Journal of Chemical Natural Resources Vol. 02, No. 02, 2020 |150 – 155

JCNaR

Journal of Chemical Natural Resources

Comparison Study of Fabrication and Characterization of Bead Chitosan Hydrogel and Yarn Chitosan Hydrogel From High Molecular Chitosan

***Siti Aisyah*[1]*, Harry Agusnar*[2*]*, and Zul Alfian*[3]**

[1,2,3]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Jalan Bioteknologi No.1 Kampus USU Medan 20155, Indonesia

Abstract. The research about comparison study of fabrication and characterization of bead chitosan hydrogel and yarn chitosan hydrogel from high molecular chitosan has been successfully conducted. High molecular chitosan was dissolved into 100 ml of 1, 1.5, and 2% of acetic acid and stirred until the chitosan was dissolved completely. The formed chitosan solution was then taken as much as 6 mL using a syringe and dropped slowly to form small beads into a Petri dish containing NaOH 0.3 M then string into a Petri dish containing acetone 1% and dried at ±50ºC. The bead chitosan hydrogel and yarn chitosan hydrogen results were characterized in which differences of functional groups on chitosan with beads chitosan hydrogel and yarn chitosan hydrogel that occurred in the highest spectra peaks was the band at 3433.29 cm^{-1}, which indicated NH groups on chitosan had changed into an O-H group (3653.18 cm^{-1}) on the bead chitosan hydrogels 1% and yarn chitosan hydrogel 1% which showed the existence of chemical interactions. The yarn chitosan hydrogel has better absorption capability compared to bead chitosan hydrogel. Due to the surface area of the chitosan yarn hydrogel being wider than the beads' chitosan hydrogel.

Keywords: Bead Chitosan, Yarn Chitosan, High Molecular, Hydrogel

Received [21 May 2020] | Revised [16 June 2020] | Accepted [27 July 2020]

1 Introduction

Chitosan is a biopolymer of D-glucosamine produced from the deacetylation process of chitin with a strong alkali. Chitosan is a cationic polymer that is insoluble in air and alkaline solution with a pH above 6.5. Chitosan is easily soluble in organic acids such as formic acid, acetic acid, and citric acid (Rahayu & Purnavita, 2007).

The chitosan solubility in acetic acid is one of the parameters that can be used as a chitosan quality research standard. The higher the solubility of chitosan in acetic acid 2% means that the quality of chitosan produced is better (Rochima et al, 2004).

---

[*] Corresponding author at: Department of Chemistry, Faculty of Mathematics and Natural Sciences Universitas Sumatera Utara, Medan, Indonesia.

E-mail address: harryagusnar@yahoo.com

Journal Homepage: http://jcnar.usu.ac.id

The chitosan can be applied in various fields of modern industries, such as pharmaceuticals, biochemistry, cosmetics, food industry, and textile industry encouraging the development of various research that uses chitosan, including chemical or physical modification of chitosan. Physical modification of chitosan includes the change in the size of chitosan particles or granules chitosan to be smaller for wider utilization, and the development of physical and chemical modifications leading to nanoparticle shapes (Saleh et al, 1994).

Differences in chitosan shapes will affect the surface areas. The smaller the size of chitosan so the greater the surface area of chitosan and the adsorption process can take place better. Chemical modification of chitosan into chitosan gel can increase its absorption capacity. Due to the gel granules have a larger volume pore compared to the flake form, but the adsorb power of chitosan granule gel is influenced by the stability of the properties of the formed gel.

Hydrogel is a hydrophilic polymer network that is cross-linked and has a swelling capacity to absorb water or biological fluids but is insoluble due to cross-linking. In accordance with the development of technology and the need for new materials that can be applied in the fields of health. In recent years, hydrogel applications have been developed for biomedical applications. One of the hydrogel applications with promising prospects is wound dressing. This is based on the physical properties of the hydrogel and its ability to hold water and is as a surface wetting (Erizal, 2008).

Chitosan hydrogels are used in a variety of fields and are expected for further development in drug delivery, blood vessel systems, cartilage manufacturing, and wound dressings, both used as scaffold substances in food, biosensors, and adsorbents for hazardous materials (Berger et al., 2004). For other applications, it is being prepared for development and improvement such as layer by layer collected to control blood coagulation (Sakaguchi, et. al, 2003).

In simple terms, hydrogels are divided into three groups according to the original tissue, namely:

1. Network-shaped meshes

This type is limited in use due to a lack of mechanical strength and tends to be insoluble. In addition, this type also does not show easily controlled properties such as response to changes in the physicochemical environment such as pH and temperature.

2. Covalently cross-linked network

This type is the most frequently used. In this type of polymer chains are connected by cross-links. This type of network can be used for metal complexing in medium acidic. Absorption capacity depends on the extent of the network, where the wider the tissue will decrease the ability to absorb.

3. A network formed from a network of meshes and crosslinking

This network is modified from a network of meshes and cross-links, which are between the first and the second type of network.

The division of hydrogels does not have certain limitations but there is a series of unity ranging from networks in the form of meshes to networks in the form of covalently crosslinked (Berger, 2004).

Hydrogels that are chemically or physically bonded have their advantages and roles. Physically bonded hydrogels are used for relatively fast applications because the bonds are weak enough so that in dilute acid media at a certain time they will swell and eventually dissolve. It is different with chemically bonded hydrogels because the bonds are strong or difficult to change again so under acidic conditions they can last quite a long time (Varma, et.al, 2004).

Based on the description above, researchers are interested to research the comparison of the manufacture and characterization of bead chitosan hydrogel and yarn hydrogel chitosan from high molecular chitosan.

2 Materials and Methods

2.1 Equipments

In this study, the equipments used were analytical balance, hot plate, graduated cylinder, beaker glass, measuring cup, dropper pipette, volumetric pipette, petri dish, rubber ball, scoopula, magnetic stirrer, syringe, and a set of fourier transform infrared (FT-IR).

2.2 Materials

The main materials used were acetic acid (CH_3COOH) glacial, sodium hydroxide (NaOH) 0.3M, acetone 1%, distilled water, and high molecular chitosan.

2.3 Preparation of Acetic Acid 1%

As much as 5 mL of acetic acid glacial was taken using a volume pipette and put into 500 mL of the graduated flask. Next, diluted with distilled water until the marked line and then homogenized. The same procedure was conducted for 1.5% and 2% of acetic acid solutions.

2.4 Preparation of NaOH 0.3M

As much as 6 g of NaOH was dissolved with distilled water in 500 mL of to marked line and then homogenized.

2.5 Preparation of Chitosan Solution

As much as 2 g of chitosan was dissolved into 100 mL of CH_3COOH 1% solution. Then stirred using a magnetic stirrer at room temperature (25ºC) for ± 2 hours.

2.6 Fabrication of Bead Chitosan Hydrogel

As much as 6 mL of 1% of chitosan solution was measured using a graduated cylinder and inserted into the speed device. Then the chitosan solution was removed from the speed device and placed into a petri dish containing 35 mL of NaOH 0.3 M to form bead chitosan hydrogels (BCH). Next, allowed to stand for 1 hour until BCH was clearly formed. After that, the NaOH solution was discarded and washed using distilled water for 3 times until the pH was neutral. Then, dried in the oven 50ºC for 20 hours. The same procedure was performed and repeated with a concentration of CH_3COOH of 1.5% and 2% and characterized using FT-IR analysis.

2.7 Fabrication of Yarn Chitosan Hydrogel

As much as 6 mL of 1% of chitosan solution was taken and put into the speed device. Then the chitosan solution was removed from the speed device into a petri dish containing 35 mL of 1% of acetone until the yarn chitosan hydrogel (YCH) was formed. Next, allowed to stand for 1 hour until the YCH was clearly formed. Then, the NaOH solution was removed and washed by distilled water for 3 times until the pH was neutral. Then, dried in the oven at ±50ºC for 20 hours. The same procedure was conducted and repeated with a concentration of CH_3COOH of 1.5% and 2% and characterized using FT-IR analysis.

3 RESULT AND DISCUSSION

3.1 Fabrication of Bead Chitosan Hydrogel and Yarn Chitosan Hydrogel

The bead chitosan hydrogel and yarn chitosan hydrogel products were presented in figure 1 show that the immersion of chitosan in NaOH 0.3 M solution for 1 hour can form chitosan hydrogels become more apparent. After heating in the oven at 50ºC for 20 hours.

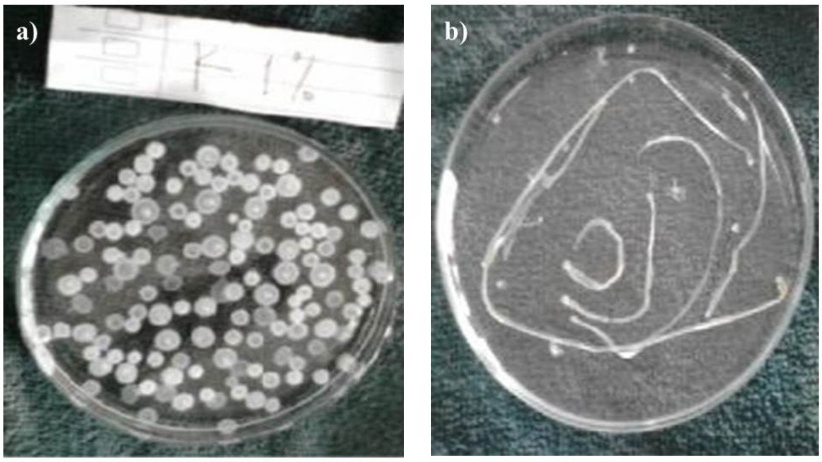

Figure 1. a). BCH and b). YCH

3.2 FT-IR Analysis

FT-IR analysis was carried out to provide information about the changes in functional groups that indicate chemical interactions of high molecular chitosan, BCH 1%, and YCH 1%. The FT-IR test results were indicated in figure 2.

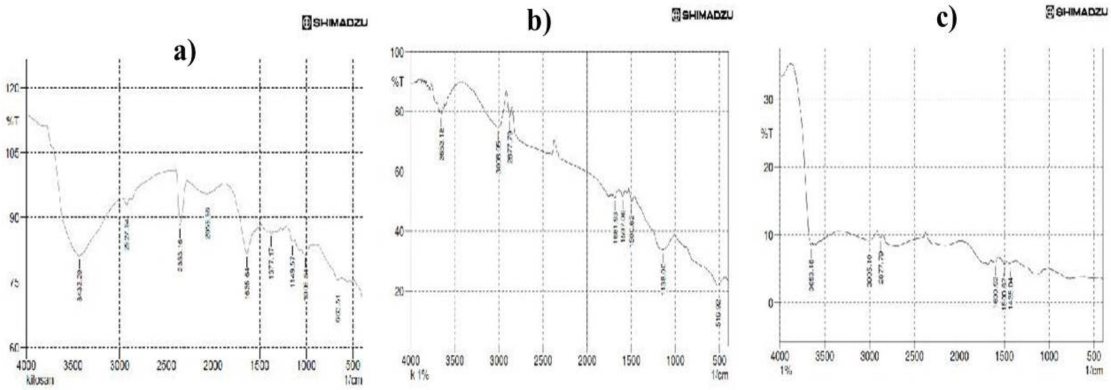

Figure 2. FT-IR spectra of a). high molecular chitosan, b). BCH 1% and c). YCH 1%

Figure 2 shows that there are differences in the functional groups of figure 2. a with figure 2. b and 2. c. at the highest peak of the spectra namely the N-H groups on chitosan change to the O-H groups on BCH and YCH. In addition, The BCH and YCH have a difference in the bands at 1681.93cm cm^{-1} and 1600.92 cm^{-1}, respectively which showed the presence of C=O bonds. On the other hand, the differences in transmittance values of each of these show the interaction between high molecular chitosan with each of the solvents to form BCH and YCH. The interaction is not only physical interactions but also chemical interactions.

4 Conclusion

In conclusion, bead chitosan hydrogel and yarn chitosan hydrogel can be produced from high molecular chitosan. YCH has a better absorption ability compared to BCH. Due to the surface area of the YCH being wider than the BCH.

References

Berger, J., Reist, M., Mayer, J.M., Felt, O., Peppas, N.A., & Gurny, R. 2004. Structure and Interactions in Covalently and Ionically Crosslinked Chitosan Hydrogels for Biomedical Applications. Europen Journal of Pharmaceutics and Biopharmaceutics 57, 19-34.

Erizal. 2008. The Effect of Hydrogel Dressing Copolymer Poli(vinylpyrrolidone) (PVP)-k-Carrageenan Prepared by Radiation and Healing Times on The Radius Reductions Burn Injured of Wistar White Rat. Indo J Chem. Vol 8. No 2:272

Rahayu, L, H dan S. Purnavita. 2007. Optimization of chitosan from chitin shell waste crab (Portunus Pelagicus) for Mercury metal Ion adsorbent: Semarang

Rochima, Sakkayawong N,P., Thiravetyan, W and Nakbanpote. 2004. Adsorption Mechanism of Reactive Dye Wastewater by Chitosan. Journal of Colloid and Interface Science 286, 36-42

Sakaguchi, Ruiz, M., Sastre, A.M, and Guibal, E. 2003. Pd and Pt Recovery Using Chitosan Gel Beads II Influence of Chemical Modifications on Sorption Properties. Separation Science and Technology 37: 2385-2403

Saleh, M.R., Abdillah., Suerman, E., Basmal, J., Indriati, N. 1994. The effect of temperature, time, and Konsentrasi solvent concentration on Ekstrasi chitosan extraction from Limbah Pengolahan frozen shrimp processing waste Beku on several Parameter quality parameters of Kitosa. Journal Of Post-Harvest Fisheries 81: 30-43

Varma, J.A., Deshpande, V.S., & Kennedy, F.J. 2004. Metal Complexation by Chitosan and Its Derivatives: a Review. Carbohydrate Polymers 55, 77-93.