JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Development of PVA based hydrogel and its Hemocompatibility Evaluation

[1]Kaushal Kumar Mahato, [2]Piyali Basak, [3]A K Banthia
[1]Assistant Professor, Pharmaceutical Biotechnology Laboratory, Radha Govind University, Jharkhand, India
[2]Associate Professor, School of Bioscience and Engineering, Jadavpur University, Kolkata, India
[3]Former Professor, Materials Research Centre, Indian Institute of Technology, Kharagpur, India
Corresponding Author-Kaushal.bme@ gmail.com

***Abstract:*Biomaterials play a significant role in healthcare applications. Different classes of biomaterials are used for their diverse applications. The most common class of biomaterials are polymeric biomaterials. To develop polymer-based biomaterials, we use natural and synthetic polymers. Hydrogels are polymeric biomaterials made up of different combinations of natural and synthetic polymers. In this research work, we have developed PVA based composite Hydrogel for medical applications**

Key Words- Hydrogel, polymer, hemocompatibility

I. INTRODUCTION

Biomaterials are engineered materials used for various medical applications.[1] These are used to restore the function of damaged organ or tissue. It can also be used for other medical applications such as prosthetic limb, tissue engineering, wound dressing, medical devices and drug delivery. Appropriate use of biomaterials can play a significant role to address several health issues and challenges. [2,3]

Therapeutic biomaterials can be classified into synthetic and natural biomaterials. Natural biomaterials are obtained from natural resources.[4] These are preferred due to its high compatibility with our living system and minimum immune response. The most common natural polymers used for fabrication of biomaterials include gelatin, chitosan, fibrin glucan and Hyaluronan. Whereas, synthetic biomaterials are developed in laboratory. Synthetic biomaterials are less biocompatible with respect to natural biomaterials. Synthetic biomaterials can be classified into two major classes such as synthetic polymers and inorganic nanomaterials. Synthetic polymers are developed using monomers and specific chemical route. During the synthesis of polymer, its composition, molecular weight and branching can be controlled. Synthetic polymers have been used for various medical applications such as scaffold preparation and controlled drug delivery [5,6]. Hydrogel can be defined as three-dimensional polymer, which can absorb significant amount of water. It remains stable in aqueous environment without dissolving its chains. [7-10] PVA hydrogel is preferred for clinical applications due to its biocompatibility and no side effect. [11-13] But it shows poor mechanical property leads to uncontrolled degradation. The aim of present research work to develop PVA and gelatine based composite hydrogel for drug delivery applications.

II.RESEARCH METHODOLOGY

Materials

Polyvinyl alcohol (PVA), mol.wt. 125000 was obtained from s.d fine chem. limited, India. Gelatine was obtained from Loba.chemiepvt. Limited. Glutardehyde (GA) solution, 25% was obtained from Merck specialities, private limited, Mumbai. Hydrochloric acid was obtained from Merck limited, Mumbai. Ethanol (B.P) was obtained from Bengal chemicals and pharmaceuticals limited, Kolkata. Potassium chloride was obtained from Merck limited, Mumbai. Potassium hydrogen phthalate was obtained from Merck limited, Mumbai. Sodium hydroxide was obtained from Ranbaxy Laboratories limited, Punjab, India. Potassium dihydrogen phosphate was obtained from Qualigens fine chemicals, Mumbai. Boric acid was obtained from Sisco research laboratories, Mumbai. Sodium chloride was obtained from Merck Specialities private limited. Trisodium citrate was obtained from s. d fine chemical limited, Mumbai.

- **Preparation of Poly (vinyl alcohol) hydrogel:**

  For this, 5 gram of poly (vinyl alcohol) was dissolved in 100 ml distilled water at 95°C with half an hour continuous stirring. Then 12.5 ml of GA reagent was added drop wise into PVA solution with stirring. The PVA film was obtained by solution casting method. The film was dried at room temperature in laminar air flow drier.

- **Preparation of Gelatine hydrogel:**

  5 gram of gelatine was dissolved in 100 ml distilled water at 60°C with half an hour continuous stirring. Then 13.5 ml of GA reagent was added drop wise into gelatin solution with stirring. The gelatine film was obtained by solution casting method. The film was dried at room temperature in laminar air flow drier.

- **Preparation of PVA-Gelatine hydrogels**:

  Dissolve 5 gram of PVA in 100 ml distilled water. To the 5% (w/v) PVA solution gelatine (0.75gm or 0.50gm or 0.25 gm) was added with constant stirring. Now heat this solution on water bath for 30 minute to get homogenous solution. The heated solution cooled to room temperature. To this solution, add GA reagent drop wise with constant stirring. The resulting solution was stirred on magnetic stirrer for half an hour. The solution was converted into membrane by solution casting method. The membranes were dried at room temperature.

Table 1: Composition of PVA-gelatine hydrogel

Sample Designation	PVA (gm)	Gelatine (gm)	Distilled water (ml)
PG-1	5	0.25	100
PG-2	5	0.50	100
PG-3	5	0.75	100

Hemocompatibility Evaluation

In the present work the hemocompatibility tests were carried out broadly on the basis of slightly modified ASTM standard [100]. The test is mainly aimed at finding the extent of hemolysis caused in the presence of the sample prepared. The hemolysis percentage is defined as

$$\% \text{ Hemolysis} = \{(OD_{test} - OD_{negative}) / (OD_{positive} - OD_{negative})\} \times 100$$

For this purpose goat's blood was collected in a beaker containing sodium citrate in the proportion of 3.8 gram of sodium citrate per 100 ml of blood to avoid coagulation .The citrated blood was then diluted with normal saline in the proportion of 8: 10.For checking hemolysis,0.2 ml of diluted blood was added to 0.5 ml of 0.01N hydrochloric acid (HCl) ,which was further diluted to 10 ml with normal saline and incubated at 37°C for 60 minute .The OD of the incubated solution was measured in a spectrophotometer at 545 nm. Since HCl is known to cause large scale rupture of RBC, the OD count of the solution was taken as positive control and was designated as $OD_{positive}$. Similarly, for negative control 0.2 ml of diluted blood was diluted to 10 ml with normal saline and was incubated at 37°C for 60 minutes. The OD of the solution was measured in a spectrophotometer at 545 nm and the same was designated as $OD_{negative}$. The reason for adding normal saline for negative control test was that it is known to cause least RBC rupture. Having obtained the two standard OD, the OD of the test material was obtained in similar lines. Samples (5 mm× 5 mm) was taken in a standard test tube containing normal saline and was incubated at 37°c for 30 minutes for providing temperature equilibrium. Diluted blood (0.2 ml) was then added to the test tube, mixed gently and incubated for 60 minutes. The OD of the sample was designated as OD test. As per accepted norm, for a hemolysis percentage less than 5, the test material was considered highly hemocompatible and a value less than 10 as hemocompatible. In a similar experiment, chelated human blood (with EDTA) was used to study the hemocompatibility of the product with the human blood.

III.RESULTS AND DISCUSSION

Table 2: Hemocompatibility result of PVA-gelatine hydrogel

	OD at 545 nm	% Hemolysis	Remarks
Positive control	0.654		
Negative control	0.035		
PG1	0.088	8.5	Hemocompatibility
PG2	0.090	8.8	Hemocompatibility
PG3	0.096	9.85	Hemocompatibility

The higher value of % hemolysis occurs may be due to unreacted glutaraldehyde present in the developed hydrogels. It can be reduced by appropriate chemical treatment. Since the % hemolysis of prepared hydrogels was found less than 10%. So these hydrogels are hemocompatibility in nature and can be used for wound healing and drug delivery applications.

IV.ACKNOWLEDGMENT

I would like to thank my supervisor, Prof A K Banthia, for giving me the opportunity to work in his lab at IIT KGP, and mentoring during master's project work. I would like thank Dr Piyali Basak, Supervisor at Jadavpur university for continuous support and motivation.

V.REFERENCES

1. Bhat, S., Kumar, A. Biomaterials and bioengineering tomorrow's healthcare. *Biomatter* 3.3 (2013): e24717.
2. Ratner, B. D., Bryant, S. J. Biomaterials: where we have been and where we are going. *Annu. Rev. Biomed. Eng.* 6 (2004): 41-75.
3. Gu, L., Mooney, D. J. Biomaterials and emerging anticancer therapeutics: engineering the microenvironment. *Nature Reviews Cancer* 16.1 (2016): 56.
4. Khaing, Z. Z., Schmidt, C. E. Advances in natural biomaterials for nerve tissue repair. *Neuroscience letters* 519.2 (2012): 103-114.
5. Pariente, J. L., Kim, B. S., Atala, A. In vitro biocompatibility assessment of naturally derived and synthetic biomaterials using normal human urothelial cells. *Journal of Biomedical Materials Research Part A* 55.1 (2001): 33-39.
6. Kim, J. K., Kim, H. J., Chung, J. Y., Lee, J. H., Young, S. B., Kim, Y. H. Natural and synthetic biomaterials for controlled drug delivery. *Archives of pharmacal research* 37.1 (2014): 60-68.
7. Janani Radhakrishnan, Uma Maheswari Krishnan, Swaminathan Sethuraman (2014) Hydrogel based injectable scaffolds for cardiac tissue regeneration. Biotech Adv (32)2: 449-461.
8. Thambi Thavasyappan, Doo Sung Lee (2017) Injectable hydrogels for sustained release of therapeutic agents. J Controlled Release 267: 57-66.
9. Hoffman Allan S (2012) Hydrogels for biomedical applications. Adv Drug Del Rev 64:18-23.
10. FaheemAkhtar Muhammad, Muhammad Hanif, Nazar Muhammad Ranjha (2016) Methods of synthesis of hydrogels A review. Saudi Pharm J 24, 554-559.
11. Yoshida, R., Sakai, K., Ukano, T. *et al.* (1991), "Surface-Modulated Skin Layers of Thermal Responsive Hydrogels as on-off Switches: I. Drug Release", *J. Biomater. Sci. Polym. Ed.*, 3(2), 155-162.
12. Woerly, S. (1997), "Porous Hydrogels for Neural Tissue Engineering", *Mater. Sci. Forum*, 250, 53-68.
13. You, C., Zhang, Z.F. and Tong, X. (2007), "Preparation and Property of PVA/Glutin/ StartchHydrogel",*China Plastics Industry*, 35(2), 47-49.