LIST OF PUBLICATIONS

Research Publications in Peer Reviewed Journals


2. Shantanu Bandyopadhyay, B. Singh and O.P. Katare; Optimized Self Nano-Emulsifying Systems of Ezetimibe with Enhanced Bioavailability Potential using Long Chain and Medium Chain Triglycerides; Colloids and Surfaces B: Biointerfaces (Elsevier BV, Netherlands; ISSN: 0927-7765); 100, 2012, 50-61; [Impact Factor: 3.456] Citations: 2


Review Publications


5. B. Singh, Shantanu Bandyopadhyay, S. Beg and O.P. Katare; Handling Poorly Bioavailable Drugs using Nanoemulsifying Drug Delivery Systems; The Pharma Review (Kongposh Publications, India; ISSN: 0973-399X); 9(54), 2011, 91-98.

6. B. Singh and Shantanu Bandyopadhyay; Enhancing Drug Oral Bioavailability using Self-emulsifying Drug Delivery Systems (SEDDS); Chronicle Pharmabiz (Saffron Media Pvt. Ltd., India; national monthly magazine); 11(15), 2011, 20-22.


9. B. Singh, A. Mohapatra, Shantanu Bandyopadhyay and R. Kapil; Endeavoring Biowaivers using BCS and IVIVC; The Pharma Review (Kongposh Publications, India; ISSN: 0973-399X); 8(43), 2010, 87-93.

10. B. Singh, R. Kapil, Shantanu Bandyopadhyay, O.P. Katare; Novel Nanostructured Lipidic Drug Delivery Systems; The Pharma Review (Kongposh Publications, India; ISSN: 0973-399X); 7(42), 2009, 118-122.

11. B. Singh, R. Kapil, Shantanu Bandyopadhyay, O.P. Katare; Dendrimers as Nanobiopolymers: Drug Delivery Applications; Pharma Buzz (3M Advertisers and Publishers Limited, India; national monthly pharmaceutical magazine); 4(9), 2009, 34-43.

12. B. Singh, Shantanu Bandyopadhyay, R. Kapil and N. Ahuja; Systematic Optimization of Drug Delivery Systems: An Insight; The Pharma Review (Kongposh Publications, India; ISSN: 0973-399X); 7(37), 2008, 146-186.


BOOK


BOOK REVIEWS


7. B. Singh, Gajanand, Shantanu Bandyopadhyay and O.P. Katare; “Enhanced Bioavailability Potential of Cationic Self Nanoemulsifying System of Candesartan”, 5th Chandigarh Science Congress; Panjab University, Chandigarh, India, 26-28 February, 2011; Abstract No PMS 34.


17. B. Singh, C. Tripathi, G. Sharma and Shantanu Bandyopadhyay; “Formulation and optimization of positively charged SNEDDS of candesartan with enhanced bioavailability potential”, Biotechnica Chandigarh 2010 on “Biotechnology: Its Blue, Green, Red and White Faces”, Panjab University, Chandigarh, India, 16-18 November, 2010; Abstract No C 06.


22. R. Kapil, S. Dhawan, Shantanu Bandyopadhyay and B. Singh; "Pharmacological and Biochemical Studies on Brain Targeting of Quercetin through Novel Nanoparticulate Formulation Strategies”, 35th Annual Conference of Environmental Mutagen Society of India (EMSI) & International Symposium on "Mutagens and Genetic Diversity for Health and Agriculture", Panjab University, Chandigarh, India, 12-14 March, 2010; Abstract No. AP 15. PRESENTATION BAGGED “BEST POSTER PAPER” AWARD


25. R. Kapil, S. Dhawan, Shantanu Bandyopadhyay and B. Singh; "Novel Buccoadhesive Films of Rivastigmine for Once-a-day Application: Development, Optimization and Evaluation”; 13th Punjab Science Congress, Panjab University, Chandigarh, India, 7-9 February, 2010; Abstract No. E P09. PRESENTATION BAGGED “BEST POSTER PAPER” AWARD

27. Shantanu Bandyopadhyay, R. Singh, L. Khurana and B. Singh; “Novel Nanoemulsifying Systems for Bioavailability Enhancement of Carvedilol”; 30th Annual Conference of Indian Association of Biomedical Scientists (IABMS); Defence Institute of High Altitude Research, Chandigarh, India; 18-20 November, 2009; PP 10.

28. S. Dehal, Shantanu Bandyopadhyay and B. Singh; “Improving Bioavailability of Simvastatin using Various Types of Self Emulsifying Formulations”; 30th Annual Conference of Indian Association of Biomedical Scientists (IABMS); Defence Institute of High Altitude Research, Chandigarh, India; 18-20 November, 2009; PP 11.


30. N. Ahuja, A. Kataria, Shantanu Bandyopadhyay and B. Singh; “Self Nano-emulsifying Drug Delivery Systems (SNEDDS) of Raloxifene Hydrochloride: Formulation, Evaluation and Optimization”; 3rd Chandigarh Science Congress (CHASCON); Panjab University, Chandigarh, India; 26-28 February, 2009; Abstract No. 42.

31. R. Kapil, S. Dhawan, Shantanu Bandyopadhyay and B. Singh; “Development and Validation of a Spectrofluorimetric Method for Estimation of Rivastigmine in Drug Formulations”; 3rd Chandigarh Science Congress (CHASCON); Panjab University, Chandigarh, India; 26-28 February, 2009; Abstract No. 31.

32. B. Singh, R. Rao, P. Kumar, N. Bhatti and Shantanu Bandyopadhyay; “Design and Development of Simple Pharmacokinetic Experiments for Students in Human Volunteers”; 3rd Chandigarh Science Congress (CHASCON); Panjab University, Chandigarh, India; 26-28 February, 2009; Abstract No. 43.

34. B. Singh, R. Singh, Shantanu Bandyopadhyay, S. Dehal; “Self Nano-emulsifying Drug Delivery Systems (SNEDDS) of Carvedilol for Bioavailability Enhancement”; 60th Indian Pharmaceutical Congress; Netaji Subhas Institute of Technology, New Delhi, India; 12-14 December 2008; Abstract No. PH 756.

Optimized self nano-emulsifying systems of ezetimibe with enhanced bioavailability potential using long chain and medium chain triglycerides

Shantanu Bandyopadhyay, O.P. Katare, Bhupinder Singh*

University Institute of Pharmaceutical Sciences (UGC Centre of Advanced Studies), Punjab University, Chandigarh 160014, India

ARTICLE INFO

Article history:
Received 19 April 2012
Accepted 12 May 2012
Available online xxx

Keywords:
SNEDDS
Formulation by Design (FbD)
Intestinal perfusion
Hyperlipidemia
Triglycerides
Nanoemulsion

ABSTRACT

The objective of the current work is to develop systematically optimized self-nanoemulsifying drug delivery systems (SNEDDS) using long chain triglycerides (LCT's) and medium chain triglycerides (MCT's) of ezetimibe employing Formulation by Design (FbD), and evaluate their in vitro and in vivo performance. Equilibrium solubility studies indicated the choice of Maisine 35-1 and Capryol 90 as lipids, and of Labra- sol and Tween 80 as emulgents for formulating the LCT and MCT systems, respectively. Ternary phase diagrams were constructed to select the areas of nanoemulsion, and the amounts of lipid (X₁) and emul-gent (X₂) as the critical factor variables. The SNEDDS were systematically optimized using 3² central composite design and the optimized formulations located using overlay plot. TEM studies on reconstituted SNEDDS demonstrated uniform shape and size of globules. The nanometer size range and high negative values of zeta potential depicted non-coalescent nature of the optimized SNEDDS. Thermodynamic studies, cloud point determination and accelerated stability studies ascertained the stability of optimized formulations. In situ perfusion (SPIP) studies in Sprague Dawley (SD) rats construed remarkable enhancement in the absorptivity and permeability parameters of SNEDDS vis-a-vis the conventional marketed product. In vivo pharmacodynamic studies in SD rats indicated significantly superior modification in plasma lipid levels of optimized SNEDDS vis-a-vis marketed product, inclusion complex and pure drug. The studies, therefore, indicate the successful formulation development of self-nanoemulsifying systems with distinctly improved bioavailability potential of ezetimibe.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

Self-nanoemulsifying drug delivery systems (SNEDDS) are newer and novel technological platforms with immense potential in oral bioavailability enhancement of lipophilic drugs. Being nano in size, such lipidic drug carrier systems are capable of surmounting the problems of low oral bioavailability of drug(s) caused owing to their poor aqueous solubility, hepatic first-pass effect, metabolism by cytochrome P450 family of enzymes present in the gut entereocytes and liver hepatocytes, P-glycoprotein (P-gp) efflux and/or restricted intestinal permeability [1].

Of the excipients employed for the formulation of SNEDDS, lipids have an immense role for the biological fate of drug. Studies have shown that the type of absorption pathway and subsequent transportation of drug is significantly influenced by the two types of lipids viz. medium chain triglycerides (MCT's) and long chain triglycerides (LCT's) [2-3]. The MCT's are directly transported by the portal blood to the systemic circulation, whereas the LCT's are transported via the intestinal lymphatics. The LCT's are likely to augment the lymphatic transport of a lipophilic drug substance leading to enhance oral bioavailability. Nevertheless, if the lipophilicity of the molecule is sufficiently high (i.e., logP ≥ 4.5) then the MCT-based systems are also likely to favour the lymphatic transportation.

The drug, i.e., ezetimibe, chosen in the present study is a BCS class II hypolipidemic drug with poor water-solubility and high permeability (logP of 4.36) [4]. Besides these, it undergoes rapid first-pass metabolism and P-gp efflux, leading eventually to marked reduction in the drug oral bioavailable fraction (i.e., 35%) in humans and animals like dogs, rats, etc. [5,6]. To circumvent the afore-mentioned limitations various formulation approaches of ezetimibe have been reported like, nanocrystals, cyclodextrins inclusion complex, suspensions but all with limited fruition [7-9].

Systematic optimization of such isotropic delivery systems using design of experiments (DoE), on the other hand, offers numerous advantages including high degree of precision and prognosis, and economy in terms of time, effort and money [10]. Application of such DoE techniques for the development of optimized drug
Optimized nanoemulsifying systems with enhanced bioavailability of carvedilol

Bhupinder Singh a, b, Ramandeep Singh b, Shantanu Bandyopadhyay a, Rishi Kapil a, Babita Garg a

a University Institute of Pharmaceutical Sciences, UGC Centre of Advanced Studies, Panjab University, Chandigarh 160 014, India
b Cipla R & D Centre, Vikhroli (W), Mumbai 400 083, India

ARTICLE INFO

Article history:
Received 1 June 2012
Received in revised form 7 July 2012
Accepted 13 July 2012
Available online xxx

Keywords:
SNEOFs
Bioavailability
Formulation by design (FbD)
SNEOFs
In situ single pass intestinal perfusion
IVIVC

Abstract

The current studies entail a novel approach of formulating the solid self-nanoemulsifying drug delivery systems (S-SNEDDS) of carvedilol solely using rational blends of lipidic and emulsifying excipients without using equipment-intensive techniques and/or inert porous carriers. Delineating the nanoemulsion regions, the amounts of Capmul MCM (i.e., lipid) and Nikkol HCO 50 (i.e., emulsifier) were selected as the critical factors for systematically formulating the optimized S-SNEDDS employing face centered cubic design. The optimized formulation (mean globule size: 40.8 nm) indicated marked improvement in drug release profile vis-à-vis pure drug and marketed formulation. Augmentation in the values of Cmax (134.2%) and AUC (85.2%) indicated significant enhancement in the rate and extent of bioavailability by the S-SNEDDS formulation compared to pure drug. In situ SPH studies ascertained the significant enhancement in absorptivity parameters of SNEDDS formulations to transport through the lymphatic system and reduced P-gp efflux. Successful establishment of various levels of in vitro mouse correlations (IVIVC's) substantiated the judicious choice of the in vitro dissolution milieu for simulating the in vivo conditions. The optimized formulation was found to be quite stable during six months of study period. The current investigations, therefore, report the successful development of systematically optimized S-SNEDDS with enhanced bioavailability potential of carvedilol.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

Nano-based drug delivery systems, especially the lipidic ones, have lately gained wide acceptance for enhancing the bioavailability of poorly soluble and permeable drugs [1]. Of late, self-nanoemulsifying drug delivery systems (SNEDDS) have emerged as an effective delivery systems owing to their inherent merits [2]. Several potential advantages of SNEDDS include, capability of bypassing hepatic portal route and promoting the lymphatic transport of lipophilic drugs, reducing metabolism by cytochrome-P450 family of enzymes present in the gut enterocytes and liver hepatocytes and/or inhibiting P-glycoprotein (P-gp) efflux [2, 12]. This has been rationally related to the nano-sized globules coupled with specific formulation components like lipids and emulgents [3]. Solid SNEDDS (S-SNEDDS) are highly sought-after owing to their myriad benefits like better portability, improved stability and higher drug loading, coupled with ease and economy of their production [4–6].

The S-SNEDDS are usually prepared by using equipment-intensive techniques like spray drying and extrusion-spheronization and/or adsorbing the liquid SNEDDS (L-SNEDDS) on to the porous inert carriers like magnesium aluminometasilicate and colloidal silicon dioxide [4]. As these specialized techniques are mired with various potential issues of robustness, process optimization, scalability and high production costs, adoption of apt formulation approach(es) obviating the use of such machination and additional excipients is thus called for.

Systematic optimization of self-nanoemulsifying formulations for various product variables viz. lipids, emulgents and co-emulgents using formulation by design (FbD) tends to reveal (any) synergism amongst the variables [5, 7]. Plus, it yields the most promising SNEDDS formulations with advantages of economics in terms of time, money and developmental effort. As the formulation of any self-nanoemulsifying system depends upon the composition of rational blends of such lipidic and emulsifying agents to yield the optimal solid SNEDDS, the use of “FbD” studies is considered almost imperative for the purpose [7–9].

Carvedilol is a poorly water-soluble drug with a log P of 4.115. It is clinically indicated not only in the management of hypertension, but for myocardial infarction and congestive heart failure too [10, 11]. It undergoes extensive first-pass metabolism in liver, leading to marked reduction in its absolute oral bioavailability in humans (about 20%) as well as in animals [12, 13]. Various

Bhupinder Singh,*1 Shantanu Bandopadhyay,1 Rishi Kapil,1 Ramandeep Singh,2 & O.P. Katare1

1University Institute of Pharmaceutical Sciences (UGC Centre of Advanced Studies), Panjab University, Chandigarh 160 014, India; 2Cipla R & D Center, Vikhroli (W), Mumbai 400 083, India

*Address all correspondence to Dr. Bhupinder Singh Bhoop, Professor of Pharmaceutics & Pharmacokinetics, University Institute of Pharmaceutical Sciences, UGC Centre of Advanced Studies, Dean Alumni Relations, Panjab University, Chandigarh 160 014 India; Tel.: 91-172-2534103; Fax: 91-172-2541142; bsbhoop@yahoo.com or bsbhoop@pu.ac.in.

ABSTRACT: Self-emulsifying drug delivery systems (SEDDS) possess unparalleled potential in improving oral bioavailability of poorly water-soluble drugs. Following their oral administration, these systems rapidly disperse in gastrointestinal fluids, yielding micro- or nanoemulsions containing the solubilized drug. Owing to its miniscule globule size, the micro/nanoemulsified drug can easily be absorbed through lymphatic pathways, bypassing the hepatic first-pass effect. We present an exhaustive and updated account of numerous literature reports and patents on diverse types of self-emulsifying drug formulations, with emphasis on their formulation, characterization, and systematic optimization strategies. Recent advancements in various methodologies employed to characterize their globule size and shape, ability to encapsulate the drug, gastrointestinal and thermodynamic stability, rheological characteristics, and so forth, are discussed comprehensively to guide the formulator in preparing an effective and robust SEDDS formulation. Also, this exhaustive review offers an explicit discussion on vital applications of the SEDDS in bioavailability enhancement of various drugs, outlining an overview on myriad in vitro, in situ, and ex vivo techniques to assess the absorption and/or permeation potential of drugs incorporated in the SEDDS in animal and cell line models, and the subsequent absorption pathways followed by them. In short, the current article furnishes an updated compilation of wide-ranging information on all the requisite vistas of the self-emulsifying formulations, thus paving the way for accelerated progress into the SEDDS application in pharmaceutical research.

KEYWORDS: self-emulsifying formulation, bioavailability enhancement, SNEDDS, SMEDDS, hepatic first-pass effect, lipid-based drug delivery

ABBREVIATIONS

SEDDS self-emulsifying drug-delivery  S-SEDDS supersaturable SEDDS system

0743-4863/09 $35.00
© 2009 by Begell House, Inc. www.begellhouse.com
Original Paper

Development of optimized self-nano-emulsifying drug delivery systems (SNEDDS) of carvedilol with enhanced bioavailability potential

Bhupinder Singh1, Lalit Khurana2, Shantanu Bandyopadhyay1, Rishi Kapil1, and O. O.P. Katare1

1University Institute of Pharmaceutical Sciences (UGC Centre of Advanced Studies), Panjab University, Chandigarh 160014, India, and 2Ranbaxy Research Laboratories, Gurgaon, India

Abstract

Carvedilol, a widely prescribed cardiovascular drug for hypertension and congestive heart failure, exhibits low and variable bioavailability owing to poor absorption and extensive hepatic first-pass metabolism. The current research work, therefore, entails formulation development of liquid self-nano-emulsifying drug delivery systems (SNEDDS) to enhance the bioavailability of carvedilol by facilitating its transport via lymphatic circulation. The formulation constituents, i.e. lipids, surfactants, and co-surfactants, were selected on the basis of solubility studies. Pseudo-ternary phase diagrams were constructed to embark upon the selection of blend of lipidic (i.e. Capmul PG8) and hydrophilic components (i.e. Cremophor EL as surfactant and Transcutol HP as co-surfactant) for efficient and robust formulation of SNEDDS. The SNEDDS, systematically optimized employing a central composite design (CCD), were evaluated for various response variables viz drug release parameters, emulsification time, emulsion droplet size, and mean dissolution time. In vitro drug release studies depicted that the release from SNEDDS systems followed a non-Fickian kinetic behavior. The TEM imaging of the optimized formulation affirmed the uniform shape and nano size of the system. Accelerated studies of the optimized formulation indicated high stability of the formulation for 6 months. The in situ perfusion studies carried out in wistar rats construed several fold augmentation in the permeability and absorption potential of the optimized formulation vis-à-vis marketed formulation. Thus, the present studies ratified the potential of SNEDDS in augmenting the oral bioavailability of BCS class II drugs.

Keywords: Self-emulsifying, SEDDS, design of experiments, central composite design, intestinal perfusion

Introduction

Cardiovascular disorders (CVDs) constitute the most prevalent group of serious diseases, accounting for nearly 30% of all fatalities, the world over (http://www.who.int/topics/cardiovascular_diseases/en/). Despite enormous innovations in novel drug delivery systems (DDS) through alternative routes, oral drug delivery of cardiovascular drugs has unambiguously been the most sought after by the patients and manufacturers alike (Gupta et al., 2009). Its status is primarily a consequence of the wide acceptability of this 'natural' route, better safety vis-à-vis the parenteral route, low cost of therapy, and improved patient compliance. Accordingly, today more than 80% of the cardiovascular DDS available commercially are the oral ones (http://www.reportlinker.com/p01893777/Innovations-in-Oral-Solid-Drug-Delivery-Advances-in-nanotechnology-controlled-formulations-peptide-delivery.html).

Carvedilol is a popularly employed drug in various CVDs. Not only is it indicated in hypertension, but it has immense potential in myocardial infarction and congestive heart failure too (Bogaard et al., 2010; Wen et al., 2010). Being a poorly water-soluble and highly permeable drug with log p of 4.115, it can be safely regarded as a BCS class II drug (VCCLAB VCL, 2005). It also undergoes extensive first-pass metabolism in liver, which leads to the marked reduction in absolute oral bioavailability in humans (~ 20%) and in animals like dogs, rats, etc.
Cardiovascular Diseases (CVDs) are the commonest cause of premature death, and frequent cause of disability. CVDs are caused by disorders of the heart and blood vessels which include coronary heart disease (i.e., heart attacks), cerebro-vascular disease (i.e. stroke), hypertension (i.e. increased blood pressure), peripheral artery disease, rheumatic heart disease, congenital heart disease and congestive heart failure. According to the latest WHO reports, the CVDs constitute the most prevalent group of serious diseases, accounting for nearly 30% of all fatalities the world over. Over 80 per cent of deaths and 85 per cent of disabilities from CVDs occur in low and middle-income countries. The Indian subcontinent, which is home to 20 per cent of the world’s population, is one of the regions with the highest burden of CVDs across the globe. The most common cause underlying the CVDs is the build-up of fatty deposits, i.e., lipids, on the inner walls of the blood vessels that supply the heart.
INTRODUCTION

Design and development of an immaculate drug product or pharmaceutical process usually involves multiple objectives under its ambit. For decades, this task has been endeavored through trial and error, supplemented by the previous experience, knowledge and wisdom of the formulator. A product development scientist, accordingly, always used to remain in a dynamic environment, taking drug delivery challenges in stride time and again. These challenges arose invariably as a result of escalating competitiveness among manufacturers to improve efficacy and cost-effectiveness of products, rapidly changing compendial and regulatory specifications for drug delivery devices, and increasing quality consciousness among physicians as well as patients. Furthermore, while optimizing such formulations, there was always a constraint on time, resources, and materials. Hence, it was important for a pharmaceutical scientist to use effective methodology to develop products in a timely manner without sacrificing quality. Development and modification of a formulation was carried out by the analysis of its composition and influence of process factors on dosage form characteristics, changing any one single factor at a time (COST).

Using this COST approach, the solution of a specific problematic property could be achieved, but attainment of the true optimum composition or process could never be guaranteed (Schwartz et al., 1973; Doornbos and Haan, 1995). However, despite applying the best knowledge, skills, and wisdom to achieve the said goal, the outcome was not easily ascertainable. The formulator could either hit the bull's eye quickly or miss the target altogether even after arduous workouts. The final product would, thus, be satisfactory but sub-optimal, as a better formulation might still exist for the studied conditions (Araujo and Brereton, 1996; Singh et al., 2005c). This conventional COST approach of drug formulation development suffers from several pitfalls, as enumerated in Box 1.
Oral lipid-based formulations: enhancing the bio-availability of poorly water-soluble drugs
Bhupinder Singh *, O. P. Katarae; Shantanu Bandyopadhyay *
* University Institute of Pharmaceutical Sciences (UGC Centre of Advanced Studies), Panjab University, Chandigarh, India

Online Publication Date: 01 February 2009
Book Review


Oral delivery of nearly one-half of the drug compounds gets thwarted owing to their high lipophilicity and consequently poor aqueous solubility. Oral bioavailability of such drugs, being a function of their aqueous solubility and dissolution, tends to exhibit low magnitude and high intra- and inter-subject variability.

Oral lipid-based drug delivery systems have proved their immense potential in ameliorating the poor and inconsistent gastrointestinal absorption of poorly soluble drugs. Of late, an alarmingly high spurt of various literature instances and marketed products of such lipid-based formulations has been witnessed across the global pharma world. A recent literature search, carried out by us, revealed that over 100 research publications have already been published in various journals on the subject employing almost every class of drugs. A bird’s eye view on the same vouches indisputable versatility and high success rate of the innovative technology that these systems hold. The concept of lipidic systems, therefore, has become immensely vital, both at industrial and academic levels.

Despite the immense utilities of the lipid-based drug formulations, only limited reviews have been published dedicated to this specialized topic to date. The information on their diverse vistas lies mostly scattered in various texts and journals. Accordingly, the maiden attempt to bring forth the pertinent facts and figures in the form of an integrated volume is indeed a commendable and timely endeavor.

Written in lucid style, the book covers myriad aspects of lipid-based formulations and their usage in enhancing the bioavailability of poorly water-soluble drugs. The book has been divided into various chapters, each encompassing a sizable account on their design and development, in vitro characterization, in vivo animal studies, and, eventually, establishment of IVIVC and IVIVR relationships. Besides, the mechanistic influence of various lipidic constituents and of such formulations during fasted and non-fasted states, and the ultimate fate of lipidic drug products in gastrointestinal milieu have been explicitly elaborated. Amongst the diverse types of self-emulsifying formulations dealt with in the book, important types include liquid SEDDS and SMEDDS, lipid-based isotropic solutions and solid dispersions, hard-capsule formats, and supersaturable SEDDS. The remarkable highlight of this book is its industrial outlook that exclusively brings forth the current market status of these lipidic delivery systems, selection of various GRAS-listed excipients for their formulation development, and scaling up the prototype formulations to Phase I/II clinical trial batches.

Based on the famous adage, ‘a picture is worth one thousand words’, a diversity of illustrations have been immaculately presented as explicative graphs, photographs, methodology flow charts, apparatus outlines, tables, bar charts, etc., that make the book an interesting read. Each chapter is adequately referenced to the pertinent and updated literature. Most book chapters have been contributed by a galaxy of authors, acclaimed in their respective domains of pharmaceutical technology, analytical research, pharmaceutics, process development, pathology, etc. Special inputs from industry experts tend to enrich the researchers on technical know-how of large scale production of such formulations.

The authors, however, have focused primarily on the conventional self-emulsifying formulations, missing due emphasis on the updates like positively-charged self-emulsifying drug delivery systems (SEDDS), solid SEDDS, and SEDDS of traditional herbal medicines, ample information on which is currently available from literature. It would be much more pragmatic if the newer and expanded edition of the book covers other relevant precepts like federal issues and toxicity concerns (especially when the particle/globule size falls in nano or sub-nano range), application of DoE optimization of such lipidic systems, technology for modification of liquid based systems into solid ones, integration of these methodologies with controlled release ones, and work examples on these novel drug delivery technologies. Another minor peccadillo of the book is that the authors explain the prevalent global perspective of these lipid-based formulations, taking instances solely from developed nations representing various continents like USA, UK and Japan. It would