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# FABRICATION AND EVALUATION OF OSMOTIC CAPSULAR PUMP FOR CONTROLLED DRUG DELIVERY

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**ABSTRACT**

Osmotic (pump) capsule is fabricated as osmotic controlled drug release system that can provide improved therapy with better patient compliance. Osmotic capsule were prepared using drug and solid dispersions separately. Fabricated osmotic capsule were evaluated for various physical parameter and *in vitro* drug release characteristics. Effect of formulation variable (osmogen) and dissolution condition variables were investigated for the test of delivery performance of osmotic capsule. Drug releases from osmotic capsule were observed for dependent solid dispersion, type and thickness of coating membrane. Various types of osmogen and osmopolymer provide prolonged, controlled and GI environmental independent diclofenac sodium release that may result in an improved therapeutic efficacy and patient compliance.

**Key words:** Osmotic pump, osmogen, osmotic pressure, controlled delivery.

## INTRODUCTION

Osmosis can be defined as the spontaneous movement of the solvent from a solution of lower solute concentration to a solution of higher solute concentration through an ideal semi-permeable membrane, which is permeable only to the solvent but impermeable to the solute. The pressure applied to the higher concentration side to inhibit solvent flow is called the osmotic pressure[1].

Based on there design and the state of active ingredient, osmotic delivery systems can be classified as single compartment and multiple compartment. In multiple compartments the drug is separated from the osmotic compartment by an optical flexible firm, which is displaced by the increased pressure in the surrounding osmotic compartment, which in turn, displaces the drug solution or suspension[2]. One main advantage of these systems is their ability to deliver drugs that are incompatible used electrolytes or osmotic agents.

The major formulation components of a typical osmotic delivery system include drug, osmotic agent[3], Osmotic components[4], Barrier layer formers[5], Semi-permeable membrane forming polymers for osmotic pumps[6], Emulsifying agents, Flux-regulating agents, Plasticizers, etc.

Diclofenac sodium is a non-steroidal anti-inflammatory agent, which is widely used in the long-term therapy for inflammation and pain killer. The biological half-life of diclofenac sodium is about aprox.120 min, therefore it requires multiple dosing. It is poorly soluble in acidic pH (1-3) and water but is rapidly soluble in alkaline pH (5-8). Thus an attempt was made to formulate a sustained release osmotic pump containing diclofenac sodium for immediate release, which eliminates adverse side effects of diclofenac sodium on long-term administration are gastrointestinal disturbances, peptic ulceration and gastrointestinal bleeding.

## MATERIALS AND METHODS

**Material:** Starch (GlaxoSmithKline pharmaceutical limited, Mumbai), NaCl (Web research lab, Mumbai), Gelatin (S.D. fine chemical limited, Mumbai) were obtained and Gelatin capsules (size 2 and 3) were purchased. All other chemicals used were obtained commercially and were of analytical grade.

**Method of preparation:** For the preparation of osmotic pumps first of all a hard gelatin capsule is taken in size (2 and

3). To make it insoluble in water, gelatin capsule is treated with 1% solution of ethyl cellulose in ethyl alcohol and dried. Then the body part of capsule (size 3) filled with a mixture of NaCl and gelatin in ratio (1:5) than another capsule of size 2 is taken than it is filled with diclofenac sodium, sodium lauryl sulphate and starch. Then capsule (size 3) is inserted into the first capsule (size 2) of body cap of capsule (size 3) is placed. A hole is created at the top of capsule then the capsules are placed in a de-humidifier. The orifice was drilled using micro drill[7].

**Morphological study and Organoleptic properties:** Shape, surface and color of capsule is examined by naked eye. Size of capsule is determined with the help of vernier caliper. Surface study is performed to find out color change and smoothness of osmotic pump after formulation.

**Solubility:** To investigate and confirm the effect of pH on diclofenac sodium solubility with and without sodium lauryl sulphate (SLS), excess amount of diclofenac sodium was added to 10 ml buffers at 25°C with different concentration of SLS[8]. The solutions were shaken and filtered through 0.45m m microporous membranes and properly diluted with deionized water. Solubility of diclofenac sodium in the solutions was measured by UV spectrophotometer (SL-159, Elico) at a wave length of 276 nm[9].

**Scanning electron microscopy (SEM):** Scanning electron microscopic studies were performed on osmotic pump to characterize the surface topography and coating thickness.

**Release study:** For the release study during dissolution apparatus USP-2003 paddle type apparatus was used. In this apparatus first 900 ml of HCl (pH 1.2) solution for first 2 hrs and phosphate buffer 7.4 pH for remaining 7 hrs at 37±1°C. The capsules are placed inside the apparatus and release of drug is evaluated. The samples were filtered and suitably diluted to determine the absorbance at 276 nm in UV spectrophotometer Elico SL-159.

**Stability study:** A stability test was conducted by storing osmotic capsules in amber bottles at ambient temperature, 40°C and 50°C. The content of DS and the dissolution of drug from these matrix tablets were tested monthly for three months. The assay of DS and the dissolution study followed the same procedure as previously described.

## RESULTS AND DISCUSSION

The present study an attempt has been made to formulate osmotic pump using gelatin, sodium lauryl sulphate, NaCl, starch and Diclofenac sodium as a model drug. Total six formulations are prepared depending on various formulation variables as shown in table 1.

**Table 1: Formulation variables for osmotic pumps**

| Name of Material | Op1 | Op2 | Op3 | Op4 | Op5 | Op6 |
|---|---|---|---|---|---|---|
| Gelatin | 10 mg | 10 mg | 10 mg | 10 mg | 10 mg | 10 mg |
| NaCl | 2 mg | 2mg | 2 mg | 2 mg | 2mg | 2 mg |
| Starch | 40 mg | 40 mg | 40 mg | 40 mg | 40 mg | 40 mg |
| Sodium Lauryl Sulphate | 1 % w/v | 1 % w/v | 1 % w/v | 1.5 % w/v | 1.5 % w/v | 1.5 % w/v |
| Diclofenac Sodium | 100 mg | 100 mg | 100 mg | 100 mg | 100 mg | 100 mg |
| Ethylcellulose in ethanol | 1 % w/v | 1.5 % w/v | 2 % w/v | 1 % w/v | 1.5 % w/v | 2 % w/v |

Weight of empty Capsule: (Approx.) 92 mg

For the preparation of osmotic pump gelatin capsule size 2 and 3 was used. These capsules are coated with 1% solution of ethyl cellulose. An orifice was prepared on cap of the capsule using microdrill. The design of formulation is illustrated in figure 1. The photomicrographs of OP preparations can be observed in figure 2. The weights of OP capsules with and without drug were shown in table 2.

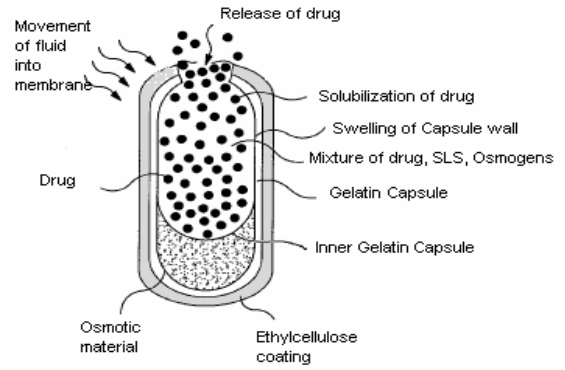


**Fig. 1: Illustration of drug release from osmotic pump**

**Fig. 2: Photograph of osmotic (pump) capsules**

**Table 2: Morphological studies of different osmotic (pump) capsules**

| Formulation | Weight (In mg) | Coating thickness (In mm.) |
|---|---|---|
| Op1 | 248±2.8 | 0.72±0.03 |
| Op2 | 250±3.5 | 0.79±0.042 |
| Op3 | 255±4.2 | 0.85±0.055 |
| Op4 | 251±2.7 | 0.75±0.036 |
| Op5 | 253±3.8 | 0.81±0.039 |
| Op6 | 256±4.5 | 0.88±0.058 |
| Empty Op | 92± 1.3 | 0.70±0.03 |

There was a negligible weight variation of the OP capsule, which was due to variation in weight of coating material and solubilizing. The *in vitro* drug release rate studies showed that the concentration of sodium lauryl sulphate is increased the rate of release of diclofenac sodium is increased. On increasing sodium lauryl sulphate content in the solid dispersion from 1 to 1.5 % w/v leads to an increased degree of solubility and therefore higher rate and extent of drug release was observed from solid dispersion, which was shown in table 3.

**Table 3: Solubility Study of various materials used in preparation of osmotic pump.**

| S. No. | Diclofenac sodium | SLS | Solubility (mg/ml) |
|---|---|---|---|
| 1. | 100 mg | ------ | 9 |
| 2. | 100 mg | 0.5 % w/v | 9.67 |
| 3. | 100 mg | 1 % w/v | 10.29 |
| 4. | 100 mg | 1.5 % w/v | 10.34 |

The concentration of solubilizing agent plays a major role in improving drug release from formulation [10, 11]. The entire range OP capsules exhibited a constant and controlled drug release profile from one hour onwards, though showing slow drug release till first one hour that must have elapsed in imbibitions of the core with the release medium and coating of ethyl cellulose which retarded the floe of fluid from outer compartment to inner compartment [12]. Capsule did not show any significant effect on rate and extent of drug release; since no burst effect was observe during drug release study. It can be inferred these orifice size has successfully prevented the membranes from rupturing effectively releasing the hydrostatic pressure developed inside the system and at the drug and constant rate over a significantly long period of time [13]. The coating thickness of the OP varied with increase in concentration of coating material it also has an effect on the release pattern of the OP, which can confirmed from *in vitro* release graph (figure 3).

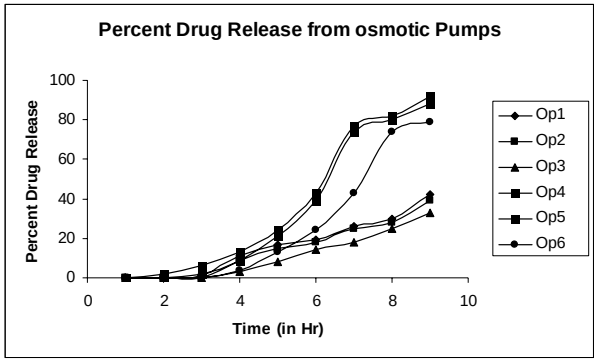


**Fig. 3: Dissolution curves of various osmotic (pump) capsules**

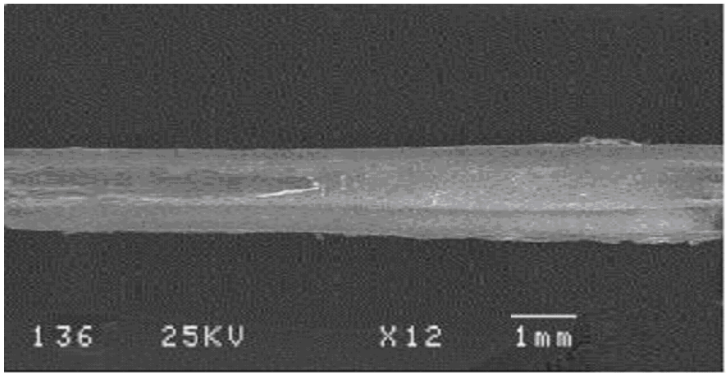


**Fig. 4: Scanning electron microscopic Photograph of wall of osmotic (pump) capsules OP6**

A uniform coating of polymer obtained over the capsule which was confirmed by SEM images shown in figure 4. The formulations were not affected when subjected to different stability conditions. The release profile remained unchanged after three months storage of osmotic capsules.

## CONCLUSION

Based on the finding of the present investigation, it was concluded that desired environmentally independent and controlled drug delivery of like diclofenac sodium from oral osmotic pump can be achieved by approximately selecting dispersion, type of membrane and optimizing its thickness, by adjusting the concentration of solubilizing agent (sodium lauryl sulphate) and incorporating optimized amount of osmopolymer (starch). All formulations were found to be smooth and capsular. There thicknesses of all the osmotic pumps are similar. Diclofenac sodium was used as a marker or model agent. On basis of *in vitro* release profile of diclofenac sodium, it was concluded that the osmotic pump containing sodium lauryl sulphate provided sustained release for 7 hour and remain stable and intact.

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