holland, Numata,

* Corresponding author at: Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Sri Lanka.
E-mail address: tmadhujith@gmail.com (T. Madhujith).

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