INNOVARE JOURNAL OF SCIENCES

Vol 1, Issue 1 , 2013

Research Article

FORMULATION AND EVALUATION OF HYDROGEL WITH ASCORBIC ACID USING ALOE VERA GEL POWDER AS A DRUG CARRIER

OJHA KHYATI, SHENOY VRANDA, GUPTA SAUMYA, SUSEEM S.R.[2]*

[1]School of Biosciences and Technology; [2]School of Advanced Sciences, VIT University, Vellore 632014, Tamil Nadu, India* Dr. S. R. Suseem, Assistant Professor (Senior), Pharmaceutical Chemistry Division, School of Advanced Sciences, VIT University, Vellore 632014, Tamil Nadu, IndiaEmail: suseem_sr@yahoo.co.in

Received:10 May 2013, Revised and Accepted:12 May 2013

ABSTRACT

Objective: The aim of this study is to develop a controlled release hydrogel and to evaluate the efficiency of its drug delivery. Even though the synthetic polymer drug carriers will be safely metabolized, they will not impart any health benefit unlike the natural carriers such as starch and Aloe vera. Hence, in the present investigation in vitro release characteristics of ascorbic acid based hydrogel formulated using Aloe vera gel powder as a drug carrier and nutrient fortifying excipient has been used.

Methods: Hydrogel is a recent approach of sustained drug delivery which is advantageous because of its unique drug release patterns like swelling and diffusion. Vitamin C is a well known antioxidant which scavenges free radicals and Aloe vera enhances the bioavailability of vitamin C which is also protecting it from degradation along with its other essential properties.

Results: Various evaluation parameters have been carried out such as swelling studies and in vitro release studies. These evaluation studies results have shown that maximum swelling percentage was seen at pH 1.4 and least in distilled water which imparts that even in acidic medium the formulated hydrogel can outlive. Appreciable swelling was seen in pH 5.4 and 7.4. Furthermore, the hydrogel was seen to undergo disintegration in distilled water.

Conclusion: The in vitro release studies showed that the drug was released at a pre-determined rate over a controlled period of time hence it can be used in sustained drug delivery. The materials used in this study are bio available and biocompatible hence will not impart any toxicity and side-effects.

Keywords: Hydrogel, ascorbic acid, Aloe vera, gelatin, swelling, starch.

INTRODUCTION

Metabolic equilibrium is maintained in homeostasis but an imbalance in it can lead to oxidative stress. Many medicaments in the form of antioxidants are presently available but they are not effective in the bioavailability because of their rapid systemic drug release patterns. The conventional drugs available in the market possess many drawbacks such as their systemic release patterns are not uniform as the drug delivery is not of controlled form, neither are they targeted in their action, further there are chances of inducing side effects.

The recent approach in drug delivery systems is targeted drug delivery system where in many delivery forms are possible such as hydrogels, liposomes, resealed erythrocytes, niosomes, nanoparticles, microspheres and magnetic microspheres. Hydrogel is a recent approach wherein the shortcomings of conventional dosage forms have been circumvented with the introduction of controlled release dosage forms. They are capable of controlling the rate of drug delivery, leading to more sustained drug levels further it increases their systemic availability and thus leads to an increased therapeutic action [1].

A hydrogel is a three-dimensionally cross-linked hydrophilic polymer network that may absorb and retains large amount of water up to thousands of times its dry weight. The excellent biocompatibility property of hydrogels makes them most promising for applications such as tissue engineering and drug delivery [2]. Water absorbed by hydrogel is not released under ordinary conditions [3]. A general notion is that the diffusion of these molecules is in relation with molecular variables such as the size of the solute, molecular interaction of the solute with the polymer chain of hydrogel, the degree of its cross-linking and as well as some environmental variables such as the pH, temperature and electric field [4].

Vitamin C is a powerful antioxidant [5] it acts as “scavengers” and prevents the free radicals from oxidizing the cells in our body. Present investigation involves the use of a natural carrier such as *Aloe vera* gel powder having inherent tremendous medicinal values [6]. It is noted that *Aloe vera* gel powder may enhance the intestinal absorption, effective delivery of poorly absorbable drugs, sustained release of pharmaceutical dosage forms, protection against degradation of vitamins and the enhancement of bioavailability of vitamin C. When taken internally along with the drug it may improve the digestive musculo-skeletal and immune-related conditions apart from acting as an antioxidant [7-9].

The gelatin starch mediated hydrogel is a very novel approach as till date research have not been performed using gelatin and starch combined with *Aloe vera* gel powder and poly vinyl pyrrolidone. The cross-linker used poly vinyl pyrrolidone helps in cross-linking by providing framework to the hydrogel. The parenteral mediated hydrogel drug delivery is administered by needle 16-20 number size. The drug used in the present study is Ascorbic Acid. Its chemical formula is $C_6H_8O_6$ and the IUPAC name is (R)-5-[(S)-1, 2-dihydroxyethyl)-3, 4-dihydroxy-5(H)-furan-2-one. In living organisms L-Ascorbic acid acts as an antioxidant by protecting the body against oxidative stress. It is also a cofactor in at least eight enzymatic reactions including several collagen synthesis reactions that, when dysfunctional, cause the most severe symptoms of scurvy.

Hydrogels of natural polymers, especially polysaccharides, have been used recently because of their unique advantages. Polysaccharides are, in general, non-toxic, biodegradable and abundant [10]. Moreover, natural polymers are biocompatible and enhance the drug release efficacy with reduced toxicity and improved patient compliance with *in vivo* degradation at a well

defined rate [11] and hence starch was used in association with poly vinyl pyrrolidone in our present study.

MATERIALS AND METHODS

Materials

The chemicals such as ascorbic acid, poly vinyl pyrrolidone, gelatin, starch were procured from sigma aldrich chemicals ltd, Bangalore. All the chemicals and reagents were used for the present study was in analytical grade. *Aloe vera* gel powder, distilled water, and millipore water were used for the preparation and purification of hydrogels.

Methods

Preparation of *Aloe vera* gel

The leaves of Aloe vera plant were collected. Freshly cut *Aloe vera* leaves were washed with millipore water and then cut open to collect the gel. The gel is then washed with Millipore distilled water and air dried for two days under ambient condition and then at 50ºC in a hot-air oven for four days to get a solid dry mass. This was then converted into fine powder by mechanical grinding and sieving. The *Aloe vera* gel powder is then stored under refrigeration [12].

Preparation of hydrogel with drug by chemical cross-linking method

Ascorbic acid, *Aloe vera* gel powder, gelatin and starch were weighed. Melting point of gelatin and starch were noted. Both were separately dissolved in hot water and kept in hot water bath until a clear solution was obtained. The two solutions were mixed with constant stirring and were cooled to room temperature. To this ascorbic acid solution along with *Aloe vera* gel powder was added with constant stirring. The setup was then kept on a rotary shaker for uniform mixing. To this emulsion poly vinyl pyrrolidone solution was added and thus hydrogel was formed.

Evaluation of hydrogel

The following evaluation parameters were studied in the present work

In vitro release studies of ascorbic acid

The hydrogel (1 gm) was taken in 900 ml of 0.1 M hydrochloric acid in a dissolution apparatus. *In vivo* conditions were simulated by maintaining the temperature at 37 ± 1°C , 50 rpm in a dissolution apparatus. Aliquots were taken at regular intervals and analyzed spectroscopically at 244 nm [13].

Swelling behaviour of hydrogel

The hydrogel (0.5 gm) was immersed directly in freshly prepared 0.1 M Phosphate buffer of pH 1.4, 5.4, 7.4 and distilled water for 48 hours at room temperature to study the swelling behaviour. The swollen product was then weighed again to get the final weight and percentage swelling was calculated as follows: % Swelling = (W e - W d) / W d × 100; Where W_e is the weight of the product after hydration for 48 hours, and W_d is the weight of the dried product [14].

RESULTS AND DISCUSSION

Formulation of Hydrogel

An amber coloured, translucent, viscous hydrogel was formed from starch and gelatin which can be seen in Figure 1. It is enriched with ascorbic acid and *Aloe vera* gel powder as the drug carrier. The gel was cross-linked properly on the addition of 1 ml of aqueous solution of PVP which provided the framework.

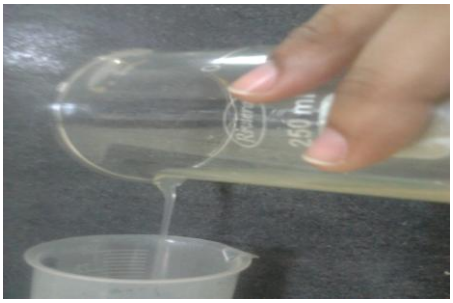

Fig. 1: Ascorbic acid loaded hydrogel formulation

In vitro release studies

In vitro release studies are essential to know the amount of drug released, since hydrogel is a form of controlled drug release. The amount of ascorbic acid released at the intervals of 1 hour was determined at 244 nm using UV-Vis Spectrophotometer which can be seen in Table 1.

Table 1: *In vitro* release studies of ascorbic acid loaded hydrogel

Time (hour)	Amount of ascorbic acid released (gm/L)
1	3.32
2	5.39
3	7.40

The Table 1 signifies that as the time increases the amount of drug released also increases. This is mainly because of increase the swelling property of hydrogel in water and the space between polymer chains becomes large. Hence the drugs with appreciable water solubility, like ascorbic acid, will thus release rapidly. The absorbance of ascorbic acid at 244 nm is then seen after every one hour intervals and is depicted in Figure 2, 3 and 4.

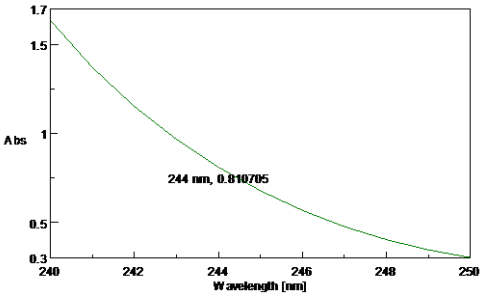

Fig. 2: Absorbance of ascorbic acid after 1 hour

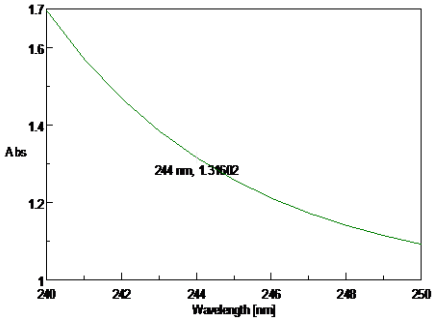

Fig. 3: Absorbance of ascorbic acid after 2 hours

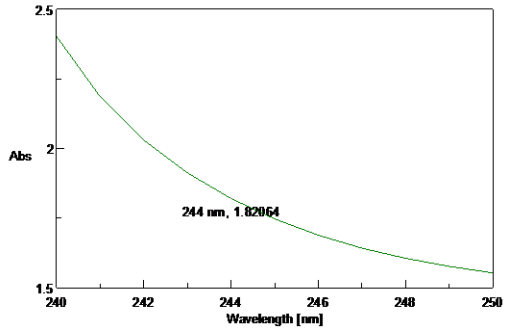

Fig. 4: Absorbance of ascorbic acid after 3 hours

The Figures 2, 3 and 4 clearly depict that the *in vitro* release of the drug has been increased with respect to the increase in time.

Percentage of Swelling

Swelling is the most important property of the hydrogel. This is possible since the polymers swell without dissolving in an aqueous biological environment. At equilibrium, the gels comprise 60-90 % fluid and only 10-30 % polymer. The hydrogels swell in water and the space between polymer chains becomes large as can be seen in Figure 5.

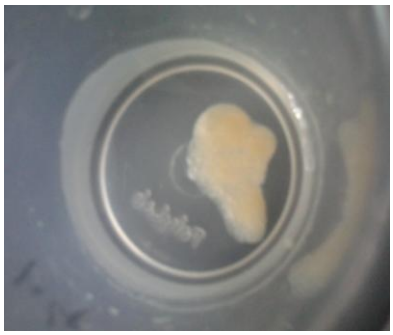

Figure 5: Swelling of hydrogel implies the release of drug through diffusion

Thus, the release of low molecular weight drugs from the hydrogel will not be hindered by the presence of polymer networks, but depends primarily on the solubility of the drugs. Drugs with appreciable water solubility, like ascorbic acid, will be released quite rapidly. In this study, the swelling behaviour of gelatin-starch hydrogel was studied at different pH which is discussed in Table 2.

Table 2: Percentage swelling of hydrogel at different pH

pH	% swelling
Distilled water	5.2
1.4	110.4
5.4	64
7.4	79.8

Table 2, reveals that the percentage of swelling is considerably good at various pH which implies that as the swelling percentage increases more, and drug is diffused in the system.

From the Table 2, it is evident that maximum swelling percentage was observed in pH 1.4 and least in distilled water. Appreciable swelling was seen in pH 5.4 and 7.4. Furthermore, the hydrogel was seen to undergo disintegration in distilled water. Hence it is suggested that along with the normal pH conditions even at low pH state the formulated hydrogel can successfully release its drug contents.

CONCLUSION

Ascorbic acid hydrogel preparation represents a feasible and productive approach to deliver antioxidants in a controlled manner. Polymers with desired hydrophilicity and hydrophobicity can be chosen to impart the desirable dissolution and drug release patterns in the present study. In addition, the materials used in the hydrogel's preparation are bio-available, bio-compatible with non-toxicity. From the results it can be clearly concluded that the diffusion of ascorbic acid from the hydrogel has gradually increased with respect to time suggesting that the drug is released at a pre-determined rate over a controlled period of time.

REFERENCES

1. Shaikh Rahamathullah. Design and evaluation of controlled release layered matrix tablets of Paracetamol and Verapamil HCl. Masters Thesis, Universiti Sains Malaysia, 2009.
2. Brondsted H, Kopecek J, Harland RS, Prud'homme RK Eds. In Polyelectrolyte Gels. ACS Symposium Series 480. American Chemical Society. Washington, DC, 1992; Chapter 17.
3. Kunal Pal, Banthia AK and Majumdar DK. Starch based hydrogel with potential biomedical application as artificial skin. African Journal of Biomedical Research 2006; 9: 23-29
4. Yasuda K et al., Biomechanical properties of high-toughness double network hydrogels. Biomaterials 2005; 26: 4468-4475.
5. Gramlich G, Zhang J, Nau WM. Increased Antioxidant Reactivity of Vitamin C at low pH in Model Membranes. J. Am. Chem. Soc. 2002; 124: 11252-11253.
6. Eshun K, He Q. Aloe vera: A valuable ingredient for the food, pharmaceutical and cosmetic industries. A review, Crit. Rev. Food Sci. Nutr. 2004; 44: 91-96.
7. Shelton RM. Aloe vera: Its chemical and therapeutic properties. Int. J. Dermatol. 1991; 30: 679- 683.
8. Madan J, Sharma AK, Singh R. Fast Dissolving Tablets of Aloe Vera Gel. Trop. J. Pharm. Res. 2009; 8(1): 63-70.
9. Hamman HH. Composition and applications of Aloe Vera gel. Molecules 2008; 13: 1599-1616.
10. Cascone MG, Barbani N, Cristallini C, Giusti P, Ciardelli G and Lazzeri L. Bioartificial polymeric materials based on polysaccharides. Journal of Biomaterials Science, Polymer (2001); 3(12): 267–281.
11. Choi S, Chung, MH. A review on the relationship between Aloe vera components and their biologic effects. Semin. Integr. Med. 2003; 1: 53-62.
12. Subramanian K, Narmadha S, Vishnupriya U, Vijayakumar V. Release characteristics of Aspirin and Paracetamol drugs from tablets with Aloe vera gel powder as a drug carrier. Drug Invention Today 2010; 2(9): 424-428.
13. Government of India. Ministry of Health and Social Welfare. Indian Pharmacopoeia. The Controller of Publication, New Delhi; 1996.
14. Pal K, Banthia AK, Majumdar DK. Preparation and Characterization of Polyvinyl Alcohol–Gelatin Hydrogel Membranes for Biomedical Applications. AAPS PharmSciTech. 2007; 8(1): E142-E146.