Formulation development of prolonged-release matrix tablets - factors influencing drug dissolution rate

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Introduction

Chronic pain remains a major societal burden that is associated with a decline of normal daily functioning and quality of life. Appropriate management of chronic pain aims to improve quality of life and daily function by alleviating not only pain symptoms, but also comorbid conditions (Martin et al., 2016). Oral opioids have become the drugs of choice for the treatment of moderate-to-severe chronic pain because of flexibility, convenience and ability to maintain relatively steady blood concentrations (Petrovska Jovanovska et al., 2018). Controlled release formulations could be a suitable dosage forms in chronic pain management (i.e. reduced dose frequency, less fluctuation in plasma concentration, reduced side effects and good patients’ compliance).

For the design of generic oral drug product with prolonged release properties using Quality by Design, QbD approach, a variety of polymers with different physicochemical characteristics could be used in order to modulate the drug release behaviors. Therefore, during the one facor-at time experiments it is highly desirable to determine the critical material attributes (CMAs) of the selected excipients (controlled release polymer/s), to evaluate the transport mechanism involved in the drug release process, as well as to be able to predict quantitatively the resulting drug release kinetics as the product most important critical quality attributes (CQA) (Saurí et al., 2014).

The aim of this study was to develop a generic film-coated matrix tablets with water soluble opioid drug (API). In that direction, we have evaluated the influence of different types of polymers (HPMC, PVac/PVP, HEC, PEO and PMAMMMA) on the properties of designed tablets in order to find the polymer or combination of polymers which will give most similar release profile with the reference drug product.

Materials and methods

Different formulations of film-coated tablets were prepared by wet granulation process using S1. HPMC (Colorcon, DE), S2. HEC (Ashland, UK), S3. PVAc/PVP (BTC, DE), S4. PEO (Colorcon, DE) and S5. PMAMMMA (Eudragit, DE) as drug release modifying polymers in concentration of 30% (w/w) respectively. The active substance (API, opioid analgesic, hydrochloride salt, BCS class II) was pre-blended with microcrystalline cellulose (FMC, IR) and selected polymer (S1-5) in high shear granulator
Afterwards, granulation liquid was added, the wet mass was passed through 0.630 mm sieve and the granules were subsequently oven dried (MOV-212S; Panasonic, JP). The dried granules where passed through 0.813 mm sieve and blended with magnesium stearate (FaciSpa Carasco, IT). The final blends were subsequently compacted into round 7.0 mm tablets with compression force of 5.0-5.5 kN (Korsch XL 100, DE). Prepared tablet cores were coated with Opadry 20A220058 Yellow (Colorcon, DE), (O’HARA Labcoat M).

Final blends were characterized for bulk/tapped density, Carr-index, Hausner ratio and angle of repose according to Ph. Eur. 8.7 methods. Prepared film-coated tablets were evaluated for mass and mass variation, hardness, thickness and diameter (TBH 425 TD, Erweka GmBh, DE). Prepared film-coated tablets were smooth and elegant in appearance. The formulated tablets passed the uniformity of weight, uniformity of thickness and diameter tests respectively and were in acceptance criteria according to QTPP of the reference product, except for S3, were results for hardness of the tablets was in unsatisfactory level (2.3 kP). Obtained results from the in vitro release studies pointed the influence of the used polymers on API release behavior. The S4 and S5 showed significant differences with respect to the release rate of API compared to reference product (similarity factor $f_2$ of 34.64 and 14.93, respectively). On the other side, S1-3 had the $f_2$ of 53.5, 51.1 and 55.2, respectively, thus representing potential candidates for further formulation modification and evaluation. The drug release data from all examined samples fit well to the Higuchi expressions, which points that drug release mechanism independently from which polymer/polymers will be used, will be a complex mixture of diffusion, swelling and erosion.

**Conclusion**

Prolonged release film-coated tablets of watersoluble opioid analgesic have been successfully formulated using HPMC, HEC or PVAc/PVP as drug release modifiers. The type of polymer used as CMA was found to significantly affect the tablet properties, especially the API release rate, as the CQA of the final drug product and were able to provide the desired drug release over a 12 h time period.

**References**

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