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Review

An In sight into Novel Drug Delivery System: In Situ Gels

Rabiah Bashir[1], Mudasir Maqbool[1*], Irfat Ara[2], Mehrukh Zehravi[3]

[1]Research Scholar, Department of Pharmaceutical Sciences, University Of Kashmir, Srinagar, Jammu and Kashmir, India, [2]Research officer, Regional Research Institute of Unani Medicine, Srinagar, Jammu and Kashmir, India, [3]Lecturer, Department of Clinical Pharmacy Girls Section, Prince Sattam Bin Abdul Aziz University Alkharj, Saudia Arabia

ABSTRACT

In situ gelling devices, as they enter the body, are dosage forms in the shape of the sol but turn into gel types under physiological circumstances. Transition from sol to gel is contingent on one or a mixture of diverse stimuli, such as transition of pH control of temperature, irradiation by UV, by the occurrence of certain ions or molecules. Such characteristic features may be commonly employed in drug delivery systems for the production of bioactive molecules for continuous delivery vehicles. The technique of in situ gelling has been shown to be impactful in enhancing the potency of local or systemic drugs supplied by non-parenteral pathways, increasing their period of residence at the absorption site. Formulation efficacy is further improved with the use of mucoadhesive agents or the use of polymers with both in situ gelling properties and the ability to bind with the mucosa/mucus. The most popular and common approach in recent years has provided by the use of polymers with different in situ gelation mechanisms for synergistic action between polymers in the same formulation. In situ gelling medicine systems in recent decades have received considerable interest. Until administration, it is in a sol-zone and is able to form gels in response to various endogenous factors, for e.g elevated temperature, pH changes and ions. Such systems can be used in various ways for local or systemic supply of drugs and successfully also as vehicles for drug-induced nano- and micro-particles. In this review we will discuss about various aspects about use of these in situ gels as novel drug delivery systems.

Keywords Gels, in situ gelling system, polymers, pH change, stability

INTRODUCTION

Gels are semi-solid, compact solid objects distributed in liquid amounts that are comparatively large but heavier than liquid. Because of the 'hydro' prefix, hydrogels are classified as aqueous gels. Hydro means a substance which is already saturated with water. The cross-linked hydrophilic polymer networks in particular are temed as hydrogels. Hydrogels are able to maintain their 3D shape although they can absorb huge amounts of water and swell. Hydrogels exist in two forms insitu gels and pre-formed hydrogels. Basic viscous liquids that do not change after administration are known preformed hydrogels whereas the solutions or fluids that gel because of physico-chemical modifications after approaching the particular site are known as in situ gels (Huffman, Afrassiabi *et al*., 1986). Systems for in situ gel formation have been extensively researched for the continued distribution of medications. The benefits of insitu polymer delivery systems are as easiness of drug delivery and decreased administrative rate, improved tolerance by patients and convenience, have inspired this desire. The formulation of these gels is the result of one or more combinations of factors, such as pH transition, modulation of temperature and exchange of solvent. The method of in situ gelling can therefore be formulated via various routes, including oral, nasal, ophthalmic, and so on. Several natural as well as synthetic polymers are employed for the synthesis of in situ gels such as gums which include gellan gum, guar gum, sodium alginate, caprolactone, etc. Gastroretentive systems which are formulated as in situ gels aim to improve medication bioavailability in contrast with traditional liquid dosing. The gel produced by the system of in situ gelling phenomenon is less in weight than gastric fluids, is filled with gastric mucosa due to the bioadhesive polymer design, induces gastric dosage retention and enhances the time of gastric residence, leading to the prolonged delivery of drugs in the gastrointestinal system. The importance and interest of the oral controlled delivery (CR) approach has grown in recent years as systemic drug absorption and patient conformity need to be improved. CR programmes also maintain reliable drug levels, dose minimization, side effects and safety upgrades. In order to improve the simplicity and ease of administration, the delivery of the exact dose and the lengthy residence times of a pharmaceutical substance in mucosal contact, which are typically encountered in semi-solid dosage formulations, this modern way of delivering medicine, are important. Because of one or a combination, various stimuli help in situ gel formation, including pH transitions, modulation of temperature process of solvent exchanging. Smooth polymer methods are encouraging ways to supply drugs; once they are delivered, these polymers undergo a conversion from sol to gel. Now in medical uses, the effects of using biodegrading polymers are evident (Rajinikanth and Mishra, 2008).

*Correspondence: Mudasir Maqbool
E-mail: bhatmudasir.scholar@kashmiruniversity.net
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METHODS OF FORMATION OF IN- SITU GEL DRUG DELIVERY SYSTEMS

The production of in situ gel biomaterials is caused by four commonly described mechanisms (HB, Bakliwal *et al*., 2010):

- Physiological stimuli such as pH and temperature.
- Physical variations of biomaterials such as swelling and solvent exchange.
- Biochemical changes e.g. Chemical, enzymatic, and photo-initiated polymerization) (HB, Bakliwal *et al*., 2010)

In situ gel development dependent on physiological stimuli
Thermally triggered system:

The most popular class of environmentally sensitive polymers in pharmaceutical science is probably temperature sensitive hydrogels. The use of a biomaterial that is caused by a rise in the temperature of the sun-gel is an attractive way to treat the structure on the ground. The maximum range of critical temperature for such a system is the atmospheric as well as physiological heat. This medicinal therapy which needs no outside heat supply besides that of the human body to induces gel formation. A helpful system, such as appendices on the surface of the skin or oral cavity, should be tolerable to allow small fluctuations in local temperatures. Around there are about 3 key approaches in the manufacturing of the polymer solar-gel thermal reaction method. Thermosensitive and thermo reversible gels are also known as negative thermosensitive gels [1, 3]. Gels having a reduced critical solution temperature (LCST) are negative hydrogels when they are heated, they contract above LCST. For translating the ambient temperature to physiological temperature, low critical temperature polymers (LCST) are used. Polymers (N-isopropyl acrylamide) are among the polymers with a valuable LCST transition that have been researched most extensively (PNIPAAm).The polyethylene-oxide-polymer (PEO-PPOPEO)is triblock co-polymer is pluronic and liquefied at low-slung temperatures, on the other hand once heated, the substance produced after transformation differs from disorder to micelle and forms the polymers appropriate for freezing in situ. High critical solution heat (UCST) has a positive hydrogel sensitive to temperature, which contracts when cooling during UCST cooling. Polymer networks such as polyacrylic acid, polyacrylamide show positive inflammatory temperature dependence. The most often used are thermoreversible poly (ethylene oxide)-poly (propylene oxide)-prepared gels (Poloxamer, Tetronics, Pluronics). Silicone alternatives provide a smoothly flowing spray at room temperature and gels at body temperature. Pro-Lastins, a novel 'protein polymer' that undergoes an irreversible transformation to a gel, form a firm, durable gel when inserted into the system as a solution within very short time. It resides at the injection site, giving absorption periods ranging from few days to several weeks and administering a device like this into the ideal body cavity would be easy (Bromberg and Ron 1998; Cappello, Crissman *et al*., 1998; Qiu and Park, 2001).

pH triggered systems:

One more kind of insitu gels is dependent upon physiological stimulus and gel formulation occurs by change in value of pH. Addition to variations in ambient pH, entirely pH dependent polymers comprise of simple groups that either gain or lose protons or pendant acidic groups. Polymers are known as polyelectrolytes with a broad variety of ionizable species. Hydrogel swelling increases as the added pH increases in the case of weakly acidic (anionic) groups, but decreases if the polymer contains weakly basic (cationic) groups. Derivatives of, PAA (Carbopol®, carbomer) are anionic pH sensitive polymers. Similarly, low viscosity polyvinyl alcohol, acetal diethyl amino acetate (AEA) form a hydrogel at neutral pH and solutions at pH 4. Drugs manufactured in the form of liquefied formulations possess several drawbacks, ranging from reduced bioavailable portion at the absorption site and fast removal capability. PAA solution having low pH will affect the surface of eye until the lacrimal fluid is neutralised at absorptions high enough to induce gelation to reduce these variables and enhance the distribution of this compound by producing a solution of poly(acrylic acid) (PAA) that would gel at pH 7.4.Mixing PAA with HPMC, a visco solvent, PMA and polyethylene glycol mixtures have similarly being used to achieve gelation dependent on pH change, partially solved this problem (Kumar and Himmelstein, 1995; Aikawa, Mitsutake *et al*., 1998; Alexandridis and Lindman, 2000; Soppimath, Aminabhavi *et al*., 2002; Patel, Chavda *et al*., 2010).

Physical Mechanism based In Situ Gel Formation
Swelling:

In situ gels are also formed after a substance imbibes H_2O from ambient atmosphere then inflate into the requisite surface. Myverol 18-99 (glycerol mono-oleate) is such a product, that is a polar lipid that expands and leading to formation of lyotropic liquid crystalline phase structures in water. It possesses certain characteristics that are bioadhesive in nature and can be broken down by the action of enzymes in vivo (Esposito, Carotta *et al*., 1996; Geraghty, Attwood *et al*., 1997).

Diffusion:

By this approach in situ gels are formed by the incorporation of the solvent into the underlying tissue from the polymer solution, resulting in polymer matrix precipitation or solidification. A useful solvent for such structures has been found to be NMP (Mottu, Gailloud *et al*., 2000).

Chemical reactions based In situ Gel formation
Ionic Cross Linking:

In the context of various ions, polymeric compounds can show a phase transformation and several polysaccharides can break down within the ion-sensitive environment. Whereas k-carrageenan is transformed to stiff, brittle gels in reaction to smaller quantities of K+, i-carrageenan forms elastic gels due to the availability of Ca2+. Anionic polysaccharide gellan gum sold on the market as Gelrite® forms in-situ gels in the presence of mono-and divalent cations, in particular Mg2+, Ca2+, Na+ and K+. Divalent cations, in particular Ca2+, can induce lower methoxypectin gelation. Likewise, in the presence of divalent/polyvalent cations, alginic acid is gelled. Normal in situ enzyme-catalyzed configuration has not yet been thoroughly researched, but does have some advantage over photochemical and chemical approaches. For example, the enzyme mechanism works well under physiological conditions without the need for dangerous chemicals, such as initiators and monomers. Smart stimulus-responsive delivery systems have been studied using hydrogels that can produce insulin. Cationic pH-sensitive polymers containing immobilised insulin and glucose oxidase can swell and release stored insulin in a pulsatile manner in response to blood glucose levels (Adler, Maurice *et al*., 1971; Schoenwald and Smolen, 1971; Durrani, Davies *et al*., 1992; Guo, Skinner *et al*., 1998; Bhardwaj, Kanwar *et al*., 2000).

Enzymatic cross-linking:
This formulation type has not been extensively studied, but has some benefits over other methods of in situ gel formulation e.g. photochemical and chemical. Enzymatic cross linking method works fine under biological conditions lacking the prerequisite for possibly injurious substances. Hydrogels that can contain insulin have been tested using intellectual stimulus responsive delivery systems. Using cationic pH-sensitive polymers that store immobilized insulin, retained insulin is periodically released and glucose oxidase can be expanded in reaction to blood glucose levels. Changing the quantity of enzyme also provides a practical means to track the frequency of formation of gel, that permits the mixtures to be inserted before the gel formation is achieved (Schmolka, 1972; Podual, Doyle Iii *et al*., 2000).

Photo-Polymerisation:
For in situ biomaterial formation, photo-polymerisation is widely used. Solution of monomers or reactive macromers is injected with an initiator into a tissue location in order to incorporate the electric radiation needed for the gel formation. Usually, for wavelengths that are longer UV and visible wavelengths are used. Since it is biologically toxic and has poor tissue penetration, the short ultraviolet wavelength is not commonly used. Ketones, like 2,2-dimethoxy-2-phenyl acetophenone, are frequently included, as an initiator for ultraviolet photo-polymerization whereas initiators like camphorquinone and ethyl eosin are often included in visible light systems. This configuration effectively can be planned for degradation by biochemical or enzymatic pathways or may be optimised in vivo for longer survival. Once connected to the target site by injection, the photopolymerizable structures are photocured in situ gel with the assistance of optic fibre cables and then released for a longer time. The photo-reactions have high physiological temperature polymerization speeds. Furthermore, the instruments are best positioned in complicated ordered sizes to create an implant (Burkoth and Anseth, 2000; Bashir, Majeed *et al*., 2019; Majeed, Bashir *et al*., 2019).

APPLICATIONS OF IN SITU GELLING SYSTEM

Oral In Situ Gelling Systems:
In this, the experimental application of pH-sensitive hydrogels to particular areas of the gastrointestinal region in the site-specific delivery of drugs is addressed. Hydrogels of silicone microspheres which release prednisolone into the gastric medium or have gastroprotective properties have been developed with varying proportions of PAA derivatives and cross-linked PEGs. Dextran hydrogels cross-linked with polysaccharides, such as amidade pectin, guar gum and inulin, have been developed as a potential colon-specific drug delivery mechanism for faster swelling under elevated pH conditions. Gellan gum and sodium alginate formulations were developed by researchers in which calcium ions were used as complexing agents and were gelatinized by liberating these ions into the acidic medium of stomach. Xyloglucan, pectin and gellan gum, natural polymers are used for the oral in situ gel distribution processes. Designed for the continuous distribution of PCM the formulation using pectin was established. Pectin is soluble in water so there is no necessity of adding an organic solvent (Carelli, Coltelli *et al*., 1999; Miyazaki, Aoyama *et al*., 1999; Kubo, Miyazaki *et al*., 2003).

In Situ Gels As Opthalmic Drug Delivery Systems:
Natural polymers are usually used in the ocular delivery system, like gellanic gum, alginic acid, and xyloglucan. To relieve intraocular glaucoma stress in the local ophthalmic delivery method several combinations such as an anti-inflammatory agent, an antimicrobial agent, and autonomic medications are used. Because of high turnover & dynamics of tear fluid have been designed to solve the ophthalmic in-situ gel bioavailability problem .Traditional delivery method also leads to low availability & therapeutic reaction, enabling the drug to be easily extracted from the eye. Viscosity enhancers like Poly Vinyl alcohol, Carbomers, Carboxy Methyl Cellulose, Hydroxy Propyl Methyl Cellulose are used in ocular preparations to enhance the viscous nature of these formulations, thereby increasing the precorneal residence time and increased bioavailability. To increase the infiltration of corneal ingredients like surfactants, preservers, chelating agents' penetration enhancers are used (Durrani, Davies *et al*., 1992; Miyazaki, Kawasaki *et al*., 2001; Kubo, Miyazaki *et al*., 2003).

Nasal Drug Delivery:
The polymers like gum gelan & gum xanthan are used in the nasal in-situ formation. The effectiveness of Momethasone furoate has been evaluated in therapeutic treatment of allergic rhinitis as an in situ gel. In vivo experiments were performed using sensitised rats as model of allergic rhinitis and the effect of in-situ gel on antigen-induced nasal symptoms was observed. A rise in nasal symptoms compared to the marketed nosonexex preparation was found to resist in situ gel (Wu, Wei *et al*., 2007; Cao, Ren *et al*., 2009).

Rectal system of drug delivery:
This approach is useful for the prescription of several kinds of medications packaged as liquefied, semi-solid (liniments, emulsions & froths) and suppositories in the form of solid delivery formulations. Discomfort is often caused by the classic suppositories during penetration. Also suppositories cannot be adequately held at a single rectum site they can travel upward to the intestine, making it possible for the first-pass effect of the drug to be encountered. Choi *et al* devised and tested revolutionary in situ gelling liquid suppositories with a gelling temperature of 30-36°C using Poloxamer 188 and/or Poloxamer 407 to give temperature - sensitive gelling properties which are intended for use in rectal and vaginal drug delivery systems (Choi, Lee *et al*., 1999). Miyazaki *et al* formulated and evaluated in situ gel of Indomethacin by the use of thermo-reversible xyloglucan-based gel for the rectal delivery of drugs. Compared to commercial suppository administration, large medication immersion and a pro longed drug residence time were demonstrated by Indomethacin loaded xyloglucan-based device administration to rabbits (Miyazaki, Suisha *et al*., 1998; Bilensoy, Rouf *et al*., 2006).

Vaginal In Situ Gels:
Vagina serves as a potential route for the administration of drugs. For the continuous release of active ingredients like estrogens, peptides, progestins, and proteins, formulations based on a thermoplastic graft copolymer undergoing in situ gelation have been produced. A combination of poloxamers and polycarbophils mucoadhesive thermosensitive gels showed increased and maintained antifungal effectiveness of clotrimazole drug compared to conformist polyethylene glycol based formulations in a recent report (Miyazaki, Suisha *et al*., 1998; Bilensoy, Rouf *et al*., 2006).

Injectable In Situ Gels:
One and only apparent ways to supply medications for extended release is to formulate the dosage forms as injectable or implantable delivery system. Primarily used are thermoreversible gels, primarily produced from poloxamers. The utility of poloxamer gel alone or with the inclusion of viscosity enhancers like CMC, HPMC, or dextran has been researched for the epidural administration of medications in vitro. The lightweight gel reservoir acts as the rate limiting stage compared to control solutions and significantly extends the dural penetration of medicines. These dosage forms might be advantageous for the production of a managed delivery of drugs for systemic absorption. Pluronic F127 gels containing either insulin or insulin-PLGA nanoparticles have been evaluated. Poloxamer gels have also been tested to administer human growth hormone intramuscularly and subcutaneously or to create a prolonged acting single dose lidocaine injectable (Miyazaki, Suisha *et al*., 1998). Recently, a novel type of depot protein injectable managed release formulations were prepared consisting of blends of poly (D, L-lactide)/1-methyl-2-pyrrolidone solutions from Pluronics. The hydrogel developed occurs in the form of a sol at increased temperature of around 45°C and becomes a gel after injecting subcutaneously and thereafter rapid body temperature cooling was made by using biodegradable polymers of poly (ethylene oxide) and poly (L-lactic acid).The injectable drug delivery system is used to cross-link pluronic acid modified hydrazide with aldehyde modified cellulose derivative forms for example carboxy methyl cellulose, hydroxy propyl methyl cellulose, methyl cellulose, etc. This in-situ forming gel has been employed to minimise pelvic pain, bowel obstruction and infertility in order to prevent postoperative peritoneal adhesion (DesNoyer and McHugh, 2003).

In Situ Gels as Dermal and Transdermal Drug Delivery Systems:
Percutaneous administration of indomethacin was based on using a thermally reversible gel of Pluronic F127 as a vehicle. Studies in the living bodies of animals indicate that as a basis for topical drug administration, 20% gel in the aqueous phase can be of useful value. Transdermal delivery of insulin was adequate by using poloxamer 407 gel. Insulin permeation was synergized by using the combination of iontophoresis and chemical enhancers (Chang, Oh *et al*., 2002; Ricci, Bentley *et al*., 2002; Ito, Yeo *et al*., 2007).

SIGNIFANCE OF IN SITU GELLING SYSTEM

Possibilities of delivering perfect and accurate amounts of in situ gel compared to the ordinary gel currently developed are of great importance. In-situ drug transfer system formation possess several advantages e.g. simplicity of drug transport & less rate of drug administration, better quality enforcement & wellbeing of patients. Improving availability and developing continuous controlled release formulations, particularly for drugs with a narrow absorption window, now have a tremendous impact on the field of drug delivery. However, conventional oral liquid dose types in the upper gastric region are hampered by poor retention, leading to bioavailability difficulties. From all of this, the conditions for prolonging the gastric residence period of such formulation types the stomach leads to a drastic solution, requiring a decrease in density to promote floating in the gastric fluids, thereby obtaining the kind gastroretentive continuous release dosage forms. This modern advancement that has been made in the continuous drug delivery system is represented by the floating in situ gel system today. In this procedure, which undergoes polymeric modifications when it enters gastric contents, a low viscosity solution can be easily applied, producing a viscous in situ gel with a density smaller than the gastric fluids (Talukder and Fassihi, 2004). Conventional ophthalmic formulations suffer from the inherent drawbacks like they have poor bioavailability & therapeutic index due to rapid drainage of the drug. These drawbacks can be overcome by using the in situ gel system that exists as drops instilled into the eye and undergoes a sol-gel transformation from the instilled dose. It is suitable for forming a liquid dosage shape that can survive the release of medications and remain in contact for an increased period of time with the cornea of the eye. Reduced accumulation of drugs drained via the ducts of nasolacrimal can lead to any adverse toxic effects (Parekh and Shah, 2013).

Some In Situ Gel Formulations Systems Are As Under:
Timoptic-XE
It is an ocular dosage form of in situ gel developed by Merck and Co. Inc., containing the active ingredient timolol maleate. It is supplied as a clean, isotonic, buffered gel that is aqueous. Two dosage strengths of 0.25 percent and 0.5 percent are commercially available for this formulation. There is a pH of around 7.0 and an osmolarity of between 260 and 330 mOsm in the solution. Each 0.25% Timoptic-XE ml consists of timololol 2.5 mg. Inert chemicals are gum gellan, mannitol, tromethamine, and H2O used for injecting the medicine, the preserving agent added is 0.012 percent benzododecinium bromide. This ocular in situ formulation decreases elevated and usual ocular tension of the eyes, preceded or not by glaucoma, when applied topically to the skin (Rathi, Zentner *et al*., 2001; Shah, Patel *et al*., 2009; Patel, Nagesh *et al*., 2012; Swapnali, Preeti *et al*., 2014; Jain and Jain, 2017).

Regel: Depot-Technology
It is the patented drug delivery systems of Macromed and is focused on a three-block copolymer consisting of poly (lactide-co-glycolide)-poly (ethylene glycol)-polymer (polymer) (lactide-co-glycolide). It is a collection of thermally reversible gelling polymers produced for intravenous delivery that provides a variety of, degradation rates, freezing temperatures and functional properties as a function of hydrophobic level, polymeric concentration and molecular weight. The physicochemical characteristics of the polymer experience a reversible transition in step after injection, leading in the creation of gel depot for water which is insoluble as well as biodegradable. Frozen Paclitaxel preparation is available as Oncogel. The formulation occurs as free-flowing liquid below room temperature that forms an in-situ gel after injection in reaction to body temperature. hGHD-1 is a new human growth hormone (hGH) injectable depot formulation that uses the Macromed Rule drug delivery mechanism to care for patients with HGH deficiency (Rathi, Zentner *et al*., 2001; Shah, Patel *et al*., 2009; Patel, Nagesh *et al*.. 2012; Swapnali, Preeti *et al*., 2014; Jain and Jain. 2017).

Cytoryn
Cytoryn is a novel in situ injectable interleukin-2 (IL-2) is peritumoral, depot formulation using the drug delivery system Regel for cancer immunotherapy. It's one of Macromed's drugs. It immediately creates a gel depot upon injection from which the medication is released in a controlled manner. It exists as a free-

flowing fluid below room temperature. Immunological response is improved by safely supplying 4 times the highest endured dose allowed by standard IL-2 therapy. Systemic Antitumor Immunity activated by Cytoryn is the IL-2 in its bioactive nature is stabilized and released by the Regel mechanism. The extent of spread and degradation of the depot governs the release of medications (Rathi, Zentner *et al*., 2001; Shah, Patel *et al*., 2009; Patel, Nagesh *et al*., 2012; Swapnali, Preeti *et al*., 2014; Jain and Jain, 2017).

DISCUSSION

Due to their rapid gastric transfer from the stomach, oral dosage forms pose low bioavailability problems, particularly in the case of drugs that are less soluble at alkaline intestinal pH. Likewise, drugs that create local activity in the stomach are easily emptied and do not get enough stomach residence time. So, in such situations, the frequency of dose administration is increased. A floating drug delivery system has been designed to avoid this problem (Majeed, Bashir *et al*., 2019; Maqbool, Fekadu *et al*., 2020). In many medical and biomedical applications, including managed drug delivery; developments in in-situ gel technologies have spurred progress over the past few decades. In order to meet the ever growing needs of the pharmaceutical and medical fields, many novel in situ gel-based delivery matrices have been developed and manufactured. In situ gelling systems at room temperature are liquid, but when in contact with body fluids or pH changes, they undergo gelation. A type of mucoadhesive drug delivery system is in situ gel forming drug delivery (Majeed, Bashir *et al*., 2019; Maqbool, Fekadu *et al*., 2020). Gel formation depends on factors such as regulation of temperature, change in pH, ion presence, and ultra violet irradiation from which the drug is released in a sustained and regulated manner. In the preparation of the in situ gelling method, many natural, biodegradable, biocompatible and synthetic polymers such as alginic acid, pluronic F127, xyloglucan, gellan gum, carbopol, pectin, chitosan, poly (DL lactic acid), poly (DL lactide coglycolide) and poly-caprolactone etc. are used. Intestinal, ocular, rectal, vaginal, injectable and intraperitoneal routes are administered mainly with in situ gels. Due to its many benefits over traditional drug delivery systems such as sustained and extended drug release, reduced administration frequency, enhanced patient compliance and comfort, the in situ gelling system is now very common (Mohd, Maqbool *et al*., 2019).

CONCLUSION

The distribution of in-situ drugs provides a huge incentive for liquid orals to be developed for the continuous release of drug substance. Continuous delivery of the medicine, high steadiness plus biocompatibility properties creates formulations forms of the insitu gel that are very stable. The in situ method of gelling is also useful for paediatric and geriatric patients. In the distribution and therapeutic application of medicines, the importance of the in situ gelling process is enormous. Developments in in situ gel technology have sparked research over the past few decades in the fields of various therapeutic and biomedical uses, together with controlled delivery of the drug. In order to meet the ever growing requirements of the drug and medical industry, several innovative sol gel transition based distribution matrices have been developed and manufactured. At room temperature, in situ gelling systems are liquid, they undergo gelation when interacting with fluids of body or pH changes. A type of mucoadhesive drug delivery scheme is in-situ gel forming medication distribution. Composition of the gel be subject to factors such as high temperature management, transition of pH, occurrence of ions, and irradiation by UV rays which makes it possible to release the substances in a continuous and regulated manner. The in situ gelling procedure is now very popular due to its numerous benefits above conventional approaches of drug delivery e.g. continuous and prolonged drug release, reduced administration frequency, improved patient compliance and comfort.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest

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