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Preparation and characterization of chitosan–polylactide composites blended with Cloisite 30B for control release of the anticancer drug paclitaxel

Rajashree Nanda, Abhisek Sasmal, P.L. Nayak*

P.L. Nayak Research Foundation, 53/A, Keshpur, Cuttack 753006, Orissa, India

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ABSTRACT

Chitosan (CS) and polylactide (PLA) at different ratios were blended with different wt% of montmorillonite (MMT) (Cloisite 30B) solution by the solvent evaporation method. MMT was incorporated in the formulation as a matrix material component which also plays the role of a co-emulsifier in the nanocomposite preparation. Paclitaxel (PTX) with different concentrations was loaded with CS–PLA/MMT nanocomposites for studying in vitro drug delivery systems. The composites were characterized by FTIR, SEM, and XRD methods. The drug release was studied as a function of, pH and drug concentrations. The kinetics of the drug release was studied in order to ascertain the type of release mechanism. Based on the diffusion as well as the kinetics, the mechanism of the drug release from the composite matrix has been reported.

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1. Introduction

In recent years, biodegradable polymers have attracted attention as biomaterials particularly, for tissue engineering, gene therapy, wound healing and controlled drug delivery (Ikada & Tsuji, 2000). The most important advantage of biodegradable polymers is the disappearance of implanted foreign materials from the body as a result of their biodegradation. Important biodegradable polymers used in biomedical applications are poly(lactic acid) (PLA), poly(glycolic acid) (PGA), poly(e-caprolactone) (PCL), poly(3-hydroxybutyrate) (PHB), copolymers of polyglycolide, chitosan and soy protein (Edlund & Albertsson, 2002; Jain & Rajeev, 2000; Kamath & Park, 1993; Mikos, Lyman, Freed, & Langer, 1994; Park, Cohen, & Langer, 1992; Taylor, Daniels, Andriano, & Heller, 1994; Tsuji & Ikada, 1998; Urayama, Kanamori, & Kimura, 2002).

Chitosan is a biodegradable polymer obtained by the deacetylation of chitin, which is present in shells of insects and marine crustacean (Kas, 1997; Roberts, 1992). This is a marine based polymer. Chitosan has a number of beneficial properties including biodegradability, bioactivity, non-toxicity as well as good adhesion and sorption. These properties are largely responsible to a wide range of applications (Ravi Kumar, 2000). Chitosan is also a valuable component of polymer blends and composites (Mucha & Miśkiewicz, 2000; Mucha, Wańkowicz, & Balcerzak, 2007). Using an appropriate technological process one may obtain films, fibres, gels and foams as well as chitosan beads of different sizes and morphologies. Numerous in vitro studies have analyzed the response to chitosan of smooth muscle cells, macrophages, osteoblasts, chondrocytes, erythrocytes and whole blood. In addition, many studies have been conducted with mice, rats, rabbits, and canine animal models in order to describe in vivo biocompatibility, biodegradability, drug delivery, DNA delivery, and wound healing using chitosan as a carrier (Chandy & Sharma, 1990; Demarger-Andre et al., 1994; Fukuda, 1980; Kato, Onishi, & Machida, 2003; Onsoyen & Skaugrud, 1990; Singla & Chawla, 2001).

Polylactide is a plant based polymer derived from agricultural feed stocks. Polylactide and its copolymers form a family of biodegradable and biocompatible polymers that have been widely used in biomedical applications. Among the various aliphatic degradable polyesters, polylactide (PLA) has been considered as one of the most interesting and promising biodegradable materials and has been used in medical applications, such as surgical sutures (Fambri, Pegoretti, Fenner, Incardona, & Migliaresi, 1997) drug delivery systems (Khang, Rhee, & Jeong, 2003) and bone fixtures (Bergsma, Bos, Rozema, Jong, & Boering, 1996). The use of these products in vivo has a tremendous advantage over traditional products due to the fact that PLA can be metabolized directly inside the body (Bergsma et al., 1995). In the medical industry, there has been extensive research on the in vivo and in vitro degradation of PLA as surgical sutures, drug delivery systems and internal bone fixation (Drumright, Gruber, & Henton, 2000).

Paclitaxel (Fig. 1), a poly-oxygenated naturally occurring diterpenoid isolated from the bark of the Pacific yew tree, Taxus brevifolia, is a microtubule-stabilizing agent (Miller & Ojima, 2001). It binds to the β-subunit of the tubulin heterodimer ultimately resulting in the arrest of the cell division cycle between the prophase and anaphase stages, eventually leading to apoptosis of the cancer cells (Kuhn, 2003). It has been used against a wide

* Corresponding author. Tel.: +91 671 2441635; fax: +91 671 2441635.
E-mail address: plnayak@rediffmail.com (P.L. Nayak).

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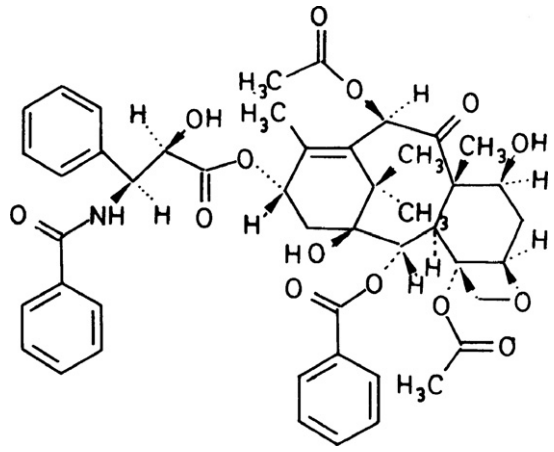

Fig. 1. Chemical structure of paclitaxel.

spectrum of cancers, including breast cancer, ovarian cancer, lung cancer, head and neck carcinomas, and acute leukemia. However, the success of its clinical application is limited by its low therapeutic index and low solubility in most pharmaceutical solvents. More effective chemotherapy using paclitaxel will rely on the development of new dosage forms, among which nanoparticles of biodegradable polymers and lipid bilayer vesicles (liposome) seem the most promsing . Currently, the only available dosage form of paclitaxel is Taxol® for intravenous (i.v.) infusion, which is a solution of paclitaxel in an adjuvant called Cremophor EL, which causes serious side effects such as hypersensitivity reactions, nephrotoxicity, neurotoxicity and cardiotoxicity (Kongshaug, Cheng, Moan, & Rimington, 1991; Mankad et al., 1992; Tatou et al., 1996; Webster et al., 1993). In recent years, various controlled delivery forms, such as polymeric micro/nanospheres, liposomes, micelles, parenteral emulsion, and prodrugs have been investigated to increase its solubility, to minimize the side effects as well as to avoid the use of toxic adjuvant (Denis et al., 1988; Gibbs, 2000; Holton, 1990; Jordan & Wilson, 2004; Markman, 2000; Perez, 1998; Seiden, 2001; Singla, Garg, & Aggarwal, 2002; Wani, Taylor, Wall, Coggon, & McPhail, 1971).

Drug-loaded nanocomposites of biodegradable polymers have great potential to provide an ideal solution for most of major problems encountered in chemotherapy and those of targeting function have become a focus in this area, which can be realized by "decorating" the nanocomposites surface with specific ligands that can recognize the cancer cells and mediate the ligand–receptor interaction between the decorated nanocomposites and cancer cells. The nanocomposites have been prepared by blending various compositions of chitosan–PLA with MMT (Cloisite 30B). MMT can provide mucoadhesive capability for the nanoparticle to cross the GI barrier (Dobrozsi, 2000). MMT is also a potent detoxifier, which belongs to the structural family known as the 2:1 phyllosilicate. MMT could absorb dietary toxins, bacterial toxins associated with gastrointestinal disturbance, hydrogen ions in acidosis, and metabolic toxins such as steroidal metabolites associated with pregnancy. Calcium MMT has also been used extensively in the treatment of pain, open wounds, colitis, diarrhea, hemorrhoids, stomach ulcers, intestinal problems, acne, anemia, and a variety of other health issues. Not only does MMT cure minor problems such as diarrhea and constipation through local application, it also acts on all organs as well (Alfredo et al., 2001; Cypes, Saltzman, & Giannelis, 2003; Fejer, Kata, Eros, Berkesi, & Dekany, 2001; Forni, Iannuccelli, Coppi, & Bernabei, 1982; Lee & Chen, 2004; Lee & Fu, 2003; Lin et al., 2002; Sekine, Yoshida, Matsuzaki, Yanaki, & Yamaguchi, 1999).

In the present publication, we report on the preparation of a novel nanocomposites formulation, i.e. biodegradable CS–PLA nanocomposites incorporated with medical clay, montmorillonite (MMT) called CS–PLA/MMT nanocomposites, for oral chemotherapy by paclitaxel as a prototype drug due to its excellent therapeutic effects against a wide spectrum of cancers. The composites have been characterized using FTIR, XRD and SEM techniques. The kinetics of the drug delivery system have been reported.

2. Experimental

2.1. Materials

Chitosan (CS) (degree of deacetylation = 95%) was purchased from India Sea Foods, Kerela, India. Polylactide (PLA, product number P1566, M_W = 85,000–160,000 Da) was purchased from Sigma–Aldrich. Paclitaxel was a generous gift from Bristol Myers Squibb. Dichloromethane (DCM, product number DS1432, HPLC/spectro grade) was purchased from Tedia (Tritech Scientific Pte Ltd., Singapore), acetic acid, NaH_2PO_4, NaOH, and other chemicals were used as analytical grade and purchased from Sigma–Aldrich Company.

2.2. Preparation of chitosan-PLA nanocomposites

To prepare the blend of chitosan and PLA, solutions of chitosan and PLA were first separately prepared at the concentration of 1% (w/w) in chloroform. Blend solutions of different compositions (i.e. the weight ratios between chitosan and PLA of 100/0, 95/5, 90/10, 80/20, 0/100 (w/w) respectively) were then prepared by casting a mixture of the solutions on a Teflon dish. To this blend solution MMT of different compositions (1 wt%, 3 wt% and 5 wt%) were added with constant stirring for 8 h at room temperature to get a homogenous solution. It should be noted that stirring was used to homogenize the mixture prior to pouring onto the dish. The cast films were allowed to dry at room temperature for 3 days and were collected for characterization.

2.3. Drug loading

Paclitaxel-loaded chitosan–PLA/MMT nanocomposites were prepared by emulsion/solvent evaporation method. In short, paclitaxel of different loadings, i.e. 5 wt%, 10 wt%, 15 wt%, 20 wt% and 25 wt% with (80:20) CS–PLA/MMT were dissolved in 8 ml chloroform. The resulting solution was emulsified in 120 ml aqueous solution containing 2% (w/v)w/v PVA and then sonicated 120 s with an output power of 30 W. The formed emulsion was allowed to evaporate overnight at room temperature to harden the particles. The suspension was centrifuged, washed three times with deionized water and freeze-dried. This compound was used for drug delivery purposes.

2.4. Dissolution experiments

Dissolution experiments were performed at 37 °C using the dissolution tester (Disso test, Lab India, Mumbai, India) equipped with six paddles at a paddle speed of 100 rpm. About 900 ml of phosphate buffer solution (pH 1.2 and 7.4) was used as the dissolution media to stimulate gastrointestinal tract (GIT) conditions. A 5 ml aliquot was used each time for analyzing the paclitaxel content at a fixed time interval. The dissolution media was were replenished with a fresh stock solution. The amount of paclitaxel released was analyzed using a UV spectrophotometer (Systronics, India) at the λ_{max} value of 232 nm.

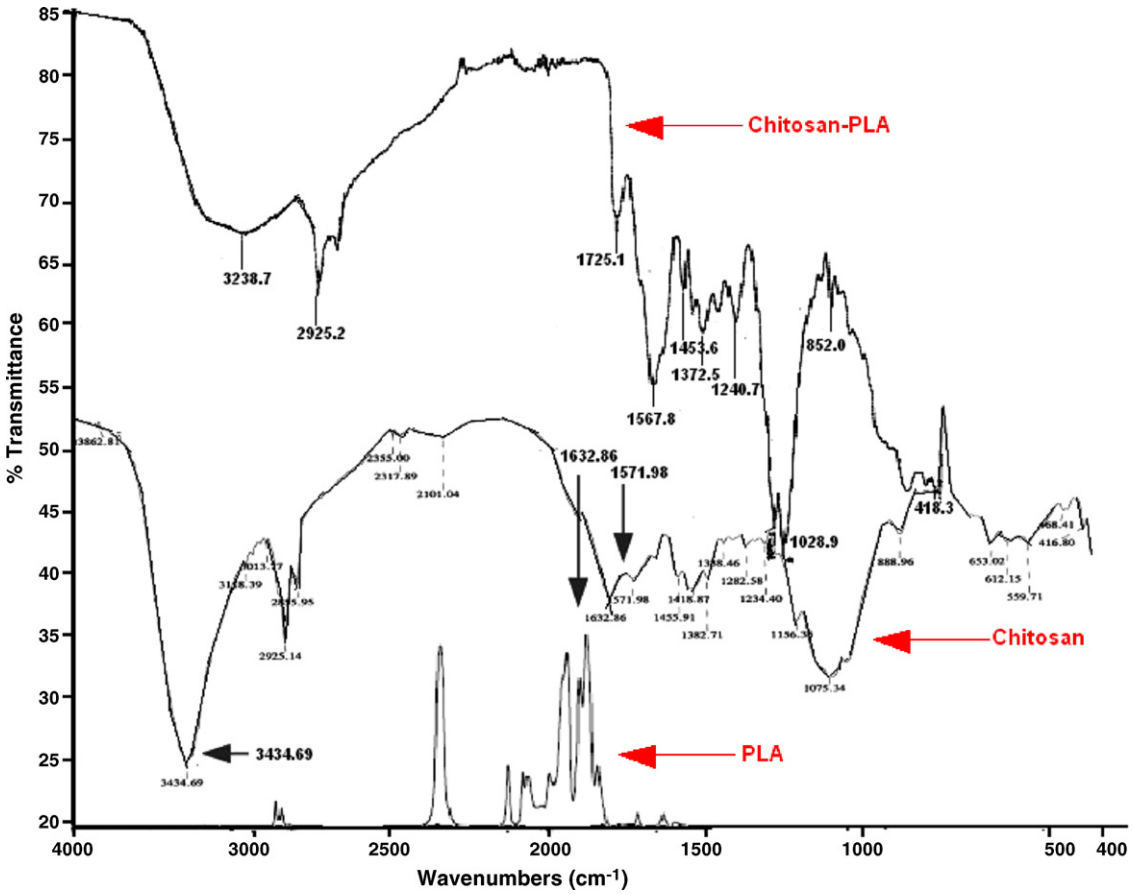

Fig. 2. FTIR spectra of pure PLA (i.e. the bottommost curve), pure chitosan (i.e. the middle curve) and chitosan/PLA blends (80:20) (i.e. the topmost curve).

3. Characterization

3.1. Fourier transmission infra red spectroscopy (FTIR)

The FTIR spectrum of the chitosan–PLA blends was obtained using a BIORAD-FTS-7PC type FTIR spectrophotometer.

3.2. X-ray diffraction (XRD)

The change in gallery height of the blend was investigated by WAXD experiments, which were carried out using an X-ray diffractometer (BEDE D-3 system) with Cu Kα radiation at a generator voltage of 40 kV and a generator current of 100 mA. Samples were scanned from $2\theta = 1–30^\circ$ at a scanning rate of 2°/min.

3.3. Scanning electron microscopy (SEM)

The blending of the chitosan–PLA composites containing different concentrations was characterized using SEM (440, Leica Cambridge Ltd., Cambridge, UK). The powdered specimens were placed on the Cambridge standard aluminium specimen mounts (pin type) with double-sided adhesive electrically conductive carbon tape (SPI Supplies, West Chester, PA). The specimen mounts were then coated with 60% gold and 40% palladium for 30 s with 45 mA current in a sputter coater (Desk II, Denton Vacuum, Moorestown, NJ). The coated specimens were then observed on the SEM using an accelerating voltage of 20 kV at a tilt angle of 30° to observe the microstructure of the chitosan–PLA composite blends.

3.4. Swelling studies

Water absorption of the polymer–drug conjugates was measured following ASTM D 570-81. The samples were preconditioned at 50 °C for 24 h and then cooled in a desiccator before being weighed. The preconditioned samples were submerged in distilled water at 25 °C for 24 h. The samples were removed and dried with a paper towel before weighing. Water absorption was calculated as a percentage of the initial weight. The soluble material loss was checked by weighting the specimens after drying them in an oven at 50 °C for another 24 h. The total water absorption for 24 h was calculated including the soluble material loss:

$$\%\,\text{Swelling} = \frac{W_1 - W_2}{W_2} \times 100$$

where W_1 = weight of swollen composite after 24 h and W_2 = weight of dry composite.

4. Results and discussion

4.1. Fourier transmission infra red spectroscopy (FTIR)

The FTIR spectra of the PLA, chitosan (CS) and chitosan–PLA composites have been investigated. Fig. 2 shows FTIR spectra of pure PLA (i.e. the bottommost curve), pure chitosan (i.e. the middle curve) and chitosan/PLA blends (80:20) (i.e. the topmost curve).

In case of pure CS, the broad band at 3434 cm^{-1} corresponds to the amine and hydroxyl groups; the peak at 2925 cm^{-1} is due to –OH stretching; the absorption band at 1632 cm^{-1} is due to the carbonyl (C=O) stretching of the secondary amide (amide I band), and the bending vibrations of the N–H (N acetylated residues, amide

II band) at 1571 cm^{-1} (Sankalia, Mashru, Sankalia, & Sutariya, 2007). The peaks at 1418 and 1382 cm^{-1} belong to the N–H stretching of the amide and ether bonds and N–H stretching (amide III band), respectively. The peaks observed at 1156 and 1075 cm^{-1} are due to the secondary hydroxyl group (characteristic peak of –CH–OH in cyclic alcohols, C–O stretch) and the primary hydroxyl group (characteristic peak of $–CH_2–OH$ in primary alcohols, C–O stretch) (Chen, Wu, Mi, & Lin, 2004).

In case of PLA, the peak around 1760 cm^{-1} is for carbonyl group of PLA.

The IR spectra of chitosan and PLA composite have also been taken to ascertain whether there is any reaction between the two molecules. All the groups present in neat chitosan and neat PLA as mentioned above are also present in the composite spectra. Hence it is evident that there is no chemical reaction between the two moieties.

4.2. X-ray diffraction analysis

Wide-angle X-ray diffraction (WAXD) is a classical method for determining the gallery height (d-spacing distance) in clay particles (Di, Iannace, Maio, & Nicolais, 2003). The d-spacing can be determined by the diffraction peak in the XRD patterns, and can be expressed by Bragg's equation ($\lambda = 2d_{001}\sin\theta$), where d_{001} is the inter-planar distance of (0 0 1) diffraction face, θ is the diffraction position, and λ is the wave length (Choi, Kim, Park, Chang, & Lee, 2003). During intercalation, the insertion of polymer into the organoclay galleries forces the platelets apart and increases the d-spacing, resulting in a shift of the diffraction peak to lower angles. In the case of Cloisite 30B, the peak occurs at $2\theta = 4.8^\circ$.

Fig. 3 shows XRD pattern of chitosan–PLA/MMT nanocomposites. The clay peak in the nanocomposites systems was shifted to small angle, indicating a further intercalation of the clay by chitosan–PLA in all cases. The chitosan–PLA exhibit a very strong crystalline peak at $2\theta = 16.6$ Å, corresponding to the (2 0 0) and/or (1 1 0) plane typical of an orthorhombic crystal. All the results of CS–PLA/MMT nanocomposites show similar X-ray crystalline peaks $2\underline{\theta} = 16.6$ Å, but the intensities of crystalline peaks decrease with increasing content of MMTs. This result indicates that the crystallinity of CS–PLA/MMT nanocomposites is smaller than that of chitosan–PLA matrix and gradually decreases as the content of MMT increases.

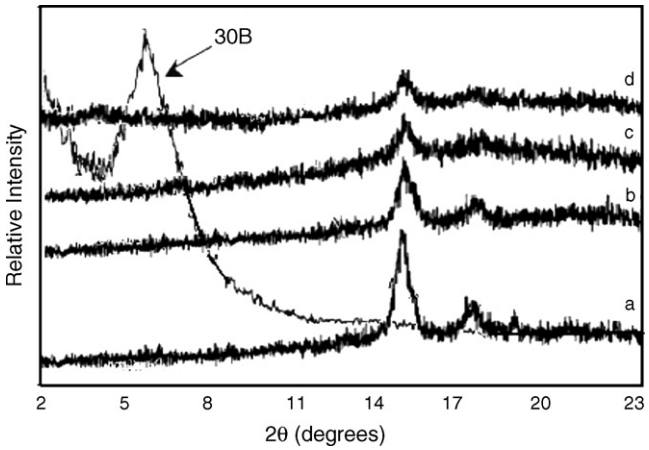

Fig. 3. X-ray diffraction data of (a) chitosan–PLA (80/20), (b) 1% MMT, (c) 3% MMT, (d) 5% MMT nanocomposites and Cloisite 30B.

4.3. Scanning electron microscopy (SEM)

Fig. 4 shows SEM micrographs of the blend having the weight-fractional percentage of PLA of 5, 10, 20 and 0% respectively. As seen from the SEM micrograph, the voids present in these micrographs are PLA particles which were dissolved away after the blend films were immersed in concentrated acetic acid solution for 2 min. From these micrographs, chitosan and PLA were found to phase-separate during the evaporation of the solvent. When PLA was the minor phase, the PLA particles were found to distribute very regularly

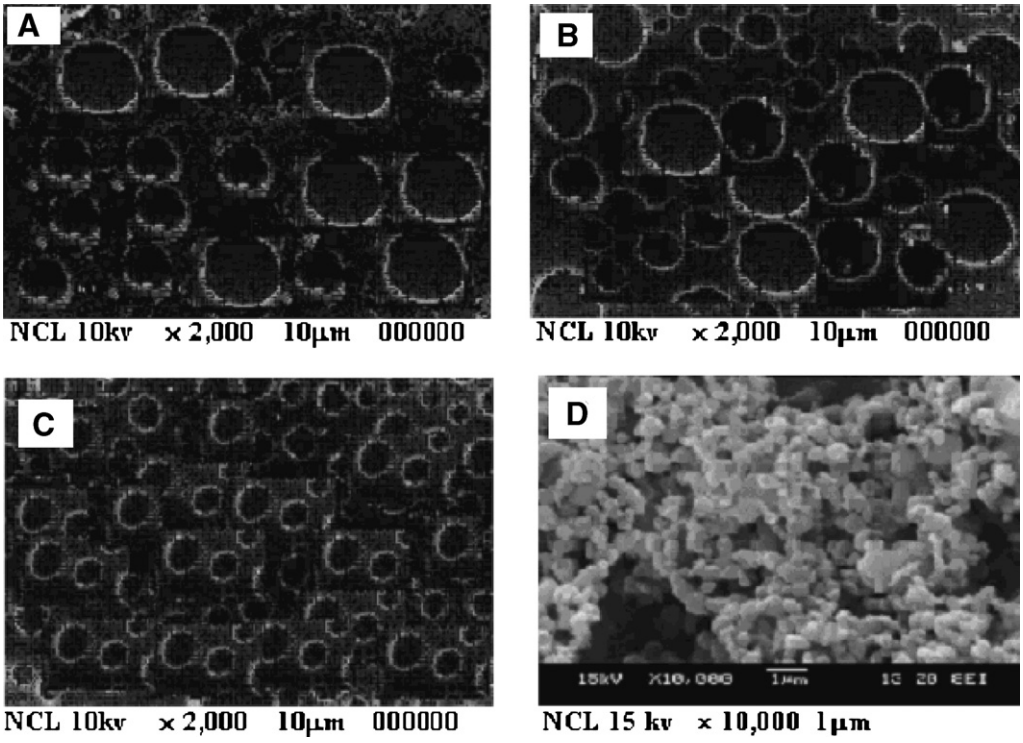

Fig. 4. Scanning electron microscope of chitosan–PLA (95/05, 90/10, 80/20,100/0).

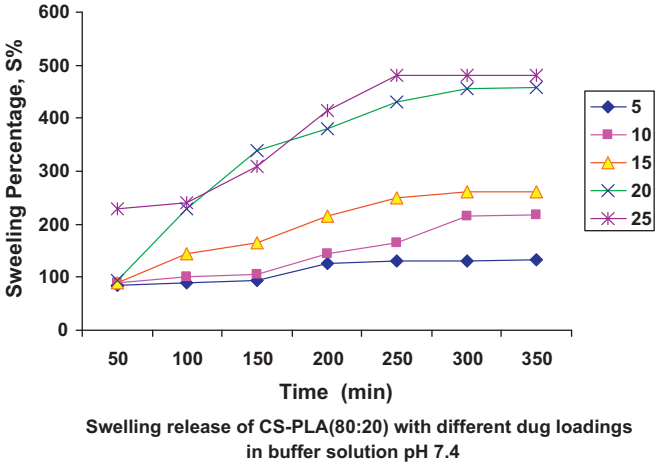

Fig. 5. Swelling isotherms of chitosan–PLA nanocomposite in 7.4 pH buffer solution.

throughout the chitosan matrix and the size of the particles was found to increase, while the number of the particles was found to decrease, with increasing amount of PLA from 5 to 20 wt%.

4.4. Equilibrium swelling studies

The swelling behavior of the composites has been investigated. It is generally known that the swelling behavior of the polymer network depends upon the nature of the polymer, polymer solvent compatibility and degree of cross-linking. However, in the case of ionic networks, swelling behavior depends upon mass transfer limitations, ion exchange and ionic interaction (Frank & Lauterbur, 1993). The swelling behavior of the composites is shown in Fig. 5.

It shows that the swelling increases with time up to a certain level, and then levels off. The swelling parameters are shown in Table 1. The values of S_{eq} % are 100–132% for 5% drug loading and 230–482% for 25% drug loading. Hydrophilicity of different drug loadings becomes greater with an increase of drug loading, so the swelling of CS–PLA nanocomposites increases with increasing amount of drug loading.

5. In vitro drug release

5.1. Effect of pH

In order to investigate the effect of pH on the drug release of composite chitosan–PLA (80:20), we have measured the % cumulative release in both pH 1.2 and 7.4 media. Cumulative release data presented in Fig. 6 indicates that by increasing the pH from 1.2 to 7.4, a considerable increase in the cumulative release is observed for all the composites. From Fig. 6(A) and (B), it is seen that the 25 wt% drug–polymer composites have shown longer drug release rates than the other composites. It can be seen that paclitaxel released from CS–PLA/MMT nanocomposites are 30.8, 36.95, 38.18, 38.37, 48.52% at pH 1.2 and 40.15, 44.71, 47.89, 56.09, 64.63% at pH 7.4 within 15 h with different drug loadings 5, 10, 15, 20 and 25% respectively. This suggests that the drug release properties of CS–PLA/MMT nanocomposites are pH sensitive. Hence the drug release depends upon the nature of the polymer matrix as well as pH of the media. These results suggest that the drugs in the blend are suitable for the basic environment of the large intestine, colon, and rectal mucosa.

Table 1
Swelling parameters of CS–PLA (80:20) nanocomposite with different drug loadings.

Drug loading	S_{eq} %	n	k
5%	132	0.77	2.76
10%	217	0.80	2.50
15%	262	0.64	3.27
20%	458	0.73	3.22
25%	482	0.75	3.50

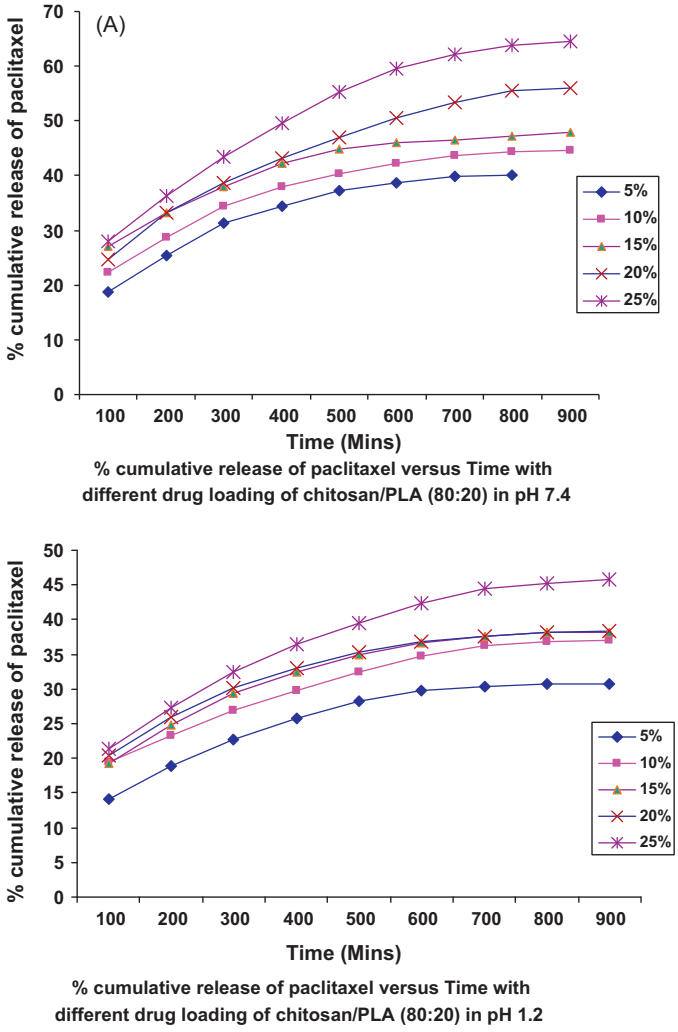

Fig. 6. % Cumulative release of paclitaxel vs. time for different formulations loaded with CS–PLA (80:20) in (A) pH 7.4 and (B) pH 1.2 media.

5.2. Effect of time

More than 25% paclitaxel is released from all composites at pH 7.4 within 3 h, whereas less than 44 wt% of the drug is released at pH 1.2 within 4 h. It seems that the release profile shows the initial burst release which indicates that a significant amount of paclitaxel initially associated with nanocomposites remained on their surfaces by weak interactions forces between CS–PLA/MMT and paclitaxel. The release half times t_{50} (time required for releasing 50 wt% of drug) for 5, 10, 15, 20 and 25 wt% drug loading are 4.16 h, 5 h, 7 h, 7.5 h, 8 h at pH 7.4 and 1.2 h, 2 h, 3 h, 3.5 h and 5 h at pH 1.2 respectively.

5.3. Effect of drug loading

Fig. 6(A) and (B) displays the release profiles of paclitaxel-loaded CS–PLA/MMT nanocomposites at different amounts of drug loadings. Release data showed that formulations containing the highest amount of drug (25%) display fast and higher release rates than

the formulations containing a small amount of paclitaxel. The prolonged drug release was observed for formulation containing lower amount of paclitaxel. The release rate becomes quite slower at the lower amount of drug in the nanocomposites, due to the availability of more free void spaces through which a lesser number of drug molecules could transport. For all the PTX loaded formulations, 40% of PTX release has occurred in about 6 h, but 65% of the drug release was observed around 11 h.

6. Drug release kinetics

The drug delivery system was developed for the purpose of bringing, uptaking, retaining, releasing, activating, localizing and targeting the drugs at the right time period, dose and place (Langer, 1990; Langer, 1998; Lewis, Chasin, & Langer, 1990; Rathbone, Witchey-Lakshmanan, & Ciftci, 1999). Biodegradable polymers are now-a-days used as carriers of drugs either in vitro or in vivo. Through precise control of the drug carrier architecture, the release of the drug can be tuned to achieve a desired kinetic profile From time to time, various authors have proposed different types of drug release kinetics and mechanisms based on the polymer matrices. It has been proposed that drug release from matrices usually implies water penetration in the matrix, hydration, swelling, diffusion of the dissolved drug (polymer hydro fusion), and/or the erosion of the gelatinous layer. Several kinetics models relating to the drug release from matrices, selected from the most important mathematical models, are described over here. However, it is worth to mention that the release mechanism of a drug would depend on the dosage from selected, pH, nature of the drug and, of course, the polymer used. The most probable kinetics used for the drug release over the years are depicted below.

(i) Zero-order kinetics (Xu & Sunada, 1995):

$$W = K_1 t \quad (1)$$

(ii) First-order kinetics (Singla & Medirata, 1988; Xu & Sunada, 1995):

$$\ln(100 - W) = \ln 100 - K_2 t \quad (2)$$

(iii) Hixon–Crowel's cube-root equation (erosion model) (Singla & Medirata, 1988):

$$(100 - W)^{1/3} = 100^{1/3} - k_3 t \quad (3)$$

(iv) Higuchi's square root of time equation (diffusion model) (Higuchi, 1963):

$$W = K_4 t \quad (4)$$

(v) Power law equation (diffusion/relaxation model) (Kulkarni, Soppimath, & Aminabhavi, 1999):

$$\frac{Mt}{M_\infty} = K_5 t^n \quad (5)$$

Mt/M_∞ is the fractional drug release into dissolution medium and K_5 is a constant incorporating the structural and geometric characteristics of the blend. The term 'n' is the diffusional constant that characterizes the drug release transport mechanism. When $n = 0.5$, the drug diffuses through and is released from the polymeric matrix with a quasi-Fickian diffusion mechanism. For $n > 0.5$, an anomalous, non-Fickian drug diffusion occurs. When $n = 1$, a non-Fickian, case II or zero-order release kinetics could be observed.

In the present research program, the drug release kinetics was monitored by plotting the cumulative release data vs. time by fitting to an exponential equation of the type (Ritger & Peppas, 1987) as represented below:

$$\frac{Mt}{M_\infty} = Kt^n$$

Table 2
Release kinetics parameters of different formulations at pH 7.4 and pH 1.2.

Sample code	k	n	Co-ordination-coefficient, r
7.4 pH			
5%	0.08	.50	0.964
10%	0.04	.55	0.968
15%	0.07	1.68	0.961
20%	0.25	1.55	0.955
25%	0.29	1.66	0.963
1.2 pH			
5%	0.24	.48	0.979
10%	0.02	0.54	0.944
15%	0.19	1.55	0.978
20%	0.04	1.67	0.969
25%	0.20	1.88	0.991

Here, Mt/M_∞ represents the fractional drug release at time t, K is a constant characteristic of the drug–polymer system and n is an empirical parameter characterizing the release mechanism. Using the least squares procedure, we have estimated the values of n and K for all the five formulations and these data are presented in Table 2. The values of K and n have shown a dependence on the, % drug loading and polymer content of the matrix. Values of n for composites prepared by varying the amount of drug containing 5, 10, 15, 20 and 25 wt% and keeping chitosan (80%) and PLA (20%) constant, ranged from 0.55 to 1.68 suggesting shifting of drug transport from non-Fickian to anomalous type. The value of n more than 1 may be due to a reduction in the regions of low micro-viscosity inside the matrix and closure of micro-cavities during the swollen state of the polymer. Similar findings have also been reported wherein the effect of different polymer ratios and other factors on dissolution kinetics were investigated (Aminabhavi & Naik, 1998; Lyu, Sparer, Hobot, & Dang, 2005; Ritger & Peppas, 1987).

7. Conclusion

Controlled delivery devices that utilize biodegradable polymers have a significant advantage over competing delivery systems in that there is no need for surgical removal of the device. Further, if the polymer degrades only at the surface, the drug release process is simplified in water diffusion into the bulk is minimized and drug release rate is governed by polymer degradation rate. Novel nanocomposites of chitosan and polylactide blended with MMT (Cloisite 30B) were prepared and characterized by FTIR spectroscopy, X-ray diffractometry and scanning electron microscopy. This blend was loaded with different amounts of anticancer drug paclitaxel to study the drug release behavior. The swelling studies of the nanocomposites have been reported. The drug was released in a controlled manner. The drug release was monitored by changing time, % drug loading and pH of the medium. It was observed that the release was much more pronounced in the basic medium than the acidic medium. The kinetics of the drug release was investigated and based on the kinetic parameters such as 'K' and 'n' values the probable drug release mechanism has been reported.

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