Saudi Pharmaceutical Journal (2015) **23**, 352–365

King Saud University

Saudi Pharmaceutical Journal

www.ksu.edu.sa
www.sciencedirect.com

REVIEW

Revealing facts behind spray dried solid dispersion technology used for solubility enhancement

Bhavesh B. Patel [a,b,*], **Jayvadan K. Patel** [c,1], **Subhashis Chakraborty** [b,2], **Dali Shukla** [d,3]

[a] *Ph.D. Research Scholar in Pharmaceutics, Faculty of Pharmacy, Hemchandracharya North Gujarat University, Patan 384265, Gujarat, India*
[b] *Technical Service, Pharma Polymer & Services, Evonik India Pvt Ltd., Mumbai 400 072, Maharashtra, India*
[c] *Nootan Pharmacy College, Visnagar 384 315, Gujarat, India*
[d] *Department of Pharmaceutics, IIT, Banaras Hindu University, Varanasi 221 005, India*

Received 31 October 2013; accepted 14 December 2013
Available online 23 December 2013

KEYWORDS

Amorphous solid dispersion;
Quality by Design;
Solubility enhancement;
Selection of polymer;
Spray drying

Abstract Poor solubility and bioavailability of an existing or newly synthesized drug always pose challenge in the development of efficient pharmaceutical formulation. Numerous technologies can be used to improve the solubility and among them amorphous solid dispersion based spray drying technology can be successfully useful for development of product from lab scale to commercial scale with a wide range of powder characteristics. Current review deals with the importance of spray drying technology in drug delivery, basically for solubility and bioavailability enhancement. Role of additives, selection of polymer, effect of process and formulation parameters, scale up optimization, and IVIVC have been covered to gain the interest of readers about the technology. Design of experiment (DoE) to optimize the spray drying process has been covered in the review. A lot more research work is required to evaluate spray drying as a technology for screening the right polymer

* Corresponding author. Address: Technical Service, Pharma Polymer & Services, Evonik India Pvt Ltd., Research Center India (RCI), Krislon House-First Floor, Sakinaka, Andheri (E), Mumbai 400 072, Maharashtra, India. Tel.: +91 9833746909; fax: +91 22 6624 6996.
E-mail addresses: bhavesh_botad@yahoo.co.in, bhavesh.patel@evonik.com (B.B. Patel), jayvadan04@yahoo.com (J.K. Patel), subhashis.chakraborty@evonik.com (S. Chakraborty), dali_shukla@rediffmail.com (D. Shukla).
[1] Tel.: +91 9825565796.
[2] Tel.: +91 9820521292.
[3] Tel.: +91 8652311226.

Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.jsps.2013.12.013

for solid dispersion, especially to overcome the issue related to drug re-crystallization and to achieve a stable product both *in vitro* and *in vivo*. Based on the recent FDA recommendation, the need of the hour is also to adopt Quality by Design approach in the manufacturing process to carefully optimize the spray drying technology for its smooth transfer from lab scale to commercial scale.

Contents

1. Introduction

In recent times, many new chemical entities (NCEs) have been synthesized on the basis of structure of their target receptors using combinatorial chemistry, which results in the invention of very large molecules with greater degree of hydrophobicity. Their poor aqueous solubility may cause poor solubilization in the gastrointestinal tract with low and unpredictable bioavailability (Shukla et al., 2011). It is frequently documented that almost 40% of NCEs discovered by the pharmaceutical researchers are poorly soluble or lipophilic in nature (Giri et al., 2010). The solubility performance of drugs remains one of the most challenging qualities in formulation development and it results in challenge in targeted delivery of poorly water soluble drugs (Kumar et al., 2011). Solid dispersion is one of methods which involves dispersion of one or more active ingredients in an inert carrier or matrix in solid state prepared by melting, dissolution in solvent or solvent evaporation method (Verma et al., 2011). Solid dispersion based spray drying technology is widely applied in pharmaceutical industry because it is simple, economic and advantageous (Patel and Patel, 2012; Hite et al., 2003; Mohanachandran et al., 2010). This review article covers an overview of spray drying technology, critical process parameters (CPPs) and their effect in final product quality, effect of various additives in spray drying, screening methodology for selection of suitable carrier polymer, scale up in spray drying and *in vitro–in vivo* correlation (IVIVC) of spray dried formulation. Quality by Design (QbD) is also an important aspect in optimization of the spray drying process parameters to assure the desirable reproducibility and quality of final product; therefore, it has also been covered under this review.

2. Various methods to overcome solubility issue

As shown in Table 1, various physical and chemical methods can be used to improve the solubility of poorly water soluble drugs. Particle size reduction is one of the physical methods to enhance solubility, but sometime decreasing the particle size may cause the agglomeration, which may retard the solubility and bioavailability during storage of final product. Presenting the compound as a molecular dispersion combines the benefits of a local increase in the solubility as well as stability of amorphous form of drug (Pouton, 2006; Leuner and Dressman, 2000). Selection of right carrier polymer is also vital to improve solubility and stability, so screening right excipient for solid dispersion technology has also been covered in the current review. As shown in Fig. 1, absorption of a BCS class II drug can be significantly improved by optimization of the formulation in such a way that it maintains class II drugs in a solubilized condition at the absorption site and due to that it gives a similar absorption profile like that of a class I molecules. For BCS class III and IV molecules, the permeability and absorption can be improved by means of chemical modification during the drug synthesis (Pouton, 2006).