JOURNAL REVIEW: SOLID DISPERSION CARRIER

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ABSTRACT

Solid dispersion is one of the most effective formulation techniques to increase the solubility and dissolution rate of drugs that are classified as poorly water-soluble. Low solubility causes low bioavailability, so a formulation approach that is able to modify the physicochemical properties of the drug is needed. This review aims to summarize the latest developments related to the use of various types of carriers, manufacturing methods, and their effectiveness in increasing the solubility and dissolution of drugs through a solid dispersion system. Various studies were analyzed using the method of smelting, solvent evaporation, freeze-drying, co-grinding, to a ternary approach, with carriers such as PVP, HPMC, PEG 4000/6000/8000, poloxamer, chitosan, and surfactant. Almost all solid dispersion formulations succeed in increasing the solubility and dissolution rate of the drug compared to the pure form. This increase is influenced by the drug-carrier ratio, polymer properties, and preparation methods. Some studies even report an increase in dissolution more than double and an increase in solubility up to 100 times in certain drugs. Hydrophilic carriers such as PVP and PEG consistently provide the best results, while the combination of ternary with surfactants increases stability and inhibits recrystallization. Solid dispersion is a very potential formulation approach in overcoming drug solubility problems. The right carrier selection, component ratio optimization, and appropriate manufacturing methods are key factors for the success of increasing drug bioavailability.

Keywords: *Solid Dispersion, Drug Solubility, Dissolution Rate, Poorly Water-Soluble, Bioavailability, Carrier, PVP, HPMC, PEG, Poloxamer, Chitosan, Surfactant, Manufacturing Method, Smelting, Solvent Evaporation, Freeze-Drying, Co-Grinding, Stability, Recrystallization.*

INTRODUCTION

The bioavailability of oral drugs is highly dependent on the solubility and dissolution rate of the active substance in the gastrointestinal fluid. Many modern pharmaceutical active substances are classified as drugs with low solubility (poorly water-soluble), so they have non-optimal absorption when given in conventional preparations. (hande et all, 2021)

As a solution to the challenge, the solid dispersion technique has been proposed and developed since the beginning of the classical study by Chiou W. L. & Riegelman S. in 1971. They defined solid dispersion as a solid system consisting of one or more active substances dispersed in an inert hydrophilic carrier matrix. This system can be made through various methods such as melting (fusion), solvent dissolving, spray-drying, or lyophilization. (Zaini et al, 2010).

The advantage of solid dispersion lies in its ability to increase the solubility and dissolution rate of the drug by changing the crystalline state of the drug into an amorphous form, reducing the particle size, increasing wettability and porosity, and increasing the contact between the drug and the solvent medium. Thus, solid dispersion also has the potential to increase the bioavailability of drugs that were previously difficult to absorb. (Nikghalb et all, 2012)

In a solid dispersion system, the selection of the type and characteristics of the carrier is very important. Hydrophilic carriers, both synthetic and natural polymers, are

often used because of their ability to dissolve quickly in water media so that it helps to release drugs quickly. Matrix porosity, drug-carrier interaction, and preparation methods affect the physicochemistry of the preparation and the stability of solid dispersion. (Duncan, 2002)

With the increasing number of new drugs based on hydrophobic compounds, it is important to comprehensively understand the available carrier options both in terms of type (synthetic polymers, natural polymers, surfactants, amorphous materials, etc.), physicochemical characteristics, and their advantages and disadvantages. A literature review that delves into various types of carriers, their mechanisms of action, advantages & disadvantages, and the influence of the drug-carrier ratio is very relevant to help design efficient drug preparations

METHODS

This review article was conducted using data research methods utilizing 40 research journals published domestically and internationally in the last 5 years, namely 2020-2025. Searches were conducted on Science Direct, Pubmed, Google Scholar, and other journal search engines.

RESULT AND DISCUSSION

Method	Active Ingredient	Polimer	Research Results
1.SOLVENT EVAPORATION, FREEZE-DRYING *(GHODAKE ET ALL, 2022)*	Febuxostat	PVP K-25(60-300 mg), l-Arginine (150-300 mg)	Solid dispersion shows a significant increase in solubility, with the Freeze-drying method giving the highest solubility, reaching 86.44% after 100 minutes.
2.FLUIDIZED BED PROCESSING (FBP), SOLVENT EVAPORATION *(SURAWASE,BAHETI,2021)*	Simvastatin	Gelucire 44/14(1:3), PVP-K30, Poloxamer-188	Simvastatin solid dispersion using Gelucire 44/14 with a ratio of 1:3 shows an increase in maximum solubility up to 260,55 µg/mL. The dissolution kinetic follows the zero sequence model.
3.SOLVENT EVAPORATION *(WIBOWO& SUKMAWA,2022)*	Celecoxib	HPMC: PVP(1:2), HPMC:PEG (1:2)	Solid dispersion of celecoxib with HPMC-PVP carrier ratio 1:2 shows the highest dissolution rate (0,808 mg/cm²/min), twice as high as pure celecoxib (0,400 mg/cm²/min).
4. Solvent Evaporation *(Tampubolon,2021)*	Ibuprofen	PEG 6000 (1:05)	Solid dispersion of ibuprofen with PEG 6000 is made with a ratio of 1:1, increasing solubility up to 9,986 times compared to pure ibuprofen. The increase in solubility reaches 85.5% in medium pH 6.8.

5.Melting Method *(Kartalina&Wibowo,2021)*	Celecoxib	HPMC-PEG 6000(1:1:1, 1:1:2, 1:2:1)	Melting celecoxib with HPMC and PEG 6000 using a 1:1 ratio results in a double increase in solubility compared to pure celecoxib, with an increase in dissolution rate of up to 80%.
6.Solvent Evaporation (Solvent Method) *(Aprilianti,Umar, Zaini,2024)*	Atorvastatin	PVP K-30 (1:9, 3:7, 5:5, 7:3, 9:1)	Solid dispersion of atorvastatin with PVP K-30 in a ratio of 1:9 produces a solubility that increases by 9,986 times. The dissolution test showed an increase in dissolution of 86,136% in 30 minutes.
7.Melting Method *(Najih Dkk,2021)*	Meloxicam	PEG 6000 and Poloxamer 188 (99:1, 98:2)	Solid dispersion of meloxycam with PEG 6000 and Poloxamer 188 showed changes in the top of the meloxycam crystal and increased solubility by 80%, higher than pure moloxicam.
8.Solvent Evaporation) *(Rahayyu,Alita,Widjaja,2024)*	Ezetimibe	PEG 8000 (1:1,1:2,1:3)	Solid dispersion of ezetimibe using PEG 8000 increases solubility with dissolution reaching 80%, compared to only 40% in pure ezetimibe in 45 minutes.
9.Solvent Evaporation *(Yenti, Siregar,Ben, 2021)*	Asam mefanamat	PVA(1:1, 1:2, 1:4)	The manufacture of a solid dispersion system of Mefenamic Acid using PVA results in an increase in the dissolution rate of mefenamic acid. The best formula with a 1:1 ratio shows a dissolution rate of up to 104%.
10.Melting Method *(Larasati&Windahsih,2021*)	Ibuprofen	PEG 4000	Solid dispersion of ibuprofen with PEG 4000 at a dose of 52 mg/kg BB showed an increase in analgesic effect by 71.68%, with higher pain protection at a dose of 156 mg/kg BB (91.60%).
11.Simplex Lattice Design *(Alpons,Aisyah,Harmastuti,2021)*	Ezetimibe	Tween 80(4.681%)and Ethanol (16.319%)	The solid dispersion system of ibuprofen using Tween 80 and Ethanol results in increased penetration and viscosity of the drug.
12.Solvent Evaporation *(Abdullah,Imtihani,2022)*	Kitosan	PVP K-30 (1:2)	Chitosan granules in a solid dispersion system show good granule flow velocity and meet the requirements of physical quality.

13.Solvent Evaporation *(Seftian,Laksitorini,Sulaiman,2024)*	Resveratrol	Soluplus, Poloxamer 407	Resveratrol's solid dispersion formulation with Soluplus and Poloxamer 407 increases solubility and bioavailability significantly compared to pure form. Research results show that the use of Soluplus can increase solubility up to 100 times at low drug load (<30%).
14. Melting method	Medicine that is difficult to dissolve in water	Carrier Inert (Hidrofilik)	Successfully increasing the solubility, dissolution rate, and bioavailability of drugs that are difficult to dissolve.
15. Solvent evaporation (2023)	Mirtazapine (MRT)	PVP K30 & Poloxamer 188	The optimum formula shows an increase in water solubility, loading efficiency, dissolution rate, and an increase in bioavailability in vivo.
16. (*Co-Grinding Method*) (2023)	Candesartan-cilexetil	Mannitol	Increase the dissolution rate compared to the mixture of physical and pure substances..
17. (*Melting Method*) (2023)	Ibuprofen	Poloxamer 188 - PEG 6000	The solid dispersion system showed a significant increase in the dissolution rate of Ibuprofen.
18.Solid Dispersion (2023)	Kurkumin (*Curcuma heyneana*)	Not specific in the abstract	The research aims to increase the bioavailability of low curcumin.
19. (*Dissolution Method*) (2023)	Ramipril	Combination PEG 6000 and HPMC	Successfully showed an increase in the dissolution rate of Ramipril.
20.Various methods (2023)	Efavirenz	Not spesific in the abstract	Discuss the improvement of Efavirenz's dissolution and Efavirenz stability.
21. Solvent evaporation (2025)	Etoricoxib	Kollidon® VA 64	The comparison of ETO-KOL-3 (1:3) was obtained optimally, with the aim of increasing the dissolution.
22. Solid Dispersion (2025)	Flukonazol	Polivinilpirolidon (PVP) dan PEG 6000	Formulation with PVP provides better stability, and stable preparations show an improved dissolution profile.
23. Ternary Solid Dispersion (TSD) dan Kokristalisasi (2025)	Pharmaceutical Active Ingredients (API) (BCS Kelas II & IV)	Polimer or surfaktan	TSD increases solubility, bioavailability, and stability. Effective cocrystallization overcomes the solubility challenge..
24. Solvent Evaporation,2024	API Hard To Late	Matriks Polimer	Solid dispersion technique increases solubility,

)			dissolution rate, and oral bioavailability by stabilizing API in amorphous form.
25.Solid Dispersion*(sadiar ti dkk., 2022)*	Nigedipin	PVP K-30	The solid dispersion formula showed a significant increase in the dissolution of nifedipine compared to pure nifedipine and physical mixtures.
26..Solid Dispersion biner *(Bustaman et al., 2024)*	Atorvastatin	Polivinilpirolidon (PVP K-30)	Solid dispersion with PVP K-30 shows an increase in in vitro dissolution of atorvastatin which is better than pure drugs.
27.Solid state grinding *(sonita et al. 2023)*	Ketoprofen	Proline 1:1, 1:2, and 2:1 (ketoprofen: proline)	A multicomponent mixture is a binary mixture (does not form new crystals).
28.co-grinding *(fadhila dkk., 2022)*	Celecoxib	PEG 4000 with comparison 6:4, 7:3, dan 8:2	Formula 1 (6:4) gives the highest % of dissolution (68,38% ± 0,744 at the 60th minute) compared to pure celecoxib (55,57% ± 0,690) and physical mixture (61,20% ± 1,464).
29.Combination method (Najih dkk., 2021)	Meloksikam	PEG 6000:Poloxamer 188 with comparison 99:1 and 98:2	Shows a decrease in the degree of crystallization and a lower melting point (DP-2:55, 4°c). FT-IR analysis shows no chemical interaction between meloksikam and the carrier.
30.Solvent Co-Evaporation *(Jessica dkk., 2023)*	Kandesartan sileksetil (CC)	HPMC with comparison 2:1 (F1), 1:1 (F3) (CC :HPMC)	The CC-HPMC solid dispersion system is capable of increasing the dissolution up to 2.42 times the single CC. The increase in HPMC concentration (F3:1:2) positively increases the dissolted CC.
31.(Solvent Evaporation) *(Noval & rosyifa., 2021)*	Natrium diklofenak	PVP K-30 1:3, 1:5, 1:7, and 1:9	Solid dispersion with a ratio of 1:9 shows the largest dissolution rate (97.42% at the 60th minute) and is significantly different from pure powder (48.01%),theincrease in PVP K30 concentration is proven to increase the dissolution rate.
32.Ternary System (*Seftian dkk., 2023*)	Drugs that are difficult to dissolve in water	Polimer (e.g., PVP, HPMC) +surfaktan (e.g., poloxamer 407)	Shows an increase in higher dissolution speed compared to binary systems. Surfactants act as crystallization inhibitors and discussion agents.

33. Solvent Evaporation (*Fauzi dkk., 2024)*	Asetosal (Asam asetilsalisilat)	PEG 6000 1:1, 1:2, 1:3, 1:4, 1:5	The best solid dispersion is found in a ratio of 1:3 with a dissolution value of 98.87%. Although there is no statistically significant difference in the dissolution rate, the presence of PEG 6000 has been proven to increase the dissolution rate.
34.Solid Dispersion *Ramaadhana dkk., 2021)*	The medicinal ingridients are difficult to dissolve	Polimer (General)	Solid dispersion is proven to be effective and promising to increase the solubility of difficult-to-dissolve medicinal ingredients. This review discusses aspects of formulation, manufacturing methods, and characterization of solid dispersion tablets.
35.Solvent Evaporation *(Singh et all.,2024)*	Nifedipine	HPMC dan PVP K-30 with the comparison of drugs : polimer 1:1, 1:2, and 1:3 (b/b)	Solid dispersion increases the solubility and dissolution rate of nifedipine significantly compared to pure drugs. The ratio of 1:3 shows the highest increase in dissolution due to the formation of amorphous systems and drug-polymer interactions.
36.Solvent evaporation method *(Manno & setianto., 2021)*	Oleanolic acid (OA)	Poloxamer 188, poloxamer 407,y-cyclodextrin (y-CD)	The solubility and dissolution rate of OA increased significantly compared to single OA; permeability also increased based on the PAMPA test.
37.Solvent evaporation *(Rahman et al.,2024)*	Ketoprofen	PVP K30 (medicine: polimer 1:1, 1:2, dan 1:3 (b/b))	Solid dispersion of ketoprofen–PVP K30 increases solubility and dissolution rate compared to pure ketoprofen. The 1:3 ratio gives the highest dissolution results due to the increase in hydrophilic properties and the formation of amorphous shapes.
38.fusion method (Pangestu dkk., 2020)	Ibuprofen	PEG 6000 with comparison ibuprofen: PEG 6000 =1:1, 5	38. Solid dispersion of ibuprofen–PEG 6000 increases the solubility and release of the drug. FTIR results showed an interaction (hydrogen bond) between ibuprofen and PEG 6000. The optimum gel formula is obtained at karbopol 1.011% and glycerin 7,489%, with the best viscosity

			and penetration flux values.
39. (*Solvent Method*) (N/A)	Azitromisin Dihidrat	Hidroksipropil Metilselulosa E5 LV (HPMC)	Azithromycin dihydrate changes part of the crystal phase to amorphous, and there is an increase in the dissolution rate.
40.(*Lyophilized Solid Dispersion*) (2023)	(*Poorly Soluble Drugs*) / SNEDDS-based	Lipid-based and adsorbent/carrier solid components	Synergistic effect to increase the stability attributes of SNEDDS-based formulations, overcoming liquid form challenges.

The results of the study showed that the solid dispersion formulation was effective in increasing the solubility and dissolution rate of drugs that are classified as difficult to dissolve in water. Various methods, such as solvent evaporation, freeze-drying, and melting method, have been used to create a solid dispersion system that successfully increases the solubility of the drug significantly. For example, in the Febuxostat formulation, the use of PVP K-25 and l-Arginine with the freeze-drying method showed an increase in solubility of up to 86.44% in 100 minutes. Likewise in Ibuprofen's formulation, the use of PEG 6000 increases solubility up to 9,986 times compared to its pure form. This shows that solid dispersion can overcome the solubility problem in drugs that have low solubility.

Choosing the right carrier is a key factor in the success of solid dispersion formulation. Hydrophilic carriers such as PVP and PEG are proven to give the best results in increasing drug solubility and dissolution. Studies using a combination of ternary carriers, such as Poloxamer-188, also show an increase in the stability of the formulation and prevent drug recrystallization. In addition, the right manufacturing method, such as solvent evaporation and freeze-drying, plays an important role in determining the success of solid dispersion. Thus, solid dispersion formulation can be an effective solution in increasing the bioavailability of drugs that are difficult to dissolve and providing more optimal therapeutic results.

CONCLUSION

Based on the data that has been reviewed from several research journals, it can be concluded that solid dispersion is proven to be a very effective approach to increase the solubility and dissolution rate of drugs that are difficult to dissolve in water. Various manufacturing methods such as solvent evaporation, freeze-drying, and melting method have successfully shown a significant increase in drug solubility and dissolution. Choosing the right carrier, especially hydrophilic carriers such as PVP and PEG, plays a key role in the success of this formulation. In addition, the combination of terner carrier with surfactant also increases stability and prevents drug recrystallization. Overall, solid dispersion techniques offer potential solutions to overcome the problem of poorly water-soluble drug bioavailability and can be used to increase the effectiveness of drug therapy.

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Conflict Of Interest

The author stated that this research was carried out without any interest attachment, both commercially and financially with any party. All data presented in this article is

purely objective and free from institutional influence or interests outside of academic goals.

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