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REACTION OF POLY (PROPYLENE IMINE) DENDRIMER WITH CARBOXYLATED AMINES

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ABSTRACT:

In this research, new derivatives of poly (propylene imine) dendrimer were synthesized using propylamine and ethylenediamine. First, amines reacted with methyl acrylate via aza-Michael addition, and then their products were treated with poly (propylene imine) dendrimer (PPI). The products were identified by FT-IR, ¹H NMR and ¹³C NMR methods. Morphology and size of particles were evaluated by scanning electron microscopy.

Keywords: NMR, PPI, FT-IR, Morphology, propylene.

1. INTRODUCTION:

Dendrimers are a group of macromolecules that are made for purposeful and scheduled drug delivery. Dendrimers are spherical ramose units containing polymer branches with different sizes. They have a single particle size distribution and a monodisperse spherical symmetry [1]. These compounds can attach many materials to their own surface and can carry them due to their multiple agent groups on the surface. This feature can be used to connect targeted macromolecules (e.g., substrates of a variety of cell receptors [2-5]). Other applications of dendrimer's drug delivery are controlled drug delivery to eyes [6,7], drug delivery through clonal [8], etc. Nano dendrimers are also used for angiography, vascular examination or examination of various tissues [9-13]. Some of the most widely used and oldest known dendrimers are

polypropylene imine (PPI) dendrimers which were synthesized and introduced for the first time by Vogtle [14]. In addition, the water-soluble PPI dendrimer is colorless and transparent [15]. Some of the unique features of dendrimerous structures are their regular and ramose structure, active multi-functional end-groups and empty spaces between branches. These empty spaces provide the possibility of acceptance of guest molecules and encapsulation of particles at different sizes [16]. That is why researchers use dendritic structures and especially dendrimers in medical sciences, pharmacology, biology, drug delivery systems, growth of stem cells, treatment of various tumors, improvement of genetic disorders, identification of cancer cells and anti-viral and antibacterial uses in recent years [17-21]. Many drugs have been found with a β -amino carbonyl or nitrile structure

that have had widespread pharmacological and medical applications. AzaMichael addition is one of the widely used reactions for the synthesis of these compounds. A wide variety of Lewis acids Brønsted acid [21,22], base [23,24] or other catalysts [25] have been explored for this reaction. Furthermore, there are a few reports of using sulfonamides as Michael donor. However, most of these methods suffer from limitations including harsh reaction conditions with low yields, tedious work-up procedures, use of expensive, toxic or unavailable reagents and solvent and the necessity of column chromatography for purification. This research work includes two parts: in the first part, each one of inesam is carboxylated with methyl acrylate between intended amines through Aza-Michael addition reaction, and in the second part, the carboxylated amines are exposed to the reaction with poly (propylene imine) dendrimer (PPI) (G1) to turn them to the target molecules.

2. RELATED STUDY:

Propylamine, ethylenediamine, methanol, poly (propylene imine) dendrimer (PPI) and methyl acrylate were all purchased from Merck company. FT-IR device from Thermo-Nicolet company with model of Nexus670 made in USA was used to identify functional groups. ^1H and ^{13}C NMR were recorded on Bruker (400 MHz) NMR spectrometer. NMR was used to detect the type and number of protons and carbons. A scanning electron microscope was used to investigate the morphology and size of structures. Methods At the beginning, Aza-

Michael reaction was done by interaction of type primary amines with methyl acrylate at the range of 40-50 °C for 24 h with uniform mixing. In the next step, the created products from the first step were exposed to the effect of the reaction so that arms grew and a newer dandruff was synthesized. The reaction conditions and molar ratio of raw materials were selected in a way that only desired products were made and side products or higher generations of dendrimers were prevented. At this step, a certain amount of amine was dissolved in methanol solvent. Then, the obtained solution was added dropwise to methyl acrylate while stirring. The reaction mixture was stirred at the temperature range of 40- 50 °C for 24 h.

A. Reaction of propylamine with methyl acrylate: Propylamine (or PA is called) (4.1 ml, 50 mmol) was dissolved in 5 ml of methanol. Then, the above solution was drop wisely added to methyl acrylate (9.1 ml). The reaction mixture was stirred at room temperature for 24 h. After the end of the reaction, the solvent was separated using rotary. The bright yellow viscous liquid obtained was very odorous The product created at this stage is called PAdervative.

B. Reaction of ethylenediamine with methyl acrylate: Ethylenediamine (or EDA is called) (1.67 ml, 25 mmol) was dissolved in 5 ml of methanol. Then, the above solution was drop wisely added to methyl acrylate (9.1 ml). The reaction mixture was stirred at room temperature for 24 h. After the end of the reaction, the solvent was separated using rotary. The yellow viscous liquid obtained

was very odorous (Fig). The product created at this stage is called EDA derivative.

3. PROPOSED METHODOLOGY:

At this step, derivatives of β -alkylamino methyl acrylate that aza-michael addition reaction in the previous step reacted with PPI at the presence of minimum amount of methanol as solvent, under the temperature of 40 °C with stirring for 48 hours. Then, the rotary solvent was separated and the purity of the product was tested by TLC. A) Reaction of PA-derivative with PPI: PPI (0.3 ml) was dissolved in methanol (1 ml). Then PA-derivative (0.5 ml) was added to the mixture dropwise. The reaction mixture was stirred at 40 °C for 48 h. Solvent was extracted after reaction using rotary. The product is a very viscous yellow liquid similar to honey. The product is highly sticky and completely sticks to the walls of container. Interestingly, at the first step, the product had a very sharp smell, but Based on spectral evidence and molar ratio considered for initial materials, it is expected that both N-hydrogen atoms of propylamine are involved in reaction with methyl acrylate, hence, the B product is the main product of this reaction. The obtained product was a yellow viscous liquid with a boiling point of 192 °C. As it can be observed in IR spectrum, absorption peaks in the areas of 2813-2966 cm^{-1} are related to stretching vibrations of C-H aliphatic. The carbonyl stretching frequency of ester appeared at 1739.95 cm^{-1} . The lack of peak for NH shows that both hydrogens of amine of PA have been replaced indicating the formation

of B product. The IR spectrum of B product has been shown in fig.

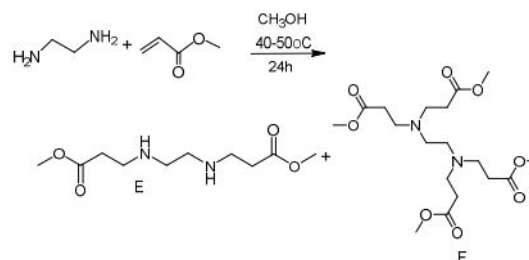


Fig.3.1. Reaction ethylenediamine with methyl acrylate.

SEM images clearly show the formation of arms and their growth. A number of SEM images are shown in Fig. Figure shows that the diameter of the arms is an average of 31.27 nm. The second image represents particles with diameters of 28.5 to 38.99 nm indicating that particles are synthesized in the nanoscale. The fourth image shows branching morphology (formation of Dendrimer).

5. CONCLUSION:

The use of poly (propylene imine) dendrimer to design an efficient core for the synthesis of a variety of dendrimers has been demonstrated by means of divergent method. The length of chains of dendrimers depends on the monomer/ initiator ratio; hence the structure and morphology of dendrimers can be changed by using different monomer/ initiator ratios. The structures of all compounds were characterized by IR, ^1H and ^{13}C NMR spectroscopies as well as SEM techniques that have fit and nano size morphology. This

method offers several advantages including short reaction time, simple work-up and good yields that could be have proper prospects of applications in organic syntheses and pharmacy processes. Afterwards, the prepared dendrimers are evaluated with in vitro methods, which show good antibacterial and antioxidant activity. Since the dendrimers are biocompatible materials and able to trap the small guest molecules hence they are promising materials as nano carrier for application in the biological and medicinal systems.

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