Synthesis of Octyl Mannoside

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***Abstract* — the application of octyl mannose is widely used in industry like drug, pharmaceuticals, biochemistry etc. Since the complexity of natural mannoside, a simple structure that consists of a single alkyl chain with mannose head group is produce as alternative. As the synthetic octyl mannoside is a new molecular science, the content, purity and molecular structure are needed. The aims are to synthesis octyl mannoside and to analyze the thermal properties of octyl mannoside. The purity, content and molecular structure was identified using Nuclear Magnetic Resonance (NMR) while thermal characteristic was identified by Differential Scanning Calorimetry (DSC). It shows that the purity of octyl mannoside is 49%. Since the yield of the product is small and does not enough for DSC analysis, the thermal properties of octyl mannoside cannot be determined.**

Keywords*— *Mannose,Octanol, Octyl mannoside

1.0 INTRODUCTION

Developing a new molecular science is one of the most interesting for researchers nowadays due to the benefits which can give huge impact to some industries. In order to develop a new molecular science, the study of intermolecular interaction is significant. Most of researchers likely to modified saccharide to form new molecules as saccharides are abundantly in this world for instance sucrose which can be found in sugar cane and sugar beets. The presence of several hydroxyl groups makes the saccharides have unique hydration characteristics [1-6].

Mannose is one of the monosaccharide that consists of 6 carbon atoms which called as hexose and it is found in polysaccharide mannan. Mannose is derived from pine trees, yeast, molds, ivory nuts and also bacteria. Mannose is inconsequential to human nutrient, however glycoprotein and mucoprotein, in body, need mannose as it is one of their components [7]. According to Sharma et al (2014) [8], cited from Bunn & Higgin (1981), in enzymatic glycation, mannose is approximate five times actives like glucose. Mannose has same chemical formula with glucose but they differ in the configuration. It has many uses in the medical hospitality. In recent studies, chicken mannose binding with lectin can cure infectious bronchitis virus [9]. Besides, mannose that combines with other sugar also can be new studies to cure illness and be antivirus to some viruses happen in this world.

In this study, the octyl mannoside was synthesized. The purity, content and molecular structure was identified. Thermal properties of the octyl mannoside were studied in order to give information to other researchers for further study. By having the purity, content and molecular structure of octyl mannoside, it can be replaced natural octyl mannoside since natural mannoside have more complex structure.

2.0 METHODOLOGY

2.1 Materials

All materials used in this study is commercialize chemicals, AR grade and used without further purification. Acetic anhydride, boron trifluoride are from Sigma Aldrich (USA). For octanol, dichlorormethane (DCM), methanol, concentrated sulphuric acid, ethyl acetate, hydrogen carbonate solution, anhydrous magnesium sulphate, sodium bicarbonate, acetonitrile, hexane, sodium methylate, $_{D}$-mannose, and butanol were purchase from Merck.

2.2 Apparatus

The purity, content and molecular structure was made using Nuclear Magnetic Resonance (NMR). The product from deacetylation is analyze for thermal characteristic using Differential Scanning Calorimetry (DSC)

2.3 Synthesis

2.3.1 α-Mannose pentaacetate

30g of $_{D}$-mannose was dissolved in 150 ml of acetic anhydride, and stirred in ice bath for 15 minutes. 2 drops of concentrated sulphuric acid which act as catalyst, was added and stirred for another 10 minutes on ice bath. The mixture was warmed at room

temperature under stirring for 45 minutes. Then, the mixture was diluted with 100 ml of ice water and extracted with 100ml of ethyl acetate for 3 times by washing with ice water. The organic layer was quenched with saturated hydrogen carbonate solution twice. The extract was dried with anhydrous magnesium sulphate, filtered and evaporated. The product is called peracetylated mannose.

2.3.2 Glycosidation [10, 11]

11.8 g of peracetylated mannose and 17 mmol of octanol were dissolved in 60 ml of DCM with the catalyst of 18.2 mmol boron trifluoride were stirred at room temperature for 24 hours. Then, the solution mixed with saturated sodium bicarbonate solution and was washed with water twice. DCM was evaporated and the product was added into acetonitrile and hexane. The acetonitrile-hexane extraction was done four times. Then, the acetonitrile layer was collected and evaporated. The product is peracetylated glycolipid.

2.3.3 Deacetylation [12]

Peracetylated glycolipid was dissolved in 150 ml of methanol and sodium methoxide is used as catalyst to induce a basic medium. The solution was stirred for 12 hours. Then, the methanol was evaporated and the product was separated by butanol-water extraction. 50 ml butanol was used. The extraction was done three times and each time 50 ml of water is used. Diluted sulphuric acid was used to neutralize the solution. The organic layer was collected and evaporated. Then the product was dried in vacuum oven at 50°C for 24 hours.

2.3.4 NMR procedure [13]

The product was dissolved in methanol-d4 and conducted at room temperature using BRUKER NMR spectrometer at 400 MHz.

3.0 RESULTS AND DISCUSSION

α-mannose pentaacetate was synthesized using D-mannose and acetic anhydride. The yield of α-mannose pentaacetate was calculated which is 78%. The product produced from glycosidation procedure is 3.16g and the weight is decreasing throughout the deacetylation procedure.

NMR analysis was compared with mannose and 1-octanol to determine the element presence in octyl mannoside produced. Fig 1 shows the H-NMR of octyl mannoside. On the right side of H-NMR, it shows that the presence of alcohol group. This peak points was compared with octanol which the alcohol used in this study. Fig 2 shows the peak data of 1-octanol while Fig 3 illustrate peak data of mannose

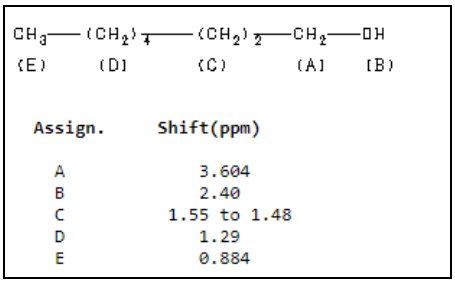


Fig 2: Peak data of 1-octanol [14]

Based on the peak of octyl mannoside, there are few of them are differ from the α-mannose and 1-octanol. The values obtained for octyl mannoside which differ from peak value of octanol are at 2.4 and 1.55 to 1.48. The octyl mannoside does not have peak at 2.4 and have peak at 1.6003 to 1.5527. At 2.4 ppm, the peak does not appear because it already deprotonated during glycosidation. The peak of octyl mannoside also was compared with mannose.

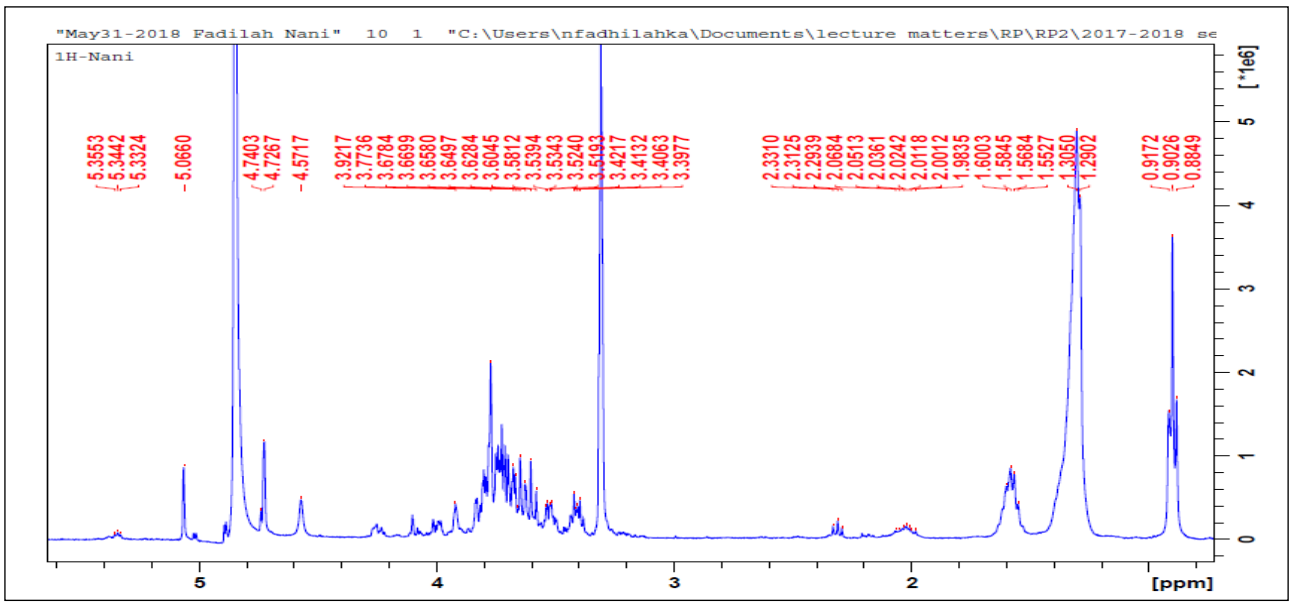


Fig 1: H-NMR of octyl mannoside

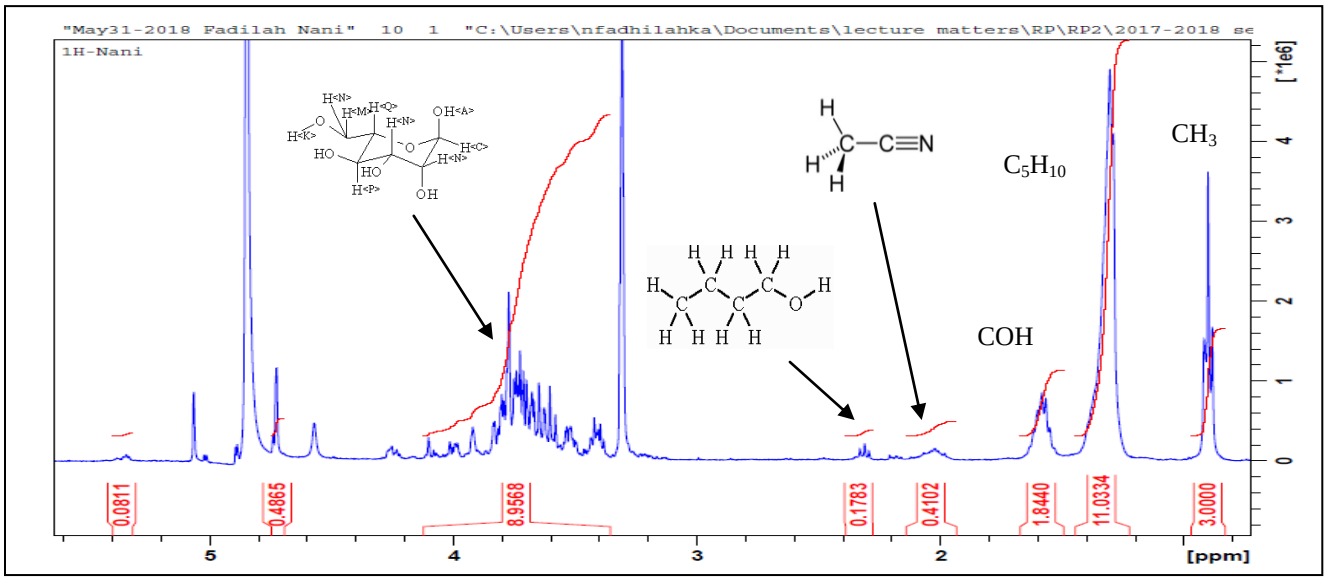
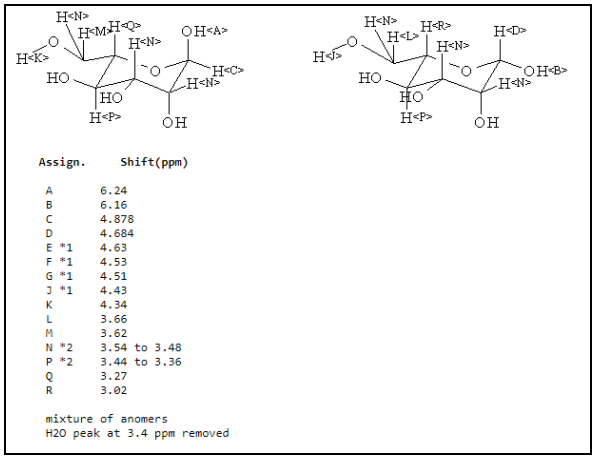


Fig 4: H-NMR integration of octyl mannoside



Assign.	Shift(ppm)
A	6.24
B	6.16
C	4.878
D	4.684
E *1	4.63
F *1	4.53
G *1	4.51
J *1	4.43
K	4.34
L	3.66
M	3.62
N *2	3.54 to 3.48
P *2	3.44 to 3.36
Q	3.27
R	3.02

mixture of anomers
H2O peak at 3.4 ppm removed

Fig 3: Peak data of mannose [15]

The similarity between peak data of mannose and octyl mannoside is just only found at 4.878, 3.66 and 3.62. This shows that there are impurities in octyl mannoside. The mannose has possibility not completely react. Fig 4 above shows the H-NMR integration for octyl mannoside.

The integration shows that octanol does not react completely as the integration only shows 17 hydrogen atoms while the octanol have 18 hydrogen atoms. From the integration, the molecular formula that was obtained is $C_7H_{17}O$. This shows that octanol does not completely react as the molecular formula for octanol is $C_8H_{18}O$. The number of hydrogen for octyl mannoside also does not same as mannose which means that the reaction also does not complete.

At peak 4.7 ppm, it represents the peak of alpha anomers (α-anomers) link between mannose and chain. By looking at H-NMR integration, at 4.7 ppm, the integration shows 0.4865 meaning that the purity of the octyl mannoside produce is only 49% which 51% is impurities.

Since the impurity of octyl mannoside is higher, the result was compared with other solvent which are butanol and acetontrile . At 2 ppm, the integration gives value of 0.4102. The peak was listed in acetonitrile peak data thus, the acetonitrile was not evaporated completely which makes the acetonitrile reacts with methanol. While at 2.29, the peak is same as butanol meaning that butanol is in octyl mannoside. At 4.57 ppm, the peak is possibly residual sugar which does not react with octanol. In this study, the ratio of mannose and octanol is 1.8:1. The unreacted sugar cannot be removed by extraction hence, it will presence in the compound as impurities.

The purity of octyl mannoside is lower is due to many factors. The main factor is probably that the α-mannose and octanol does not completely react. The reaction may need longer time for the octanol and mannose to react completely. In addition, the evaporation also may affect the result. Besides, inefficient pressure used during solvent evaporation causes incomplete removal of high boiling point solvent such as acetonitrile and butanol.

4.0 Conclusion

In conclusion, the octyl mannoside is successfully produced but the purity of the compound is only 49%. There are many factors would probably makes the product is not pure or nearly pure such as the mannose and octanol are not completely react. The solvent also does not completely evaporate

The second objective which is determining of thermal properties of octyl mannoside was not achieved due to the product produced is in small amount. The amount of the product is not enough to conduct DSC analysis as it is just can be analyze the H-NMR. The weight of product is lower can also be concluded due to

evaporation process. The organic layer probably over evaporated therefore, the product from evaporation is lower.

Thus, pure or nearly pure octyl mannoside can be synthesis using the method in this study. For further study, other than determining purity of octyl mannoside, the thermal properties, density and fluorescence study can be investigated in order to give complete information about octyl mannoside so that it can be used widely in industry. This compound is an alternative to natural octyl mannoside with simpler structure which can gives benefits to other industries like pharmaceutical, food additives, biochemical reagent etc.

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