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Quality control of proteoglycan obtained from salmon nasal cartilage in dietary supplements

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Abstract

Aggrecan, which is a chondroitin sulfate proteoglycan (CSPG), has been considered as a superior functional nutraceutical for the treatment of joint diseases and other immune system diseases when compared to chondroitin sulfate (CS). The industrial production of CSPG generally employs salmon nasal cartilage, and the quality control of CSPG is required to meet the regulations for nutraceutical products prepared from natural resources. Although there are several commercially available nutraceuticals that contain CSPG as a major component, the quality and quantity of CSPG in each supplement are not guaranteed. This paper presents a simple, rapid, and reliable analytical approach for the quality control of CSPG during production, where electrophoresis, gel filtration HPLC, and CS unsaturated disaccharide analysis with CS degradation enzymes were employed. Finally, the quality of CSPG obtained from different extraction and purification processes were confirmed using these newly developed analytical procedures.

Keywords : chondroitin sulfate proteoglycan, salmon nasal cartilage, osteoarthritis, quality control, nutraceuticals

I Introduction

Chondroitin sulfate (CS) is a largely heterogeneous glycosaminoglycan (GAG) that consists of alternating and diverse sulfated disaccharides of glucuronate (GlcA) and N-acetyl galactosamine (GalNAc) linked by β (1 → 3) bonds, while different disaccharides are linked by β (1 → 4) bonds (Fig. 1). The biological effects associated with CS are related to its ability to interact with a wide variety of other biomolecules, including extracellular matrix molecules, growth factors, protease inhibitors, cytokines, chemokines, adhesion molecules, and pathogen virulence factors *via* aspecific/specific sulfated saccharide domains within the chains[1-3].

Osteoarthritis (OA) is a global health issue affecting various ethnic groups and has a high incidence and significant economic impact[4]. OA particularly affects older generations, resulting in variable restrictions in movement, which often contribute to a significant reduction in the quality of life. Current treatments of OA are mainly aimed at pain reduction[5] and slowing the progression of the disease. This includes treatment with drugs, such as structure/disease modifying anti-osteoarthritis drugs (S/DMOADs)[6, 7]. CS inhibits the extracellular proteases involved in the metabolism of connective tissues, stimulates proteoglycan production by chondrocytes, and reduces cartilage

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Abbreviation CSPG: chondroitin sulfate proteoglycan, ΔDi-0S: 2-acetamide-2-deoxy-3-*O*-(β-D-*gluco*-4-enepyranosyluronic acid)-D-galactose, ΔDi-4S: 2-acetamide-2-deoxy-3-*O*-(β-D-*gluco*-4-enepyranosyluronic acid)-4-*O*-sulfo-D-galactose, ΔDi-6S: 2-acetamide-2-deoxy-3-*O*-(β-D-*gluco*-4-enepyranosyluronic acid)-6-*O*-sulfo-D-galactose, ΔDi-diS$_B$: 2-acetamide-2-deoxy-3-*O*-(2-*O*-sulfo-β-D-*gluco*-4-enepyranosyluronic acid)-4-*O*-sulfo-D-galactose, ΔDi-diS$_D$: 2-acetamide-2-deoxy-3-*O*-(2-*O*-sulfo-β-D-*gluco*-4-enepyranosyluronic acid)-6-*O*-sulfo-D-galactose, ΔDi-diS$_E$: 2-acetamide-2-deoxy-3-*O*-(β-D-*gluco*-4-enepyranosyluronic acid)-4, 6-di-*O*-sulfo-D-galactose, ΔDi-triS: 2-acetamide-2-deoxy-3-*O*-(2-*O*-sulfo-β-D-*gluco*-4-enepyranosyluronic acid)-4, 6-di-*O*-sulfo-D-galactose, ΔDi-UA2S: 2-acetamide-2-deoxy-3-*O*-(2-*O*-sulfo-β-D-*gluco*-4-enepyranosyluronic acid)-D-galactose, GAG: glycosaminoglycan, GalNAc: *N*-acetyl-D-galactosamine, GPC: gel permeation chromatography, HPLC: high performance liquid chromatography, NMR: nuclear magnetic resonance