A New Carbohydrate Based Polymer: Synthesis, Characterization of Poly(3-O-methacroyl-5,6-O-isopropylidene-1,2-O-(S)-trichloroethylidene-α-D-galactofuranose) and Solid State Decomposition Kinetic

Kadir Ay\(^a\), Gökhan Kök\(^b\), Emriye Ay\(^a\), Tamer Karayildirim\(^b\), Fatih Doğan\(^c\)

\(^a\) Faculty of Arts and Sciences, Department of Chemistry, Celal Bayar University, 45140, Manisa, Turkey.
\(^b\) Faculty of Science, Department of Chemistry, Ege University, 35100, Bornova, İzmir, Turkey.
\(^c\) Faculty of Education, Secondary Science and Mathematics Education, Çanakkale Onsekiz Mart University, 17100, Çanakkale, Turkey.

Carbohydrates have attracted worldwide attention for chemistry industry due to obtaining from renewable sources, eco-friendly and pharmacological properties. However, carbohydrate based polymers which are capable of biodegradation and biocompatibility have emerged as exciting topics of the polymer research\(^1\). They are synthesized by the basic raw materials including the sugars such as glucose, galactose, fructose, sucrose. Carbohydrate based polymers have some applications such as drug delivery systems, dental medicine, bioimplants, contact lenses and tissue engineering\(^2\). Poly-acrylate, -methacrylate and -vinyl sugars are the important class of synthetic poly-vinylsaccharides. Sugar-carrying methacrylates such as 3-O-methacroyl-1,2:5,6-di-O-isopropylidene-α-D-glucofuranose\(^3\), 6-O-methacroyl-1,2:3,4-di-O-isopropylidene-α-D-galactofuranose, 1-O-acryl-2,3:5,6-di-O-isopropylidene-α-D-mannofuranose, monomethacroyl sucrose have been reported in literature. Homopolymerization or copolymerization of these sugar methacrylate monomers were performed via both atom transfer radical polymerization and free radical methods using AIBN as initiator.

In this study, a new sugar derivative of the methacrylate polymer was synthesized from 3-O-methacroyl-5,6-O-isopropylidene-1,2-O-(S)-trichloroethylidene-α-D-galactofuranose by free radical polymerization with AIBN in 1,4-dioxane. The structures of the resulting compounds were confirmed by FTIR, UV-spectroscopy, \(^1\)H-NMR, and \(^13\)C-NMR. Further characterization processes were performed by thermogravimetry (TG)-differential thermal analysis, gel permeation chromatography, SEM, DLS and solubility testing. Also, the kinetics of the thermal decomposition of carbohydrate based sugar polymer were investigated with TG technique. The kinetic parameters related to the decomposition kinetics of carbohydrate based sugar polymer were calculated from Friedman, Flynn-Wall-Ozawa, Kissinger, and Coats-Redfern (CR) methods under an \(\text{N}_2\) dynamic atmosphere and at different heating rates of 5, 10, 15 and 20 °C/min. The mechanism function and pre-exponential factor were determined by a master plots method.

References