International Journal of Biological Macromolecules 87 (2016) 295–301

Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac

Use of dextran nanoparticle: A paradigm shift in bacterial exopolysaccharide based biomedical applications

Aparna Banerjee, Rajib Bandopadhyay*

UGC- Centre of Advanced Study, Department of Botany, The University of Burdwan, Golapbag, Bardhaman, 713104 West Bengal, India

ARTICLE INFO

Article history:
Received 30 January 2016
Received in revised form 18 February 2016
Accepted 23 February 2016
Available online 27 February 2016

Keywords:
Dextran
Nanobiosensor
Drug delivery

ABSTRACT

This review is a concise compilation of all the major researches on dextran nanoparticle based biomedical applications. Dextran is a highly biocompatible and biodegradable neutral bacterial exopolysaccharide with simple repeating glucose subunits. It's simple yet unique biopolymeric nature made it highly suitable as nanomedicine, nanodrug carrier, and cell imaging system or nanobiosensor. Most importantly, it is extremely water soluble and shows no post drug delivery cellular toxicity. Complete metabolism of dextran is possible inside body thus possibility of renal failure is minimum. Dextran based nanoparticles have superior aqueous solubility, high cargo capacity and intrinsic viscosity, and short storage period. The main focus area of this review is- past and present of major biomedical applications of dextran based nanomaterials thus showing a paradigm shift in bacterial exopolysaccharide based nanobiotechnology.

1. Introduction

The present scientific era is of nanotechnology which has roots of chemistry with stem of engineering and branches of biology. It shows immense promises in the field of medicine as nanodrug and nanocarrier formulation, but the main challenge lies upon the use of synthetic nanoparticle. As synthetic nanoparticle may show adverse side effects in biological system, thus use of biological nanoformulation may overcome this issue. The present review deals with structural perspective of bacterial dextran, its unique biological activities and modification as nanoparticle, and potential application of dextran nanoparticles.

In 1861, dextran was first isolated by the father of microbiology; Louis Pasteur in wine as a microbial product- which is perhaps the most blissful contribution of Pasteur to mankind with a long time impact [1]. Though different varieties of dextran are just simple combinations of glucose molecules with variable glycosidic bonds; but dextran derivatives, dextran conjugates, dextran hydrogel and micelles are extensively used as nanomedicine and nanocarrier because of its simple and nonimmunogenic biopolymeric nature. As of April 2015, Dextran 70 is in WHO model list of essential medicine as blood plasma substitute [2]. Dextran is also the first commercial bacterial exopolysaccharide [3]. The name dextran was first given by Scheibler in 1869 as the product showed some similarities with dextrin. He also showed that upon acid hydrolysis, it only produced D-glucose [4].

2. Source, structure and chemical nature of bacterial dextrans

Dextran have a basic chemical formula of H $(C_6H_{10}O_5)_n$ OH. It is a type of α-glucan produced from sucrose by the action of the bacterial extracellular enzyme dextransucrase (Fig. 1), which is commonly synthesized by several mesophilic and thermophilic bacterial genera of *Leuconostoc*, *Gluconobacter*, *Streptococcus* and *Lactobacillus* [5–13]. It is freely soluble in water, methyl sulphoxide, formamide, ethylene glycol and glycerol. Some dextran fractions may adopt a certain degree of crystallinity and may only be brought into solution by strong heating. The most unique chemical feature of dextran is- it is a neutral polysaccharide; thus have a large array of applications [14].

3. History of bacterial dextran based products in biomedical field

First commercialized bacterial dextran based product was Dextran 70, which is a 6% Dextran solution in saline water. Source organism was *Leuconostoc mesenteroides* strain 7E. Dextran 70 created a new era as synthetic blood volume expander and is in widely use till date. A further dextran product *Dextran 40* came to the biomedical market in 1961. This product is of low molecu-

* Corresponding author.
E-mail addresses: rajibindia@gmail.com, rajib_bandopadhyay@yahoo.com (R. Bandopadhyay).

http://dx.doi.org/10.1016/j.ijbiomac.2016.02.059
0141-8130/

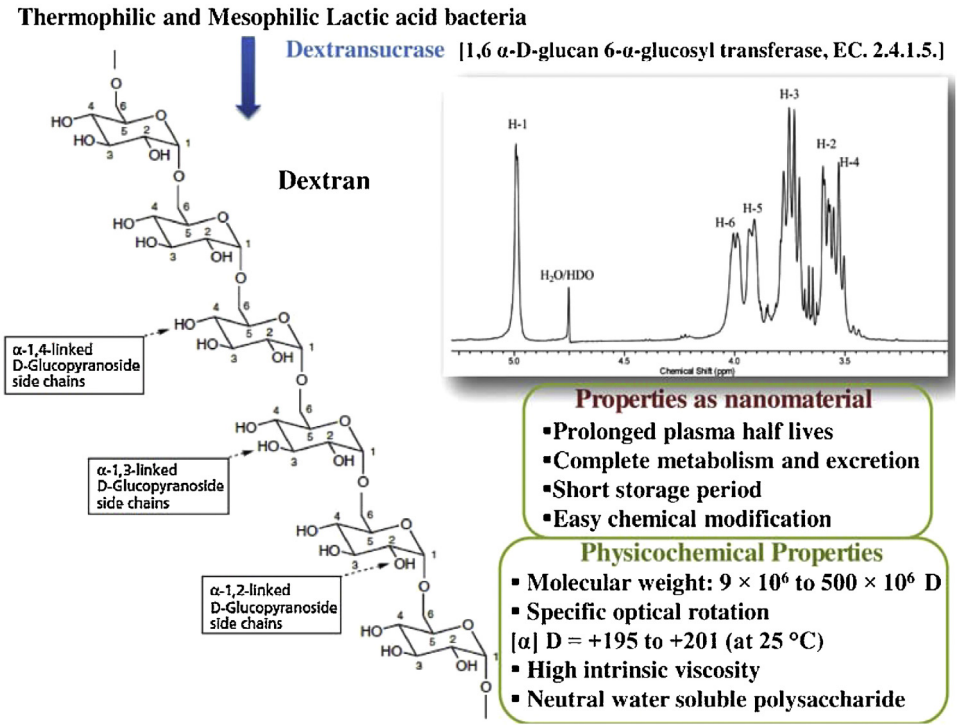

Fig. 1. Structure of bacterial dextran produced by dextransucrase and its unique physicochemical features.

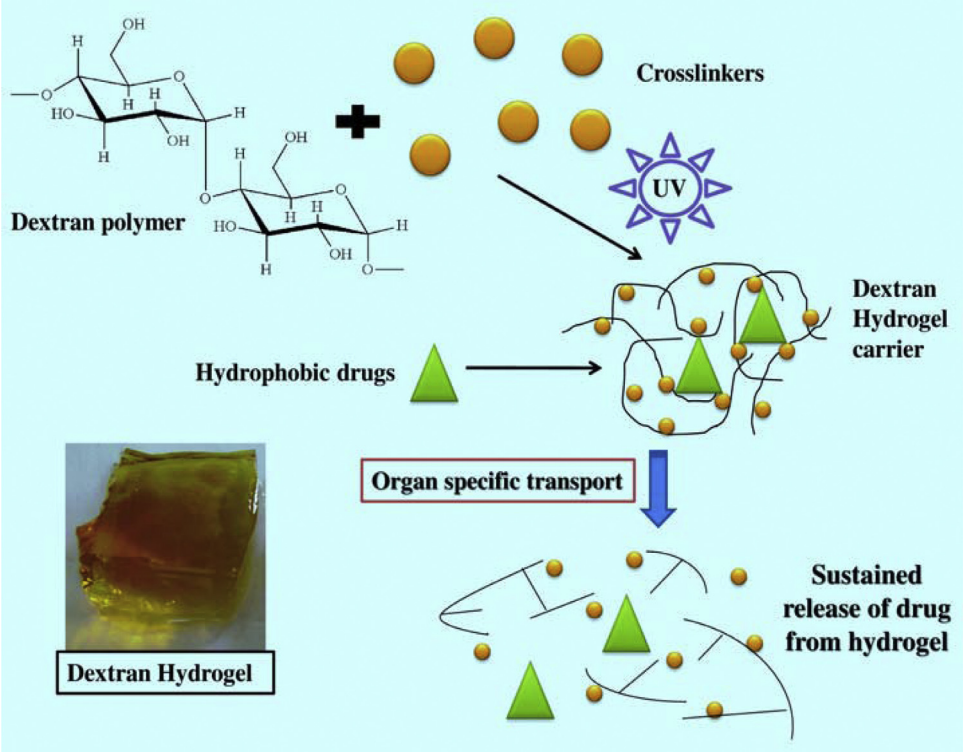

Fig. 2. Schematic representation of dextran hydrogel formation and it's role in sustained organ specific drug release.

lar weight and imparts blood flow improvement by reducing blood viscosity and inhibition of erythrocyte aggregation [15]. After more extensive animal and clinical trials, a monovalent hapten dextran fraction- *Dextran 1* was introduced in 1982. A small volume (20 ml of a 15% solution) of dextran 1 was administered prior to the Dextran 40 or 70 injections[16].

Another variation of bacterial dextran; dextran sulfate is routinely used in both high and low density lipoprotein precipitation. Most importantly it is used to in hypercholesterolemia when treated with low density lipoprotein apheresis by dextran sulfate adsorption [17,18]. Also DEAE dextran mediated transfection is the pioneer method of efficient gene transfer [19].