Radiation Synthesis and Characterization of Polyvinyl alcohol/Acrylic acid Hydrogel and its Amoxicillin drug Delivery application

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ABSTRACT

Polyvinyl alcohol /Acrylic acid based hydrogels can be synthesized by Gamma radiation technique using ^{60}Co irradiation cell at irradiation dose rate 1.8 Gray/second. The optimum conditions of hydrogel preparation takes place at different factors such as composition ratios of PVA/AAc, different co-monomer concentration and different irradiation doses resulting in hydrogel with maximum gel percent as it obtained 98%. The structures of hydrogels were characterized by FTIR analysis. The results can be confirmed the expected structures as well as free radical copolymerization. According to the swelling studies, hydrogels with high content of AAc gave relatively high swelling percent. The hydrogel showed a super adsorbent with swelling capacity 10320 %. Water diffusion into such prepared hydrogel showed a non-Fickian type where a Fickian number was 0.77. This hydrogel was used for the adsorption of amoxicillin drug from their aqueous solutions. The factors affected on the uptake conditions such as pH, time and initial feed concentration on the amoxicillin adsorption capacity of hydrogel was studied depending on Freundlish model of adsorption isotherm.. It was observed that the interaction between drug and ionic comonomers was enhanced in alkaline medium and high initial feed concentration of the drug. The ability of the hydrogel and the affinity of the drug to be adsorbed can be cleared by determining the empirical constants **n** and **k** respectively from the logarithmic form of Freundlish equation. The recovery of drug was also investigated in different pH values to study the suitable condition of drug release as drug delivery system.

Keywords, Gamma radiation, Hydrogels, Free radicals, Swelling, Adsorption; Controlled releasing.

INTRODUCTION

Hydrogels have the ability to absorb water, water-soluble molecules and

ions without loss of shape and mechanical strength [1].   There are great researches interest in the field of hydrogels because they find already industrial application and are promising materials for instance in biomedical applications for controlled drug release [2]. Natural hydrogels have the unique advantage of being compatible with living tissues. Typically the gels are fixed to support by coating, grafting and chemical linkages [3]. A special emerging topic regards the so-called smart hydrogels [4] where the hydrogel systems respond to external stimuli with physical changes in their shape. For instance, smart hydrogels have been described which are thermal-, pH-, electrical potential sensitive[5].The insolubility and stability of the hydrogel shape are due to the presence of a three-dimensional network which acts as a cage for the water molecules and other dissolved molecules and ions. Cross-links in hydrogel can be achieved by chemical cross-linkers [6] or free radical radiation copolymerization [7].It is more easy and practical to use ionizing radiation to crosslink the polymer chains and prepare quite easily an hydrogel [8]. Among the recently developed super absorbents, acrylic acid (AA)-based super absorbents have been extensively studied because AA is cheap and easily polymerized to a high molecular weight polymer. Many investigators prepared modified AA-based super-absorbents to enhance absorbency [9].

Hydrogels have a unique combination of characteristics that make them useful in drug delivery applications. Due to their hydrophilicity, hydrogels can imbibe large amounts of water. Therefore, the molecule release mechanisms from hydrogels are very different from hydrophobic polymers. Both simple and sophisticated models have been previously developed to predict the release of an active agent from a hydrogel device as a function of time. Diffusion-controlled is the most widely applicable mechanism for describing drug release from hydrogels Fick's law of diffusion with either constant or variable diffusion coefficients is commonly used in modeling diffusion-controlled release [10]. Swelling-controlled release occurs when diffusion of drug is faster than hydrogel swelling [11].. The most common reactions that occur within hydrogel delivery systems are cleavage of polymer chains via hydrolytic or enzymatic degradation or reversible or irreversible reactions occurring between the polymer network and releasable drug [12]. Under certain conditions the surface or bulk erosion of hydrogels will control the rate of drug release [13]. Chemically-controlled release can be further categorized according to the type of chemical reaction occurring during drug release. Generally, the liberation of encapsulated or tethered drugs can occur through the degradation of pendant

chains or during surface erosion or bulk-degradation of the polymer back bone [14-16].

In this study, AAc-based super absorbent interpenetrated with poly vinyl alcohol (PVA) prepared by radiation copolymerization method showed higher water and drug absorbency than AAc-based super absorbent due to higher ionic charge content and their high hydrophobic character by carboxylic groups. Although the main method for synthesis of AAc based super-absorbent is by gamma radiation techniques. The polymerization conditions and the synthesized super-absorbents were investigated. Their effects on the absorbency of water will be studied by Fick,s low of water diffusion. The adsorption capacity of amoxicillin drug can be represented by Freundlish adsorption isotherm The releasing of the drug from the hydrogel will be studied as a controlled (slow release) and burst release (fast release).

EXPERIMENTAL

1. Materials

Acrylic acid AAc and poly(vinyl alcohol PVA (with the average molecular weight 19,000) were supplied from Aldrich Chemical Co., Inc. Amoxicillin antibiotic drug was supplied from, Glaxo-Smith-Kline Co., British as an active ingredient dissolved in distilled water and measured at UV-Visible spectroscopic analysis at wavelength λ 273 nm and all the concentration of the drug can be determined by its linear standard calibration curve.
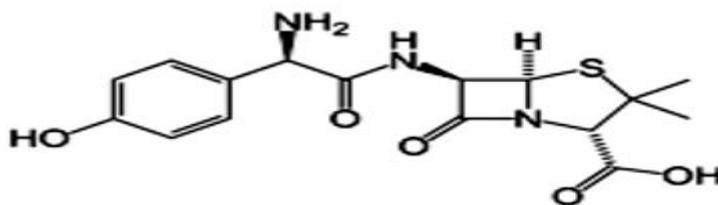
Amoxicelline

2. Preparation of PVA/AAc Hydrogel

The mixture of 1 ml of PVA (10 % concentration in water) and 0.2, 0.5, 1.0, 1.5, 1.8 and 2.0 ml of AAc in water was prepared as co-monomer ratio. The mixture of monomers in aqueous solutions were placed into a number of PVC tubes of 4 mm diameter and irradiated to 2 , 4, 6 ,8 and 10 kGy at a fixed dose rate of 1.82 Gy/sec., at ambient temperature in Gamma cell 220 type Gamma-irradiator of ^{60}Co gamma radiation. The copolymers P(PVA/AAc) obtained

from different compositions, irradiation doses and different concentrations were subjected to soxlet extraction apparatus with water as a solvent at $80^{o}C$ for 4 hours. After that; the gel yield of each was taken and dried under vacuum at $50^{0}C$ up to a constant weight for each.. Uncross-linked polymer and / or residual monomers may be included after the copolymerization process can removed from the gel structure by this extraction.

The gel fraction yield in the hydrogel was determined from the following equation:

$$\text{Gel (\%)} = (w_e/w_d) \text{ x } 100 \qquad (1)$$

Where w_d and w_e represent the weights of the dry hydrogel and the gelled part after extraction, respectively.

3. Spectroscopic analysis

An FTIR spectrometer (MIDAC Co. USA) was used for IR analysis

4. Water absorbency

Approximately 1 g of dried super absorbents were dispersed in 60 ml of de-ionized water for 30 min. The weight of the super absorbent containing absorbed water was measured after draining for 1 h, and the water absorbency was calculated according to the following equation:

$$W\text{ater uptake }\% = \frac{W_2 - W_1}{W_1}X100$$

Where: W_1 and W_2 are the weight of the dry and swollen hydrogel super-absorbent, respectively. The water–uptake process was monitored by the determination of the swelling ratio of the hydrogel at desired time intervals as previously described. For the kinetic analysis of the results; Fick's law [17] was applied :

$$F = W_t/W_\infty = k\, t^n \qquad (3)$$

Therefore; $\qquad \ln F = \ln k + n \ln t \qquad (4)$

Where; k is the swelling rate front factor which related to the structure of the network and the exponential n is a number which determine the type of diffusion The constants k and n are obtained from the intercept and the slope of the Fick's straight line relationship. W_t is the water uptakes at time t and W_∞ is the water uptake at the time of equilibrium. F denotes the amount of water absorbed at time t.

The kinetic of water–sorption mechanism study; as well as the type of water diffusion inside the polymeric network structure; the *n* value must be determined. For instance *n* = 0.5 shows Fickian type in which the sorption is diffusion controlled   whereas; a value of *n* > 0.5-1.0 indicates a non Fickian type which contributes to the water–sorption process.

5. Loading of drug onto hydrogel

Adsorption isotherm method by batching experiment were carried out using the bottle–pointed method where one gram of dry hydrogel discs the three different compositions 10/90, 20/80, 35/65 and 30/70 of P(PVA/AAc) as adsorbent materials . A series number of concentrations 10, 20, 40, 60, 80 and 100% of stock initial drug concentration 680 mg % with constant volumes 20 ml (V) for each bottle containing the adsorbent polymeric hydrogel .The samples were shaken well for 24 hours and then left to four days; to ensure adsorption equilibrium state. The concentrations of drug at equilibrium C_e were determined   using UV-visible spectrometer Unicam. 1000 model at wavelength 273nm where, the calibration curve was put through UV absorption intensity measurements of pure amoxicillin drug concentration ranged from 0-680 mg%. Therefore; q_e values are calculated from the following equation:

$$q_e = x/m = (C_i - C_e) \, V / 1000 \qquad (5)$$

Where, q_e is the weight **x** in (mg) of drug adsorbed per one gram (g) of dry hydrogel adsorbent, C_i and C_e are the initial and equilibrium concentrations of drug adsorbate solution in mg/ml while **V** is the volume of drug solution in (ml) used in the batch adsorption process.

The Freundlish equation [18] was employed to describe the adsorption data for drug compound as follows

$$q_e = k \, C_e^{1/n} \qquad (6)$$

$$\log q_e = \log k + 1/n \log C_e \qquad (7)$$

Where; **k** and **n** are the Freundlish empirical constants.

6. Releasing of drug from loaded hydrogel

Release experiments were performed by placing the PVA/AAc hydrogels loaded with amoxicillin into buffer solution at pH 8.At first, the loaded drug concentration onto gel as well as 680 mg / ml were prepared in 25 ml of 0.2 M phosphate buffer (pH 8). One milliliter sample was withdrawn on time intervals to follow the release process for 24 hour. The concentration of amoxicillin was measured using the standard calibration curve at wavelength

273 nm. The total uncertainly for all experiments ranged from 2 to 3%.The burst release of adsorbed amoxicillin as a specific adsorption (physical adsorption) from the hydrogel at pH 8.While the controlled release of non specific adsorbed amoxicillin(chemical adsorption) takes place at other lower pH values. The percentage release of amoxicillin drug at pH 8 was calculated from the following equation:

$$\textbf{Releasing\quad percent = (w/w_{total}) \; x \; 100} \qquad\qquad \textbf{(8)}$$

Where w is the weight of released amoxicillin drug at pH 8 and w_{total} is the total weight of specific and non-specific adsorbed amoxicillin drug in the gel system.

RESULTS AND DISCUSSION

1. Gelation studies

A. Effect of comonomer concentration on gel content at different irradiation dose

Figure (1) shows the effect of comonomer concentration on the gel percent as calculated from equation (1) at a constant composition ratio 35/65 as PVA/AAc. The study takes place at different irradiation dose ranged from 2-10 kGy. Both PVA and AAc monomers were dissolved in water as 70 % comonomer concentration.**:**
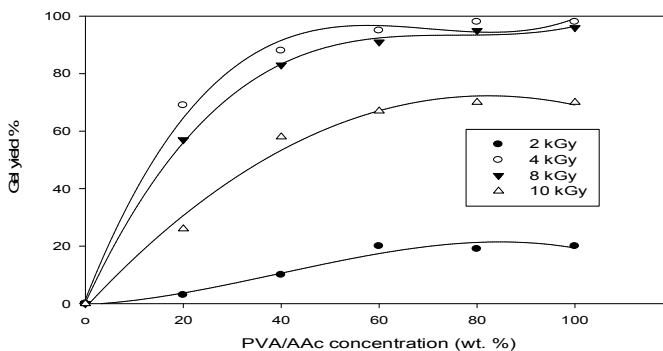

Fig. (1): Effect of PVA/ AAc as comonomer concentration on the gel yield percent at   different irradiation doses.

It is clear that the gel percent increases as the comonomer concentration increases too and the maximum gel percent occurs at 70% comonomer concentration for all the doses studied. These results explained that as the concentration increase; the free radicals become rich. Accordingly; the possible monomer– monomer interaction is higher more than monomer–solvent or solvent-solvent interaction [1] and therefore; the AAc free radicals interacted and

crosslinked through the PVA chains than the other interactions. So; the obtained hydrogel having a maximum gel fraction yield percent as well as 98% where all the PVA chains are completely and saturated crosslinked than the other lower comonomer concentration (lower than 70%).Also, it was found that the copolymerization reaction resulting in the incremental of the gel yield content with increasing the irradiation dose up to 4 kGy and after that at 8 and 10 kGy the gel sample becomes rigid in its consistence due to high density of crosslinking formed in the polymeric chains as well as the high crosslinking in the network structure.

Effect of AAc content

The influence of PVA/AAc composition on the gel fraction yield formed in the respective copolymer hydrogel was determined and shown in Figure (2) at constant concentration 70% and dose 4 kGy.
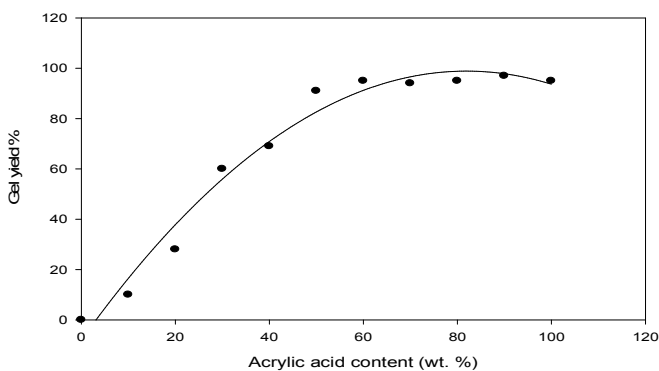

Fig. (2): Effect of AAc content of PVA/AAc hydrogel on gel yield   percent at   irradiation dose 4 kGy

It is observed that as the AAc content increases, the gel fraction yield increases. This behavior was observed for PVA/AAc hydrogel in which the content of gel is slightly higher for 35/65 to 30/70 comonomer compositions than the other compositions. These results indicated that the enhancement of the crosslinking process arises by the AAc monomer- free radicals rich solution and also the enhancement of such free radicals producing high cross-linking percent.

Spectroscopic analysis studies

FTIR spectroscopic analysis

FTIR spectroscopic analysis showed that the vinyl groups located around 1660 cm^{-1} in both acrylic acid (AAc) and Polyvinyl alcohol (PVA) are

interest to be studied. The vinyl stretching vibration band for both monomers is responsible on the free radicals formation that combined with each other to produce the expected copolymer hydrogel. The prepared hydrogel P(PVA/AAc) showed the disappearance of the vinyl group C=C at wave number 1660 cm^{-1}. This band which indicated the copolymerization of carbon =carbon as SP^2 hybridization by gamma radiation through cleavage the π bond and resulting in the formation of free radicals referring to the complete compensation of vinyl groups. On other hand; the C-C stretching vibration band increases its intensity at 1370 cm^{-1} due to increase the cross linking of polyvinyl alcohol and acrylic acid free radicals in their copolymerization.
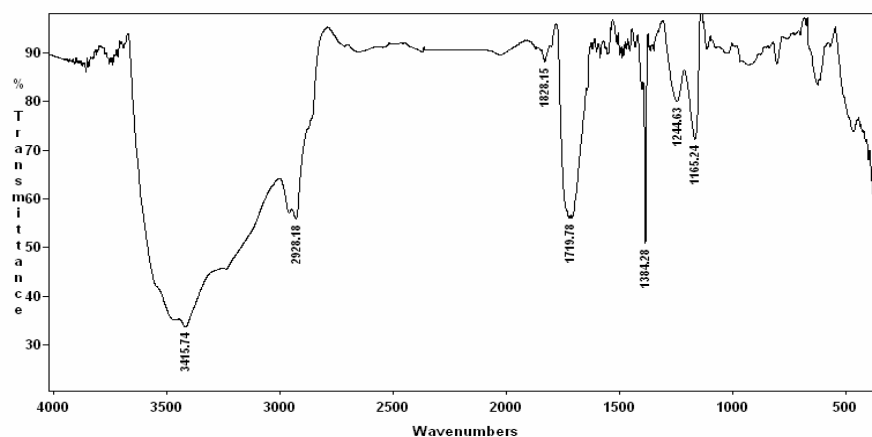

Fig.(3): FTIR spectrum for PVA/ AAc Hydrogel 35/65 composition ratio, comonomer concentration 70% and irradiation dose 4kGy

2. Swelling studies

The equilibrium degree of swelling of the hydrogel can be calculated from equation (2) as illustrated before. The degree of swelling was influenced by different factors discussed below:

Effect of time on the swelling behavior

Figure (4) shows the swelling percent of PVA/AAc copolymer as a function of time immersed in aqueous solution of different pH values 3,6 and 8. It is observed that the swelling process increases with increasing of immersion time for each pH. The highest percent of swelling was obtained after about 8 hours. However, the highest swelling occurs at composition 35/65 at alkaline pH than the neutral and much higher than in the acidic medium.
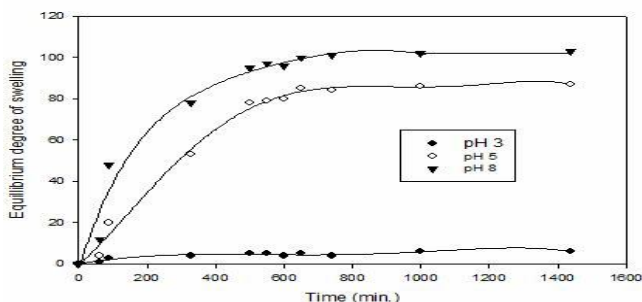
Fig. (4): Effect of time (min.) on the equilibrium degree of swelling at different pH values 3,5 and 8 under commoner composition 35/65 and comonomer concentration 70% , at irradiation dose 4 kGy and dose rate 1.82 Gy/s.

These results can be explained by the fact that, the maximum extent of equilibrium degree of swelling was at pH 8 where a complete dissociation of carboxylic acid COOH groups of AAc occurred by their deprotonation [3]. The dissociation of COOH groups can be confirmed by measuring the pH values after swelling which showed its tendency to become lower than the starting pH value. Moreover; the dissociation of COOH groups lead to form charged groups participated in the polymeric network chains structure. This resulted in electrostatic forces which played an important role in water diffusion and therefore; increases the swelling properties. While at low pH in acidic medium no protonation can be occurred, accordingly, there is no dissociation appeared and the swelling degree can not be happened.

Kinetic study of water swelling:

Figure (5) represents the relation between **ln t** and **ln F** as described before in equation (4) of Fick's low. It is applied to the initial stages of swelling as well as the short time approximation which is valid for the first 60 % of the swelling.

The results showed that **n** value have a number 0.77 which reveals to the fact that the PVA/AAc hydrogel at composition 35/65 ratio was taken as non-Fickian character. It can be said that, for higher swelling values of the hydrogels, the transportation of water into the hydrogel matrix with low relaxation rate of the polymer chains resulting in higher diffusion rate.
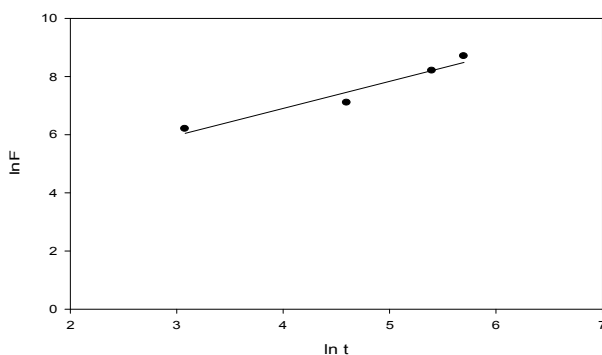
Fig. (5): kinetic of water swelling into PVA/AAc hydrogel as lnF

versus ln t at pH 8

This is generally explained on a consequence of the relaxation rate of the polymer matrix [6]. Also; the equilibrium swelling for PVA/AAc hydrogels at the composition used reached the maximum at pH 8 where the equilibrium degree of swelling is the optimum one

Effect of irradiation dose

The irradiation dose has a great effect on the swelling properties of polymer prepared with gamma radiation. It was observed from figure (6) that as the irradiation dose of the prepared hydrogel increase, its affinity and its degree of swelling increases too. The most degree of swelling is10330 % as recorded for the composition 35/65 at pH 8 as well as in alkaline medium.
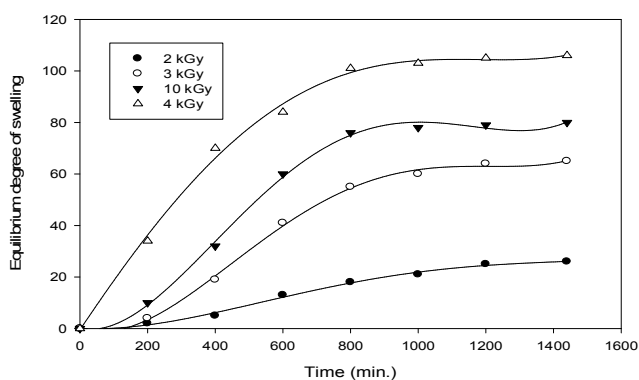

Fig. (6): Effect of time (min.) on the equilibrium degree of swelling for the hydrogels PVA/AAc prepared at different irradiation doses at dose rate 1.82 Gy/s and constant comonomer composition 35/65 and comonomer concentration 70%

This is because the cross-linking density; which increases with the irradiation dose; leads to increase the number of hydrophilic groups as well as COOH and OH groups that responsible for water up-taking by hydrogen bonding and electrostatic force effects[3-6]. Also, the volume space between the crosslinking bonds is large enough to be filled with large amounts of water molecules as a super absorbent hydrogel with high equilibrium degree of swelling.

The hydrogel composition prepared by gamma radiation at doses more than 4 kGy up to 10 kGy showed lower swelling capacity. Increasing the irradiation doses would be resulted in high density of crosslinking and this explains the reason of high rigidity of the samples irradiated at high irradiation dose. Therefore, the diffusion of water into the matrix becomes difficult because the free volume spaces between the macromolecular chains will be reduced. This clearly lowers the degree of swelling of the hydrogel for all pH values with increasing gamma irradiation dose [6].

Effect of temperature on the swelling behavior

In this study, the effect of temperature on the swelling percent of the hydrogel P(PVA/AAc) copolymer was investigated at different temperatures of the swelling medium as 20, 30, 40 and 60 °C.
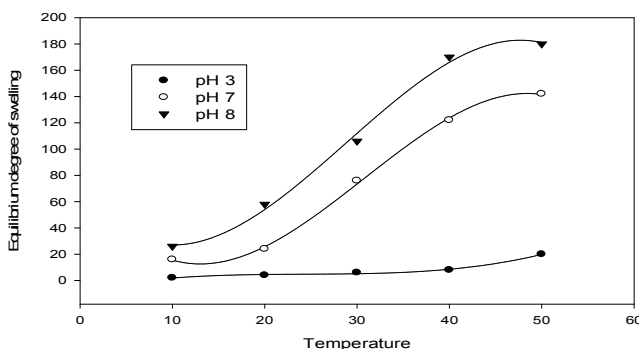

Fig. (7): Effect of Temperature (°C) on the equilibrium degree of sof PVA/AAc hydrogel of comonomer composition 35/65, comonomer concentration 70% in and acrylic acid content 70%, irradiation dose 4 kGy and dose rate 1.8 Gy/s at different pH values.

The results are represents in Figure (7) and shows that the swelling percentage increases slightly with increasing the temperature from 10°C up to 30°C. After 30°C to 60°C, a rapidly increasing in the equilibrium degree of the

swelling was observed.

These results can be explained that, with increasing the temperature of the swelling medium up to 30°C, the network chains of the polymer tends to be started in a relaxation state due to absorb some heat .energy which facilitate and enhance the water molecules to be diffused through the hydrogel [10]. A rise inq the swelling capacity was observed at temperature > 30°C which may be attributed to the degradation of some cross-linking with the chain of PVA and accordingly increases the free volume space between the chains of the network structure [11] which increases the chance of water molecules to be penetrated and therefore; increases the swelling of the hydrogel.

3. Loading of amoxicillin drug on PVA/AAc hydrogel

Effect of drug initial feed concentration:

Figure (8) shows that an increase of initial drug concentration from 50 to 680 mg/ml leads to increase the amount of adsorption capacity of drug in the adsorption medium. This result was due to the dependence of the drug solute molecules to be interacted with the surface of the hydrogel to form multi adsorbed layers. It may be originated through the adsorption of either non polar molecules or polar molecules. Always, it was provided that the adsorbent (hydrogel) –adsorbate (drug) force is relatively strong, therefore, the adsorption capacity will be increased. On the other side, at low concentration the surface of the hydrogel is covered with a layer of adsorbed water molecules, however , the adsorbent (water)–adsorbate (drug) force interaction would be virtually reduced to the weak dispersion energy of water with drug molecules so that the uptake at low concentration was concerned to be small q_e.

Also, it was found that the amount of amoxicillin drug adsorbed increases with increasing the pH values and the most adsorption capacity was at pH 8 than the other pHs This means that the adsorption of drug increases with increasing the concentration at each pH value.
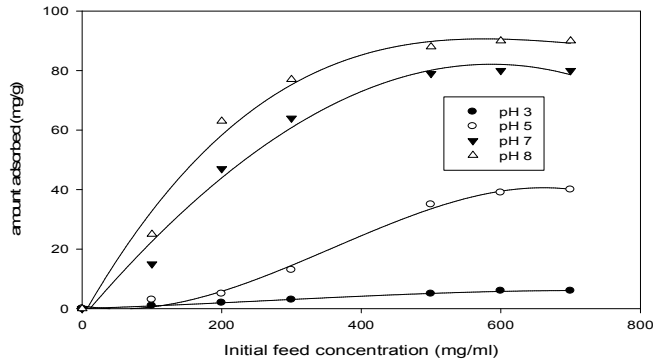
Fig.(8): Effect of initial feed concentration (mg/ml) of amoxicillin drug on the adsorption capacity of PVA/AAc hydrogel at different pH and at constant composition 35/65 ratio.

The ability of hydrogel and the affinity of drug adsorption capacity

Table (1) shows the effect of pH on the adsorption of amoxicillin drug into PVA/AAc hydrogel. The values of **k** and **n** as the empirical constants of Freundlish equation were evaluated from the logarithmic relationships as **log x/m** and **log Ce** for the adsorption isotherm curve of the PVA /AAc hydrogel at the most optimum conditions as composition ratio 35/65 , different pH 3,5,7, and 8 at constant temperature $25^{o}C$ The relation give a straight line has a slope **n** and intercept **log k** as tabulated in table (l).

Table (1): Freundlish constants k and n represented the ability of hydrogel and the affinity of drug adsorption capacity respectively and their standard deviation R^2

pH	N	k	R^2
3	0	0.18	97
5	0.48	1.02	96
7	0.77	1.1	99.6
8	0.75	1.26	99.9

It was found that **k** value is a highest at alkaline medium pH 8 and a lowest value in acidic medium pH 3. The results explained that; at pH of alkaline; the **k** value is the highest value due to the high activity of the carboxylic groups of the hydrogel. Also; in acid medium adsorption of such

hydrogel decreases because there is less protonation of OH groups of the drug and then the migration of drug molecules becomes low. This can be proved by the lower affinities as a low value of constant **n** for the drug molecules that try to be loaded onto the hydrogel at different pH$_s$ lower than 7 The best adsorption result which referred to the best expected releasing process was occurred at pH 7-8 where the affinity of the drug onto the hydrogel and its reversible process as control releasing has a maximum **n** value .The hydrogels of various pHs are approximately have the same slope and nearly, the same values of **n**. This results because the medium contains only one component of the drug; therefore; the affinity of their molecular transportation to the hydrogel have the same behavior. Furthermore; it was observed that the water swelling in presence of drug solution becomes more than that in water only and this may be due to the difference in ionic strength of their medium.

4. Releasing behavior of drug from the hydrogel

A-Effect of pH- sensor on drug release

Figure (9) shows the change of pH of water from 3 to 8 through releasing of amoxicillin drug as calculated from equation (8), when the medium start from acidic to alkaline medium, It was observed that; in acid medium the drug releasing from the hydrogel is remarkable low and then increases suddenly in alkaline medium at pH range 6.8-8. This behavior indicated the sensor pH effects [19] on operating the drug releasing from the hydrogel.
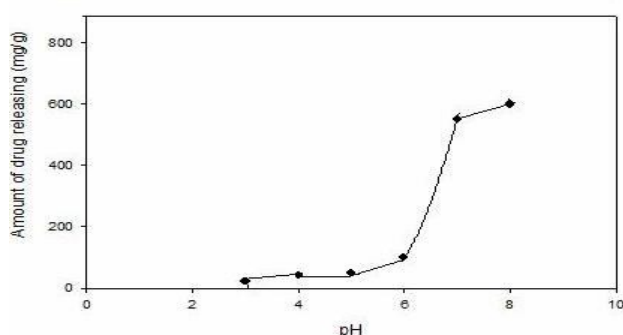

Fig. (9): Effect of pH on the amount of amoxicillin drug releasing (mg/ml) from the hydrogel loaded by concentration of 680 mg/ml.

Starting the batch releasing at pH 8 for the adsorbed disc of hydrogel (1g) loaded by an amount of drug approximately adsorbed as 680 mg/ml The reason was attributed to the fact that; at high concentration 680mg/ml, the releasing is a burst releasing because the hydrogel was physically adsorbed and

loaded by much more amount of drug on the surface as multi molecular drug layers [19]. The burst releasing decreases with decreasing the multi molecular layers consumed. with the time It was found that the amount of releasing was about 80% burst releasing (fast) and 18% controlled releasing (slow) from the loaded concentration 680 mg/ml onto the hydrogel disc.

B- Effect of time on the drug releasing from the hydrogel

As the pH of intestine organ of the human body is 8 and it takes about 1-2 hour to absorb the digestive food and transport it to the blood. So; the amoxicillin must take a time less than two hours to make its function as antibiotic drug in a vitro system. Therefore; the activation of the drug releasing at pH 8 to pH 7 increases rapidly from the hydrogel as a burst releasing within 80 min. as shown in figure (10) At this time, the burst releasing was due to the physical adsorption process caused for the drug on the polymer surface by accumulating layers that can be separated and released rapidly with the concentration 680 mg/ml.
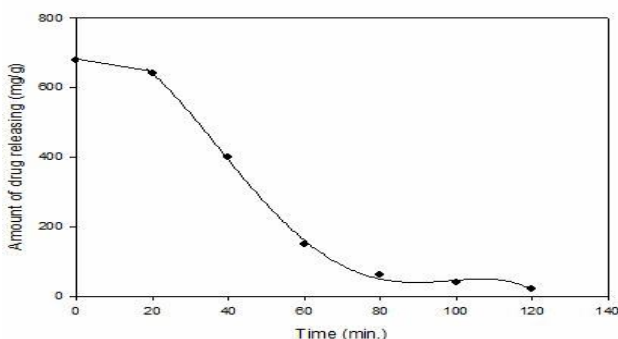

Fig. (10): Effect of time (min.) on the amount releasing of drug as 680 mg/ml by the hydrogel PVA/AAc.

After 80 min; the controlled releasing of drug occurred from inside the hydrogel matrix bounded by chemical adsorption to outside under osmotic pressure in a slow releasing through the porous [20]. The controlled releasing take places slowly by dissociation of ester groups formed between OH of the drug and COOH of the hydrogel. On the other side; a further decomposition of the hydrogen bonding occurred for transportation the drug molecules gradually from inside to outside starting from 80 to120 min. with controlled releasing about 18%. Therefore; the total releasing through the two hours is about 98% of the antibiotic amoxicillin drug (680 mg/ml) with shifting the pH value to about

(6.8-.8). After this time; traces of drug (about 2%) may be bounded with the polymer matrix and / or decomposed may be to small fragments as its transformation to small organic compounds under the effects of the surrounding conditions.

CONCLUSION

Poly (Polyvinyl alcohol-co-Acrylic acid) hydrogel was prepared by gamma radiation as a free radical copolymerization reaction. The optimum condition for the preparation of P (PVA/AAc) hydrogel at monomer concentration 70 wt % in water and monomer composition as PVA/AAc monomers 35/65 ratio .At fixed irradiation dose rate 1.82 Gy/sec, the complete gelation 98% was obtained at irradiation dose 4 kGy where a sufficient crosslinking by the monomers free radicals occurred as confirmed by FTIR spectroscopic analysis. Swelling behaviors were studied and showed highly swelling percentage 10330% and the result showed that the diffusion of water followed a non-Fikian type where *n* value 0.77. The diffusion of water increased with increasing pH value of the external solution. The loading adsorption of amoxicillin antibiotic drug onto the hydrogel P(PVA/AAc) was studied and showed that the maximum adsorption occurred at pH ranged at about 7-8 and the amount of drug loaded increased with increasing the concentration up to 680 mg/ml. The anionic carboxylic groups $-COO^-$ play the most important role in the adsorption capacity of the hydrogel for the drug. The ability and the affinity of the adsorption of amoxicillin drug were described according to Freundlish adsorption isotherm curve depending on the evaluation of their empirical constants **k** and **n**. The drug release have been investigated and showed that the basic parameter affecting the drug release behavior from P(PVA/AAc) hydrogels is the pH sensor of the drug solution. The hydrogel was considered as potential carriers for the drug–delivery systems.

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