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学 位 論 文 要 旨
Dissertation Abstract

氏名： **Md. Tazul Islam Chowdhury**
Name

学位論文題目：
Title of Dissertation **Synthesis of Rare Sugar Derivatives and Their Biological Activity on Plant Growth**
(希少糖誘導体の合成と植物生長に対する生物活性)

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As the world population grows, global food security has become an increasingly pressing concern, and crop production playing a vital role to feed the people. Therefore, to increase the yield, farmers are using so many synthetic chemicals such as pesticide, fertilizer and growth retardants, which are causing a hazardous problem in the environment. To overcome this situation, farmers are diverting their attention to the environmental friendly chemicals. Based on this regards, sustainable growth retardants are highly needed in agronomy and horticultural area especially in a greenhouse field. Plant growth retardants (PGRs) are a diverse group of chemicals which inhibits the growth of plants. To date, so many synthetic growth retardants are commercially available. They act as an antagonist of plant hormones, especially on gibberellin (GA) biosynthesis. But most of them are not biodegradable and creating hazardous problem to flora and fauna. To minimize the environmental risks, researchers of the different corners of the world are now searching for natural products and their derivatives to develop new growth regulators. Rare sugar and its fatty acid esters have already been shown to have the potential activities on plant growth. Therefore, this research aimed to explore the biological activities of new rare sugar derivatives on plant growth.

In the first study, two new growth inhibitory compounds, 6-*O*-decanoyl-D-altrose and 6-*O*-decanoyl-D-gulose, were synthesized from D-altrose (C-2 epimer of D-allose) and D-gulose (C-4 epimer of D-allose), respectively, via lipase-catalyzed transesterification using vinyl decanoate. Furthermore, the inhibitory activity of 6-*O*-decanoyl-D-altrose and 6-*O*-decanoyl-D-gulose on different plant growths

were examined. These two new rare sugar derivatives exhibited the inhibitory activity on the growth of cress, Italian rye grass, and rice seedlings similar to 6-*O*-decanoyl-D-allose, but in the case of lettuce, they showed the weaker inhibitory activity than 6-*O*-decanoyl-D-allose. In addition, co-addition of gibberellin (GA_3) with a test solution of 6-*O*-decanoyl-D-altrose or 6-*O*-decanoyl-D-gulose on rice seedlings brought the recovery of growth. These results suggest that the D-altrose and D-gulose esters as well as the D-allose ester inhibited the biosynthesis of GAs to exhibit the plant growth inhibitory activity.

In the second study, to examine the structure–activity relationship of D-allose ester, three different deoxy-D-allose analogs, 2-deoxy-D-allose (2-DOAll), 1,2-dideoxy-D-allose (1,2-DOAll), and 1,2-didehydro-1,2-dideoxy-D-allose (1,2-DHAll), and their fatty acid esters were synthesized via regioselective lipase-catalyzed transesterification. Among them, 2-DOAll and its decanoate (2-DOAll-C10) showed higher inhibitory activity on plant growth, which is similar to D-allose (All) and its decanoate (All-C10). Bioassay results of deoxy-All-C10 on four plant species suggest that the hydroxy group at the C-1 position might be important showing growth inhibitory activity. In addition, co-addition of gibberellin (GA_3) with 1,2-DHAll-C10 and 2-DOAll-C10 recovered rice growth, suggesting that they might mainly inhibit biosynthesis of gibberellin.

In the third study, 6-(decanoylamino)-1,2,6-trideoxy-D-allose (dAll-C10 amide) was synthesized from D-allose and evaluated the inhibitory activity on plant growth. Bioassay results of dAll-C10 amide on four plant species suggest that it exhibited higher inhibitory activity than the 6-*O*-decanoyl-1,2-dideoxy-D-allose (dAll-C10), and therefore, the amino group at C-6 of deoxy allose increased the inhibitory activity on plant growth. In addition, co-addition of gibberellins rescued the growth inhibition, implying that dAll-C10 amide inhibits the formation of active gibberellin (GA) in rice seedlings. Moreover, the study of mode of action of dAll-C10 amide using known growth retardants revealed that it may inhibits GA biosynthesis in a similar way to daminozide and dihydro-GA_5.

In these studies, new derivatives of rare sugar were synthesized and performed their biological activity against different plant species. Bioassay results imply that α-axial hydroxy group at C-3 and the hemiacetal group at C-1 of All-C10 and amide group of deoxy-D-allose derivative plays an important role in the growth retarding activity. Although it is not enough to conclude that rare sugar ester and amide inhibit the biosynthesis of gibberellins in a similar way to daminozide or dihydro-GA_5, these results may contribute to establish a biodegradable and environmental friendly plant growth regulator.