of the poorly water-soluble drug without any matrix material suspended in dispersion[4]. These can be used to enhance the solubility of drugs that are poorly soluble in water as well as lipid media. As a result of increased solubility, the rate of flooding of the active compound increases and the maximum plasma level is reached faster. This approach is useful for molecules with poor solubility, poor permeability, or both, which poses a significant challenge for the formulators. The reduced particle size renders the possibility of intravenous administration of poorly soluble drugs without any blockade of the blood capillaries. The suspensions can also be lyophilized and into a solid matrix. Apart from these advantages, it also has the advantages of liquid formulations over others [5]. In the present review, we are mainly focusing on the different methods of preparation associated merits, demerits, and its pharmaceutical application as drug delivery system.

ADVANTAGES OF NANOSUSPENSION

- Enhance the solubility and bioavailability of drugs
- Suitable for hydrophilic drugs
- Higher drug loading can be achieved
- Dose reduction is possible
- Enhance the physical and chemical stability of drugs
- Provides a passive drug targeting

Preparation of nano-suspension:

The most common approach that has been used for preparing nanosuspensions is micronization by colloid or jet milling [6]. The method increases the dissolution rate of the drug but does not have any impact on the saturation solubility and thus cannot improve the bioavailability of drugs.

Sucker and co-workers used a precipitation technique to produce nanoparticles by dissolving the drug in a solvent and adding the solvent to a non-solvent that cause precipitation of the fine drug particle [7]. This has the advantage of using relatively simple and low-cost equipment. However, this created problems in stirring and mixing when taken up for large-scale production. The major challenge of this technique is to avoid crystal growth that occurs on storage due to Ostwald ripening. Mainly there are two methods for preparation of nanosuspensions. The conventional methods of precipitation (Hydrosols[25]) are called 'Bottom Up technology'. In Bottom Up Technology the drug is dissolved in a solvent, which is then added to non-solvent to precipitate the crystals. The basic advantage of precipitation technique is the use of simple and low cost equipments. The basic challenge of this technique is that during the precipitation procedure the growing of the drug crystals needs to be controlled by addition of surfactant to avoid formation of microparticles. The limitation of this precipitation technique is that the drug needs to be soluble in

into breaking of microparticulate drug to nanosized particles[12, 13].

AdvaRBBBBK

pressure homogenization, change in crystalline structure of formulation occurs which may be converted to either amorphous or other polymorphic forms[26]. Alteration in the solid state of the drug particles and the extent of the amorphous portion is determined by X-ray diffraction analysis [29] and supplemented by differential scanning calorimetry analysis[25].

Surface Charge (Zeta Potential)

Surface charge properties of the nanosuspensions are studied through zeta potential. The value of particle surface charge indicates the stability of nanosuspensions at the macroscopic level. A minimum zeta potential of ±30 mV is required for electrostatically stabilized nanosuspensions[30], [31]

delivery needs for the delivery of peptides and proteins and poorly soluble molecules.
30) RH. Muller , C. Jacobs . Production and characterization of a budesonide nanosuspension for pulmonary administration. Pharm Res.19 (2002) 189–194. [PubMed]
31)JZ Yang ,AL Young ,PC Chiang ,A Thurston ,DK Pretzer . Fluticasone and budesonide nanosuspensions for pulmonary delivery: Preparation, characterization, and pharmacokinetic studies. J Pharm Sci 97 (2008) 4869–4878. [PubMed]
32) YC Liang ,JG Binner . Effect of triblock copolymer non-ionic surfactants on the rheology of 3 mol% yttria stabilised zirconia nanosuspensions. Ceram Int. 34 (2008) 2937
33) RH.Muller ,MJ Grau . Increase of dissolution rate and solubility of poorly water soluble drugs as nanosuspension.Proceedings. World Meeting APGI/APV, Paris 2 (1998) 62–624.
34) L. Bond ,S. Allen , MC Davies ,CJ Roberts ,AP Shivji , SJ Tendler et al. Differential scanning calorimetry and scanning thermal microscopy analysis of pharmaceutical materials. Int J Pharm 243 (2002) 71–82. [PubMed]
35. R.H.Muller, B.H.L.Bohm and .J.Grau. Nanosuspensions : a formulation approach for poorly soluble and poorly bioavailable drugs. In D.Wise (Ed.) Handbook of pharmaceutical controlled release technology (2000) 345-357.
36) R.H. Muller, C.Jacobs, O. Kayser. Nanosuspensions as particulate drug formulations in therapy Rationale for development and what we can expect for the future. Ad.Drug Del.Rev 47 (2001) 3-19.
37) B.W .Muller, R.H.Muller. Particle size analysis of latex suspensions and microemulsions by Photon Correlation Specroscopy.J.Pharm.Sci. 73 (1984) 915-918.
38) Montasser, H. Fessi, A.W. Coleman. Atomic force microscopy imaging of novel type of polymeric colloidal nanostructures. Eur. J.Pharm.Biopharm 54 (2002) 281–284.
39) Laura Bond, Stephanie Allen , C. Martyn . Davies, J.Clive . Roberts, P. Arif .. Differential scanning calorimetry and scanning thermal microscopy analysis of pharmaceutical materials.Int.J.Pharm 243 (2002) 71–82.
40) N. Scholer, K.Krause, O.Kayser, R.H Muller, K. Borner, H. Hahn, O. Liesenfeld, Atovaquone nanosuspensions show excellent therapeutic effect in a new murine model of reactivated toxoplasmosis. Antimicrob.Agents Chemother 45 (2001) 1771 –1779.
41) K.Peters ,S. Leitzke , JE Diederichs , K. Borner ,H. Hahn , RH. Müller et al Preparation of a clofazimine nanosuspensions for intravenous use and evaluation of its therapeutic efficacy in murine mycobacterium avium infection. J Antimicrob Chemother 45 (2000) 77-83.
42) BH. Boedeker , EW Lojeski ,MD Kline , DH. Haynes .Ultra-long duration local anesthesia produced by injection of lecithin-coated tetracaine microcrystals. J Clin Pharmacol 34 (1994) 699-702.
43) L. Jia , H. Wong , C.Cerna ,SD. Weitman . Effect of nanonization on absorption of 301029: Ex vivo and in vivo pharmacokinetic correlations determined by liquid chromatography/mass spectrometry. Pharm Res 19 (2002) 1091-6.
44)EM. Liversidge. Formulation and antitumor activity evaluation of nanocrystalline suspensions of poorly soluble anticancer drugs. Pharm Res 13 (1996) 272- 278.
45) R. Pignatello ,N. Ricupero ,C. Bucolo ,F. Maugeri ,A. Maltese ,G. Puglisi . Preparation and characterization of Eudragit retard nanosuspensions for the ocular delivery of cloricromene. AAPS Pharmscitech 7 (2006) E27.
46) P. Setler . Identifying new oral technologies to meet your drug delivery needs for the delivery of peptides and proteins and poorly soluble molecules. IIR Limited, Drug delivery systems London: (1999).
47) GC. Liversidge. Paper presented at the 23 rd International symposium of the Controlled Release Bioactive Materials Society. Workshop on Particulate Drug Delivery Systems;(1996).
46.
48) O.Kayser , C. Olbrich , V. Yardley , AP Kiderten , SL. Croft . Formulation of amphotericin-B as nanosuspension for oral administration. Int J Pharm 254 (2003) 73-5.

