How to Cite:
Kumar, P. K., & Rada, S. K. (2022). Formulation and in-vitro evaluation of Bosewellia Serrata extract loaded transferosomal gel for treatment of osteoarthritis. *International Journal of Health Sciences*, *6*(S2), 100–112. https://doi.org/10.53730/ijhs.v6nS2.4981

Formulation and In-Vitro Evaluation of Bosewellia Serrata Extract Loaded Transferosomal Gel for Treatment of Osteoarthritis

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***Abstract*---**Objective: The main objective of the current research work was to formulate and evaluate Bosewellia serrata extract loaded transferosomal topical gels. To overcome the drawbacks associated with oral administration of Bosewellia serrata extract in Osteoarthritis treatment. Methodology: Transferosomes were developed using different ratios of Phospholipon® 90G as phospholipid, Span-60 as surfactant and cholesterol as fluidity buffer. The selected best formulation of transferosomes was further optimized as a topical gel using different rate controlling polymers such as hydroxylethyl cellulose (HEC), hydroxyl propyl methylcellulose (HPMC) and, carbopol. Transcutol P was used as a penetration enhancer. In vitro diffusion studies of developed formulations were carried out using Franz diffusion cell apparatus. Results: Formulation BT10 prepared with 2:1 ratio of drug to total lipid, 2:1 ratio of surfactant to total lipid and 3:1 ratio of phospholipid to cholesterol was selected as optimized transferosomes. Further transferosomal gel was formulated by trial and error method, where different polymers considered as gelling agents. Transcutol HP and glycerol used as penetration enhancer and bodying agent respectively. Among the twelve formulations, BG11 (Carbopol 971 in 0.75% w/w) was chosen as the best formulation due to controlled invitro release of the drug with very good viscosity and spreadabilty.

***Keywords*---**diffusion, osteoarthritis, topical, transferosomal gels, transferosomes.

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
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Manuscript submitted: 27 Nov 2021, Manuscript revised: 09 Feb 2022, Accepted for publication: 18 March 2022

Introduction

Osteoarthritis (OA) is the most commonly occurring rheumatologic problem and type of arthritis with the prevalence of 22%- 39% in India. OA is most commonly affects the joints in the knees, hands, hips, feet and spine. It primarily affects the elderly population. As per the WHO, worldwide 9.6% of men and 18.0% of women over 60 years of age have symptomatic OA [1-4]. Boswellia serrata is a moderate to large-sized branching tree that grows in dry mountainous areas of India, Northern Africa, and the Middle East. In India, the main places where Boswellia serrata is marketed are Andhra Pradesh, Gujarat, Madhya Pradesh, Jharkhand, and Chhattisgarh. Traditionally Boswellia serrata is named as Saambraani in telugu language. This tree is rich in terpinoids which are having anti-inflammatory properties. Pentacyclic triterpenic acids (boswellic acids) are popularly used as anti-inflammatory agents in the treatment of OA. The basic chemical structure of boswellic acids is given in Figure 1 [5-9].

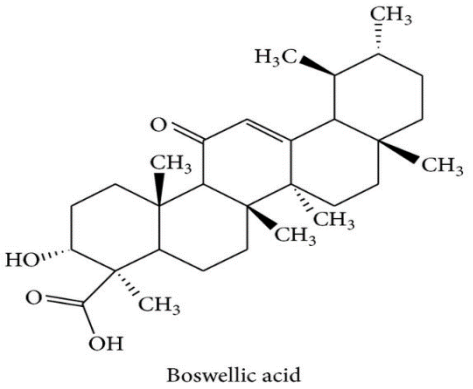

Figure 1. Chemical Structure of Bosewellic acid

The commonly available Boswellia serrata Extract (BSE) used for treatment of OA consist of β-boswellic acid, acetyl- β-boswellic acid, 1-keto-β-boswellic acid (KBA) and 3-O-acetyl-11-keto-β-boswellic acid (AKBA) [10,11]. The bioavailability of boswellic acids is very less, especially with KBA and AKBA. Hence, high dose of boswellic acids should be administered orally to get beneficial effect [11,12]. Low bioavailability may be due to poor absorption and excessive metabolism of boswellic acids. Their low water solubility and hydrophobicity following oral administration have been linked to their poor absorption [11,12]. Various ways have been tried in attempt to improve the poor absorption caused by low solubility. The topical formulation has good penetration would provide more therapeutic benefit when compared to oral administration. Moreover, the dose required to provide therapeutic action via topical delivery is expected to be less than the oral route. Transdermal drug delivery system (TDDS) is the best choice, as it will give consistent systemic drug levels with a controlled and predetermined rate of drug diffusion and hence it reduces the dosing frequency with consequent lower side effects and also improves bioavailability [13].Hence, utilization of transferosomes would be one of the proposals that have been assessed to mitigate this barrier.The main objective of the present research work was to develop the

BSE loaded transferosomal topical gels and to evaluate the in vitro diffusion ability of prepared formulations [14].

Materials and Method

BSE was procured from local market, Phospholipon 90G was received as a gift sample from Lipoid Germany. Cholesterol (CH), Span 60, Hydroxy ethyl cellulose(HEC), HPMC, Carbopol, and TranscutolP were purchased from Signet India. All the chemicals and solvents used are of analytical grade and were purchased from Sigma Aldrich.

Saturation solubility studies

The saturation solubility studies of BSE was determined in different oils such as corn oil, sesame oil, soybean oil, peanut oil, hydrogenated soya bean oil, solvents such as distilled water, Myglyol, Labrafil M 1944 CS, Oleic acid, TranscutolHP, Labrafaclipophile WL1349, Geliol SC, Capryol 90, Labrafac PG , PlurolDiisostearique , Poly ethylene glycol 400, Propylene glycol, Span 80, Tween 80, Glycerol and in various buffers such as pH 1.2 phosphate buffer, pH 6.8 phosphate buffer and pH 7.4 phosphate buffer. Saturated solutions of the drug were prepared by adding an additional quantity of drug to 2 mL of each selected vehicle and were agitated on the mechanical shaker for 48 h at 25ºC. After equilibrium attainment, samples were collected and centrifuged at 10,000 rpm for 15 min. Further 100 µL of supernatant was collected and suitably diluted with methanol and amount of the drug dissolved was quantified by using UV-Visible Spectrophotometry. Solubility was measured in triplicate in each solvent [15]. The barrier function of the skin limits transdermal drug delivery in most cases. Vesicular systems are one of the most contentious mechanisms for delivering active drug compounds transdermally. Vesicles are used in transdermal drug administration because they operate as drug carriers, delivering entrapped drug molecules across the skin, as well as penetration enhancers due to their nature. [16].

Experimental procedure of preparation of transferosomes

Modified Thin film hydration was employed to prepare transferosomes Phospholipon® 90G, unsaturateddiacyl-phosphatidylcholine content: 96.5% (PL-90G) was used as phospholipid, Span 60 was selected as surfactant based on the solubility studies. Different formulations of transferosomes were prepared by changing the ratios of drug to total lipid (Phospholipid + cholesterol), ratio of surfactant to total lipid (Phospholipid + cholesterol) and ratio of cholesterol to phospholipids. Span 60 was heated to 60°C until it was converted to a molten state, required quantity of BSE was dissolved in molten state of span 60. Cholesterol and Phospholipid were dissolved in sufficient quantity of solvent mixture (Chloroform: Methanol) taken in round bottom flask of suitable size. BSE and Span 60 mixture was added to lipid mixture and mixed well until a homogeneous solution was obtained. Then the solvent was evaporated slowly using a rota flash evaporator at 37°C using vacuum and drying was continued until a thin homogenous film was obtained. Required quantity of aqueous buffer (7.4pH phosphate buffer) was added to the obtained thin film and mixed well until

a homogenous suspension was obtained. Obtained suspension was sonicated with probe sonicator to reduce the size of each vesicle to smaller nano size range and to convert the multilamellar vesicle to monolamellar vesicles [17]. Formulation table of transferosomes is given in Table 1.

Table 1
Composition of different formulations of BSE transferosomes

Formulation code	Drug :Total lipid	surfactant :Total lipid	Phospholipid: cholesterol	Solvent (Chloroform:Methanol)
BT1	01:01	01:01	01:01	07:03
BT2	01:01	01:01	01:02	07:03
BT3	01:01	01:01	02:01	07:03
BT4	01:01	01:01	01:03	07:03
BT5	01:01	01:01	03:01	07:03
BT6	02:01	02:01	01:01	07:03
BT7	02:01	02:01	01:02	07:03
BT8	02:01	02:01	02:01	07:03
BT9	02:01	02:01	01:03	07:03
BT10	02:01	02:01	03:01	07:03
BT11	01:02	01:02	01:01	07:03
BT12	01:02	01:02	01:02	07:03
BT13	01:02	01:02	02:01	07:03
BT14	01:02	01:02	01:03	07:03
BT15	01:02	01:02	03:01	07:03
Surfactant to be used is Span 60; Phospholipid to be used is (Phospholipon® 90G; unsaturated diacyl-phosphatidylcholine content: 96.5%) (PL-90G)				

Evaluation of transferosomes

Prepared formulations of transferosomes were evaluated for following parameters.

- Drug content
  Weight equivalent to one-unit dose was taken and added to 50ml of chloroform: methanol (7:3) and mixed well until a homogeneous solution was formed. Then the solution was sonicated for 30 minutes until the entrapped drug is extracted completely into solvent. Sub dilution was made with 7.4 pH buffer by taking 2mL of above solution and diluting to 200mL. Drug content of each formulation was then estimated by measuring the absorbance against blank at 432nm. Drug content of each formulation was measured in triplicate [18-19].
- Percentage entrapment efficiency
  Percentage entrapment efficiency of each prepared formulation was measured by estimating the free drug concentration by centrifugation method. Weight equivalent to one unit doses was taken in centrifuge tube and added with 20mL of 7.4 pH phosphate buffer and centrifuged at 10000 rpm for 30 minutes to get the clear supernatant with dissolved free drug. Clear supernatant was collected and dissolved free drug was estimated

spectrophotometrically at 432nm [18-19]. Measurement of entrapment efficiency for each formulation was done in triplicate

$$\% \text{ Entrapment efficiency} = \frac{\text{Totaldrug} - \text{freedrug}}{\text{Totaldrug}} \times 100$$

- Vesicle size and zeta potential
  Vesicle size and zeta poetential for all prepared formulations was estimated using Malvern Zetasizer Nano ZS. Each formulation was diluted with 7.4 pH buffer by 100 times before measurement. Each analysis was done in triplicate. Separate method was created in the instrument for the analysis of vesicle size and zeta potential [18-19].

Preparation method of transferosomal gels

Best formulation (BT10) was taken and converted to gel formulation by taking different polymers as gelling agents. Fluronic 127 (10-30%w/w), Hydroxy ethyl cellulose (HEC) (1-3% w/w), Hydroxy Propyl Methyl Cellulose (HPMC) (1-3%w/w) and Carbopol (0.5-1%w/w) were selected as gelling agents, Transcutol HP was selected as penetration enhancer (50mg in each formulation) and glycerol was selected as bodying agent (50mg in each formulation). Weight equivalent to one-unit dose of transferosomal formulation was taken added with required quantity of glycerol and Transcutol HP and mixed under mechanical stirrer until a homogeneous solution was formed. Required quantity of polymer was dispersed in 60% volume of water in separate manufacturing vessel with continuous stirring until a homogenous dispersion was obtained. Then the swollen polymer solution was slowly transferred to drug dispersion and continued stirring for 30 minutes until the drug dispersion and polymer solutions were mixed homogeneously. Volume was made up with batch size with remaining water and continued mixing for another 15 minutes until a homogeneous gel was formed. Formulations of different transferosomal gels were represented in Table 2.

Table 2
Composition of different formulations of BSE transferosomal gels

Formulation Code	Fluronic -127 (%w/w)	HEC (%w/w)	HPMC (%w/w)	Carbopol 971 (%w/w)	Transcutol HP (mg)	Glycerol (mg)
BG1	10	0	0	0	50	50
BG2	20	0	0	0	50	50
BG3	30	0	0	0	50	50
BG4	0	1	0	0	50	50
BG5	0	2	0	0	50	50
BG6	0	3	0	0	50	50
BG7	0	0	1	0	50	50
BG8	0	0	2	0	50	50
BG9	0	0	3	0	50	50
BG10	0	0	0	0.5	50	50
BG11	0	0	0	0.75	50	50
BG12	0	0	0	1	50	50

Transferosome-Equivalent to unit dose, Water –Up to 1g

Characterization of transfersoaml gels

Prepared transferosomal gels were evaluated for various physico-chemical properties as described below:

- Measurement of pH
  All the prepared formulations pH was measured by calibrated pH meter. Each gel formulation was prepared as 10% w/v solution with water before measurement. Each measurement was done in triplicate.
- Measurement of viscosity
  All the prepared formulations viscosity was measured by calibrated cone and plate Brookfield rheometer at 50 rpm at 37°C. Each measurement was done in triplicate.
- Drug content
  Weight equivalent to one-unit dose (1g of gel) of BSE was taken and added to 50mL of chloroform: methanol (7:3) and mixed well until a homogeneous solution was formed. Then the solution was sonicated for 30 minutes until the entrapped drug is extracted completely into solvent. Sub dilution was made with 7.4 pH buffer by taking 2mL of above solution and diluting to 200mL. Drug content of each formulation was then estimated by measuring the absorbance against blank at 432nm. Drug content of each formulation was measured in triplicate [18, 19].
- Spreadability
  Spreadability of each prepared gel was measured by taking one gram of gel and spreading onto glass slide and rated them as poor, average, good and very good [20-22].

In vitro diffusion studies of prepared formulations

In vitro diffusion study of all the prepared formulations were done using electrolab diffusion cell apparatus. Each formulation diffusion was done with 6 units. Acceptor chamber of diffusion cell was filled with 25mL of 7.4 pH phosphate buffer. Neck of the chamber was covered with 0.45µ PES membrane and 100mg of formulation equivalent to 5mg of BSE was applied uniformly on the membrane and closed. Diffusion study was done at 100 rpm at 32°C. Diffusion study was continued for 12 hours and samples were collected at predetermined time intervals. Percentage drug diffused was estimated using spectrophotometric method [18-20].

Results

Saturation solubility studies

Results of saturation solubility studies are shown pictorially in figure 2. From the results oit was observed that drug poorly soluble in water with the solubility of 9.3mg/mL and solubility is increased in aqueous solvents with increased pH where the highest solubility was observed at pH 11.0 (0.1 N NaoH) with the solubility value of 18.900 mg/mL. In addition, solubility of BSE in was found higher in Glycerol, TranscutolHP and PEG 400 with the values of 109.13mg/mL,98.93 and 98.93 mg/mL respectively. Hence, these two can be

used in formulation of topical gel, glycerol as vehicle (solubilizer) and Transcutol HP as penetration enhancer respectively (Figure 2). Drug was shown good solubility in span 60 (30.70mg/mL), hence it has been chosen as surfactant in the formulation trials.

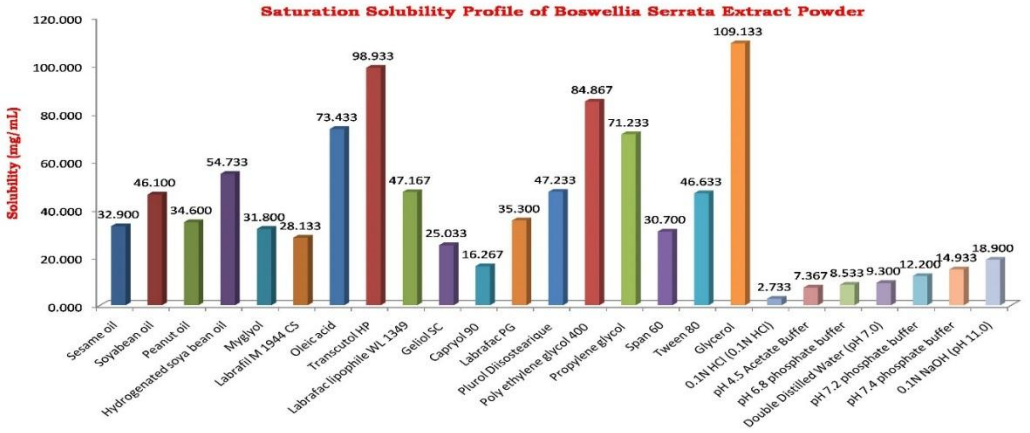

Figure 2. Bar diagram of solubility studies of BSE in various solvents

Evaluation of transfersomes

Prepared formulations of transferosomes were evaluated for following parameters (Table 3).

Table 3
Physicochemical properties of BSE loaded transferosomes

Formulation code	Drug content (%) (N=3)	Vescicle Size (d. nm) (N=3)	PDI (N=3)	Zeta Potential (mV) (N=3)	% Entrapment efficiency (N=3)
BT1	100.4 ± 0.2	165.4±1.4	0.423±0.13	-4.5±1.2	74.5±2.5
BT2	99.8 ± 0.5	184.5±1.3	0.523±0.31	-3.4±1.7	76.6±1.2
BT3	99.7 ± 1.2	134.7±2.2	0.323±0.32	-6.9±2.2	82.5±3.6
BT4	99.5 ± 0.6	201.2±1.1	0.412±0.14	-4.5±0.8	75.6±3.8
BT5	100.5 ± 0.4	115.2±0.8	0.272±0.14	-8.7±1.4	88.2±1.4
BT6	99.9 ± 0.5	162.2±1.3	0.352±0.15	-7.5±2.4	78.2±2.4
BT7	99.8 ± 0.5	172.2±1.1	0.434±0.11	-5.4±1.3	78.4±1.5
BT8	99.8 ± 0.4	141.3±1.1	0.319±0.16	-8.1±1.2	83.4±2.4
BT9	100.5 ± 0.5	195.3±1.1	0.465±0.11	-4.6±1.2	67.3±1.5
BT10	100.7±1.5	105.4±0.7	0.187±0.11	-11.8±1.3	92.3±1.5
BT11	99.8±1.2	165.4±1.4	0.345±0.13	-5.5±1.8	74.5±1.2
BT12	101.4±0.2	177.2±1.4	0.475±0.24	-4.4±1.6	72.2±1.1
BT13	100.2±0.3	154.2±1.2	0.385±0.11	-5.9±1.3	84.9±2.3
BT14	99.5±0.7	202.5±1.1	0.375±0.15	-3.4±1.8	72.6±1.4
BT15	100.1±0.2	124.4±0.3	0.192±0.09	-8.3±1.2	91.6±1.3

*N = Three replicates

Estimated drug content values of all the prepared formulations are in the range of 99.5% ± 0.6% to 101.2±0.2. Percentage entrapment efficiency of each prepared formulation was measured by estimating the free drug concentration by centrifugation method. It was observed that percentage entrapment efficiency was ranged from 67.3%±1.5% to 92.3.6%±1.5%. Formulation (BT10) prepared with 2:1 ratio of drug to total lipid, 2:1 ratio of surfactant to total lipid and 3:1 ratio of phospholipid to cholesterol has shown highest entrapment efficiency. It was observed that as the amount of phospholipid is increased entrapment efficiency was increased and as the ratio of drug to lipid ratio is increased entrapment efficiency was increased. Vesicle size and zeta potential of all the prepared formulations were estimated using Malvern Zetasizer Nano ZS. The vesicle size of all the prepared formulations were ranging from 115.2±0.8d. nm to 202.5±1.1 d. nm with the polydispersity index range of 0.187±0.16 to 0.523±0.31. Obtained size range of all formulations indicated that all formulations are nano in size range whereas the poly dispersity index (PDI) reveals that all formulations are homogeneous in size distribution. It was also observed that zeta potential of all the prepared formulations are in the range of -3.4±1.7 to -11.8±1.3 indicating that all formulations are having negative zeta potential. Based on the overall results of vesicle size and zeta potential formulation BT10 prepared with 2:1 ratio of drug to total lipid, 2:1 ratio of surfactant to total lipid and 3:1 ratio of phospholipid to cholesterol has shown lowest vesicle size with lowest PDI and highest zeta potential indicates high stability. Hence this formulation has been chosen as best formulation for converting into gel form.

Characterization of transferosomal gels

Table 4
Physico-chemical results of BSE transferosomal gels

Formulation	Drug content (%) (N=3)	pH (N=3)	Viscosity (cP) (N=3)	Spreadability/ squeezing ability
BG 1	99.6 ± 0.5	6.5±0.2	1975±175	Average
BG 2	101.2 ± 1.2	6.2±0.3	2230±55	Good
BG 3	100.4 ± 0.4	6.3±0.2	2470±90	Very Good
BG 4	100.2 ± 0.7	6.3±0.2	1730±110	Poor
BG 5	100.2 ± 1.5	6.3±0.1	1990±105	Average
BG 6	100.5 ± 0.3	6.5±0.4	2285±110	Good
BG 7	99.8 ± 0.3	6.3±0.4	2110±105	Average
BG 8	100.2 ± 0.4	6.3±0.2	2410±120	Good
BG 9	99.8 ± 0.5	6.1±0.2	2590±110	Very Good
BG10	100.2±1.5	6.5±0.5	2510±115	Good
BG11	99.8±0.6	6.6±0.3	2710±125	Very Good
BG12	100.1±0.3	6.7±0.2	3005±110	Poor

*N = Three replicates

The pH of all the prepared formulations was in the range of 6.1±0.2 to 6.7±0.2. Viscosity of all the prepared formulations were in the range of 1730±110cP to 3005±110 (Table 4). It can be understood from the result that formulations prepared with carbopol has shown higher viscosity than other polymers whereas formulations prepared with HEC has shown lower viscosity than all other

polymers. It was also observed that viscosity of formulations was increased with increasing the polymer concentration. Percentage drug diffusion values of all the formulations were shown in Table 5 and Figure 3.

Table 5
In Vitro drug diffusion results of BSE transferosomal gels

Time (Hrs)	% Drug Diffused (Mean ±SD; N=6)											
	TBG1	TBG2	TBG3	TBG4	TBG5	TBG6	TBG7	TBG8	TBG9	TBG10	TBG11	TBG12
0	0	0	0	0	0	0	0	0	0	0	0	0
0.5	17.2±2.1	13.2±2.5	10.2±1.1	20.1±2.3	15.2±1.8	12.4±2.1	15.5±2.3	10.2±1.1	9.2±1.5	12.1±2.3	7.5±3.2	6.5±2.1
1	25.5±3.2	21.3±3.4	15.6±1.2	28.3±3.8	23.4±1.3	21.3±3.4	24.5±2.3	22.4±2.5	15.6±2.5	21.3±2.1	13.2±2.3	10.2±2.1
1.5	37.5±3.1	28.5±3.2	22.3±2.1	38.2±2.3	33.4±2.5	32.3±3.4	33.5±2.3	28.1±3.4	21.3±2.4	31.2±2.1	18.5±2.1	15.4±2.3
2	45.1±3.2	34.5±2.3	29.1±2.1	51.3±4.5	42.3±4.2	37.4±2.5	45.2±1.5	35.6±4.1	28.4±2.1	25.6±2.4	24.4±2.3	18.2±3.2
3	63.2±3.3	48.2±2.1	41.2±1.2	72.5±3.2	60.1±2.5	43.2±3.1	60.4±1.5	45.6±2.3	38.5±2.5	51.3±2.5	35.2±2.1	24.5±2.1
4	87.8±2.5	65.5±2.3	50.1±2.3	98.2±2.1	79.5±2.1	65.4±2.5	83.5±2.5	63.4±2.1	49.6±2.5	68.5±2.5	40.1±2.3	35.4±2.1
6	99.6±3.4	95.4±2.1	75.5±2.7	100.2±2.1	100.5±2.1	93.4±2.3	100.3±1.1	93.2±1.1	72.5±3.4	95.6±3.4	62.3±2.1	49.4±2.1
8	99.9±2.2	100.2±1.1	100.2±3.4	100.2±1.2	103.2±2.1	100.2±1.2	100.6±1.6	100.2±2.5	98.2±3.4	100.3±2.5	75.6±2.3	60.1±1.2
10	100.2±3.1	102.1±2.3	99.2±3.5	100.2±2.2	100.2±2.1	100.5±1.2	100.3±2.1	100.3±2.1	100.2±3.2	100.3±3.2	90.2±2.1	78.2±2.1
12	100.5±3.4	100.1±1.1	100.1±2.3	100.1±1.0	100.2±2.1	100.5±1.5	101.2±1.1	100.5±2.1	100.3±3.2	100.1±3.1	100.2±2.3	90.1±1.2

*N = Six replicates

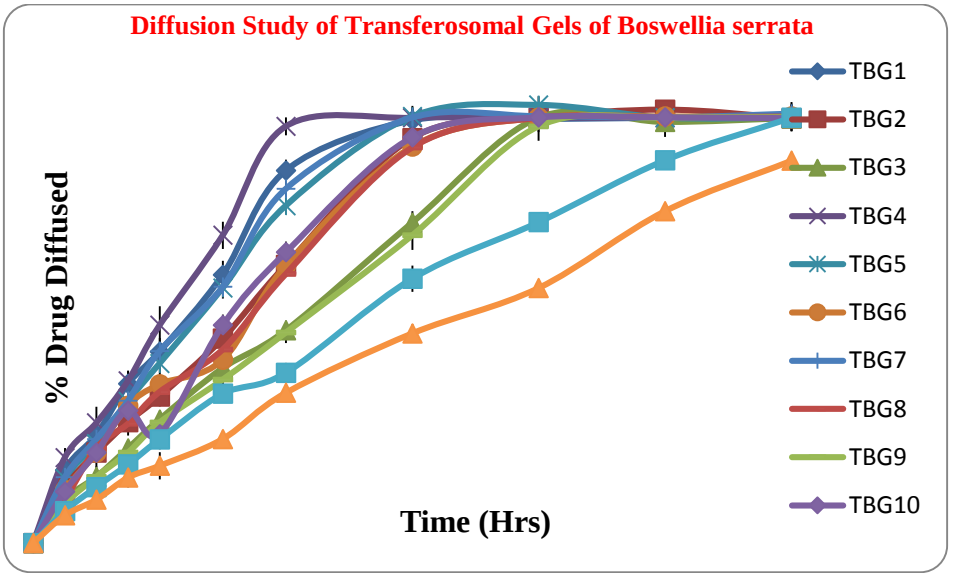

Figure 3. Time verses percentage drug diffusion plot of BSE transferosomal gels

Drug release kinetics

Drug release kinetics such as zero order release model, first order release model, higuchi model, Hixson-crowell model, karsemeyer-peppas model was done by fitting the obtained data in each kinetic model. Regression value of each formulation in each model was calculated and results obtained were shown in Table 6 and Figure 4.

Table 6
Regression co-efficient values of release kinetics of transferosomal gels

Release Kinetics	Regression Coefficient (R^2)			
	BG3	BG6	BG9	BG11
Zero Order	0.95	0.88	0.98	0.99
First Order	0.95	0.95	0.94	0.96
Higuchi	0.90	0.92	0.88	0.88
Karse-Meyer Peppas	0.98	0.96	1.00	1.00
Hixson- Crowell	0.98	0.98	0.97	0.98

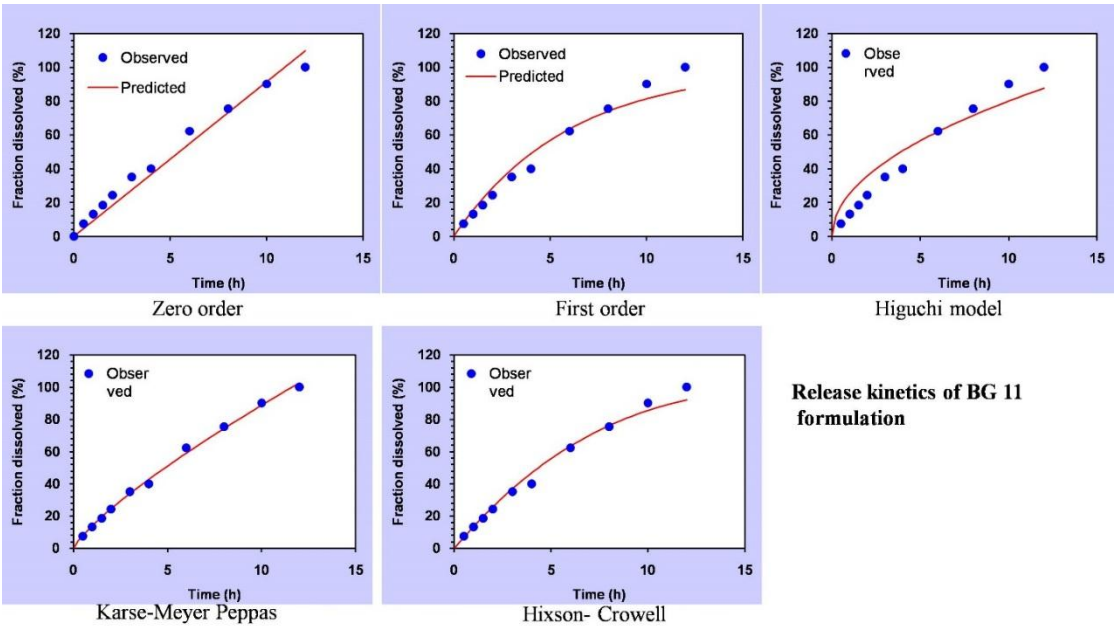

Figure 4. Release kinetics of BG11 formulation of transferosomal gels

Discussion

The topical formulation has good penetration would provide more therapeutic benefit when compared to oral administration. In the current study transferosomal gel loaded with BSE was formulated and evaluated the in vitro diffusibility and release kinetics. Initially, transferosomes were prepared. The elastic nature of transferosomes enables them to squeeze themselves as unbroken vesicles through pores or skin constrictions that are substantially smaller than the vesicle size without losing any of their integrity [23]. Transfersomes are composed of the phospholipid component and an edge activator (single chain surfactant). Proper ratio of phospholipid and edge activator enhances the permeation ability of the drug through the skin [23]. The solubilization of hydrophobic drug is made easier edge activator, which increases the drug entrapment efficiency [23]. Based the evaluation of parameters like highest entrapment efficiency, and drug content, lowest vesicle size and PDI, and highest zetapotemtial formulation (BT10) prepared with 2:1 ratio of drug to total lipid, 2:1 ratio of surfactant to total lipid and 3:1 ratio of phospholipid to cholesterol was

selected as optimized transferosomes. transferosomal gel was formulated by trial and error method, where different polymers considered as gelling agents. Transcutol HP and glycerol used as penetration enhancer and bodying agent respectively. Among the twelve formulations, BG11 (Carbopol 971 in 0.75% w/w) was chosen as the best formulation due to controlled invitro release of the drug with very good viscosity and spreadabilty. It was noticed that the drug diffusion was retarded as the concentration of polymer is increased in the gel. Formulations prepared with HEC have shown faster drug diffusion than formulations prepared with other polymers. About 90% of drug was diffused within 4-6 hours. Formulations prepared with Carbopol has shown controlled drug release pattern than formulations prepared with other polymers. About 90% drug diffusion was observed within 6-12 hours. Complete drug release within 12 hours was not observed in formulation prepared with 1% w/w of carbopol (BG12). Complete drug release was observed (99.8±3.6%) within 12 hours in case of formulation prepared with carbopol 0.75% w/w (BG11) was shown acceptable R2 value with zero order kinetics and Karse-Meyer Peppas which assures the controlled release of the drugs with long action. Hence, BG11 was chosen as best formulation among all the formulations.

Conclusion

The in vitro physico chemical properties and diffusion studies of transferosomal gel formulations revealed that the topical formulation of BSE can be successfully formulated with transferomal gel approach using Phospholipon G and cholesterol as lipid layer, span 60 as edge activator, Transcutol P as permeation enhancer and carbopol as gelling agent. The optimized formulation has met the all the predetermined quality attributes. However, evaluation of in vivo pharmacokinetic profile and pharmacodynamics activity is the future scope of the current work.

List of abbreviations

- BSE- Bosewellia serrata extract
- HEC – Hydroxy ethyl cellulose
- HPMC- Hydroxypropyl methyl cellulose
- PDI: Poly dispersity index
- SD: Standard Deviation
- RSD: Relative Standard Deviation

Conflict of interest

The authors declare that there is no conflict of interest

Acknowledgments

The authors are thankful to Department of pharmaceutics, GITAM University, Vishakhapatnam,

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