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AUSH Formulations

Original Research Article (Experimental)

Design and Development of Unani Emulgel for Vitiligo

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ABSTRACT

Background: Vitiligo is not only a cosmetic problem, but also a social and psychological problem worldwide with the prevalence rate being highest in India. Treatment is unsatisfactory in Western System of Medicine. Unani System of Medicine (USM) possesses various drugs to treat vitiligo in both topical and oral dosage forms. *Safoof-e-Bars* (SB) is an important powdered dosage form used widely to treat vitiligo, internally as *Zulal*. Externally as *Sufl* (Sediment remained after decanting the soaked drug) is used. Babchi, a component of SB, is reported to contain psoralen, an important therapeutically active compounds for treating vitiligo. But as Psoralen – the active marker compound is very slightly soluble in water, so only negligible amount of it comes in *zulal* and most of the amount remains in *sufl*. That might be the reason for local application of *sufl* as recommended by *Hakeems*. But clinically it is observed that application of *sufl* is not followed by most of the patients, due to side effects associated with its application on skin.

Objective: The present study is designed to convert *Safoof-e-Bars* into a more convenient and appealing newly evolved dosage form 'emulgel' of same composition as of SB, so that it can be used by the patients easily without any side effects.

Materials & methods: Various batches of emulgel were prepared as preliminary batches and final batches using hydro-alcoholic extract of SB and different excipients in different concentrations. Preliminary batches were formed for selecting composition and concentration of extract and excipients for final batches. Total eight batches (F1–F8) were prepared as final batches. Among these eight batches, batch F7 was selected as final batch, which was further evaluated on various parameters. Comparative quantitative analysis was done in *Zulal*, Hydro-alcoholic extract of SB and emulgel using HPLC.

Results: Optimized emulgel showed good result in physicochemical parameters. Highest percentage of psoralen was found in SB extract while lowest percentage was found in *zulal*. No growth of yeast and mould, and viable aerobic were found in emulgel on microbiological analysis. Emulgel was found to be stable for 3 months.

Conclusion: Newly developed emulgel may be recommended with *zulal* instead of traditionally used *sufl* with *zulal*. In future emulgel will provide a solution for topical delivery of hydrophobic drugs and more convenient dosage form to apply locally.

1. Introduction

In Unani System of Medicine (USM), many single drugs such as Habbul-Neel (*Ipomoea nil*), Atrilal (*Ammi majus*), Babchi (*Psoralea corylifolia*), Panwar (*Cassia tora*), Kharbaq Syah (*Helleborus niger*), Sheetraj (*Plumbago zeylanica*), Saqmooniya (*Convulvulus scammonia*) [1–3] as well as formulations in different dosage forms such as Itrifal: *Itrifal-e-Kabeer* [4], *Itrifal-e-Haman* [4,5], Majoon: *Majoon-e-Atrilal* [6], Iyaraj: *Iyaraj-e-Loghazia* [4,5], Habb: *Habb-e-Bars*, *Habb-e-Sakbinaj* [6], *Habbe-e-Hindi* [5,6], Tiryaq: *Tiryaqul Bars* [7], Tila: *Tila-e-Bars* [8], *Tila-e-Hindi* [5,9,10], Roghan: *Roghan-e-Bars* [6], Safoof: *Safoof-e-Hindi* [11], *Safoof-e-Kemri* [6,10], *Safoof-e-Kala Bichua* [10], *Safoof-e-Bars* [12–14], Arq: *Arq-e-Tezab* [5,6], Marham: *Marham-e-Bars* [5], Zimad: *Zimad-e-Bars* [14] are available which are used orally as well as topically in vitiligo (*bars*). One of the important

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compound formulation, among above mentioned drugs is *Safoof-e-Bars*, which is very much beneficial in vitiligo. *Safoof* (powder) is a dry medicament or a mixture of several medicinal ingredients which is ground or triturated and sieved. In the present study *Safoof-e-Bars* was selected which is mentioned in Unani Pharmacopoeia of India and National Formulary of Unani Medicine. The ingredients of S.B are Babchi [*P. corylifolia* Linn. (Seeds)], Chaksu [*Cassia absus* Linn. (Seeds)], Panwar [*C. tora* Linn. (Seeds)] and Anjeer-khushk [*Ficus carica* Linn. (Fruits)] in equal quantity. *Safoof-e-Bars* is used both internally as a *ZULAL* (Infusion) and externally as a *SUFL* (Sediment remained after decanting the soaked drug) in the form of *Zimad* (Paste). 10 gm of *Safoof-e-Bars* is soaked in 50 ml of water overnight. In the morning, the infusion (*Zulal*) is decanted and administered orally. The *sufl* is mixed with *Sirka Naishkar* (Vinegar) to prepare a paste and applied on the affected parts and then the affected part is exposed to Sunrays at Noon [12].

Babchi is the main ingredient of *Safoof-e-Bars* and psoralen is therapeutically active compound of babchi, which might be more responsible for its therapeutic value along with other ingredients. Since psoralen is very slightly soluble/insoluble in water [15], therefore it does not come in the *zulal*, rather remains in the sediment that is in the *sufl*. That's might be the cause or rather to say justification of external use of drug as recommended by *Hakeems*. It is observed in number of the patients who apply the *sufl* that there is itching, dryness, erythema, and blister formation associated with it. These undesirable effects due to the application of *sufl* cause non-compliance with the medication. This may result in under treatment that hampers cure. Moreover, pre-application procedure is tedious. It needs to be formulated into paste by mixing *sufl* with suitable vehicle like *sirka naishkar* (vinegar). In long term use like in vitiligo, it becomes cumbersome and may affect compliance.

In view of the above mentioned problems, and to overcome all these problems related to traditional dosage form, present study has been designed to convert *Safoof-e-Bars* into a new dosage form emulgel. The use of gels has increased in Semi Solid Preparations (SSPs) because conventional SSPs, like ointments and creams, are sticky, less spreading coefficient, less dissolution and more prone to rancidity. Moreover phase inversion is common in conventional SSPs. Gels are however limited to deliver hydrophobic drugs. So an emulsion based gels (emulgel) can be used to deliver poorly water-soluble drugs. Bioavailability and dissolution rate of emulgels are good [16–19]. Therefore, emulgels may serve as better option for topical delivery of poorly water-soluble drug. Emulgel is emerging as one of the most interesting topical delivery system of the present decade that is convenient, effective, portable, free of side effects and easy to use. Standardization is an important aspect for maintaining the safety and quality of the polyherbal formulation. Therefore, before the work of conversion of SB into emulgel has been started, standardization of *Safoof-e-Bars* was also carried out to maintain batch to batch consistency. Thereafter, the conversion of *Safoof-e-Bars* was done into emulgel by formulating different batches with different excipients and using different percentages of excipients. Final batch of emulgel was selected after analyzing all the batches on various parameters and standard operating procedures for the preparation of emulgel were fixed. The final batch of emulgel was evaluated on various parameters of emulgel and its standards were fixed. Finally quantification of psoralen in *zulal*, hydro-alcoholic extract of SB and newly developed emulgel was carried out to compare the quantity of psoralen in these samples.

2. Materials and Methods

2.1. Procurement and identification of herbal drugs

The ingredients of formulation were procured from the Pharmacy, National Institute of Unani Medicine, Bengaluru. Ingredients were identified and authenticated by Botanist, Senior Assistant Prof. S. Noorunnisa Begum, Centre for Repository of Medicinal Resources (C-RMR), Trans-Disciplinary University (TDU), Attur, Bengaluru. The voucher specimens (*F. carica*-4516, *C. tora*-4517, *P. corylifolia*-4518, *C. absus*-4519) have been deposited in the museum of Institute of Trans-Disciplinary Health Sciences and Technology, Bengaluru.

2.2. Procurement of chemicals

All the excipients used in emulgel were procured from Bengaluru.

2.3. Monographic analysis of raw drugs

All the four ingredients of *Safoof-e-Bars* i.e., Babchi, Chaksu, Panwar and Anjeer-khushk were evaluated for alcohol-soluble matter, total ash value and acid insoluble ash value to confirm their identity & cross verify the values given in Unani Pharmacopeia of India.

2.4. Physico-chemical evaluation of Safoof-e-Bars

Safoof-e-Bars was evaluated on various parameters such as organoleptic properties like appearance, colour, odor and taste, pH in 1% solution and 10% solution, successive extractive values, hydro-alcoholic extractive value, alcohol soluble matter, water soluble matter, total ash, acid insoluble ash, water soluble ash, loss of weight on drying, moisture content by toluene distillation, bulk density, tapped density, carr's index, hausner's ratio, angle of repose and qualitative analysis [12,20–23]. Moreover quantitative estimation of the extract of *Safoof* for the presence of psoralen was also done at Natural Remedies, Bengaluru.

2.5. Preparation of extracts

The foreign & earthy matter and residual materials were removed from all the ingredients of *Safoof-e-Bars* and then dried in shade. Thereafter all the ingredients were coarsely powdered separately with the help of an electric grinder. Each coarsely powdered drug was taken in equal proportion and then mixed together with the help of mixer and then extract was taken in 1:1 of water & ethanol. Drug and water was taken in the ratio as of *Zulal* (1:5) which is mentioned in UPI (2010). Same amount of Ethanol was added in water. The extract was filtered and then concentrated up to semi-solid form on water bath.

2.6. Phytochemical analysis of Safoof-e-Bars extract

The hydro-alcoholic extract obtained was subjected to various phytochemical screening as per the standard procedures to reveal the presence of various active phytoconstituents like alkaloids, carbohydrates, flavonoids, glycosides, phenols, proteins, saponins and tannins [21,22].

2.7. Formulation of different batches of emulgel

Different batches of emulgel were prepared in two parts by using hydro-alcoholic extract of *Safoof-e-Bars* and other additives which were necessary for emulgel formulation. In first part, different hit and trial batches were prepared as preliminary batches. In the second part, eight batches were prepared as final batches. Among final batches, one batch was finalized which was further evaluated on various parameters.

2.7.1. Preliminary batches

Preliminary batches of emulgel were prepared as a preliminary study for assessing the gelling agents i.e., carbopol-934 and carbopol-940; percentage of extract; penetration enhancers i.e., clove oil and menthol by evaluating the batches on appearance, colour, odor, spreadability, consistency, homogeneity, oily feel, stickiness, grittiness, phase separation and pH.

2.7.2. Final batches

After preliminary study, total eight batches were prepared with active ingredients i.e., extract using different excipients in different concentrations like carbopol-940, light liquid paraffin, span-20, tween-20, propylene glycol, methylparaben, propylparaben, clove oil, and menthol (Supplementary Table S1). Emulgels were prepared in two parts. First part was the preparation of gel base and second part was the preparation of emulsion. The gel base was prepared by dispersing carbopol-940 in purified water with constant stirring at 200 Revolution per Minutes (RPM). The pH of the gel base was adjusted to 6–6.5 using triethanolamine. The oil phase of the emulsion was prepared by dissolving oil soluble emulsifier (Span 20) in light liquid paraffin. Methylparaben and propylparaben were dissolved in propylene glycol and this solution was mixed with the semi-solid form of extract. It was then dissolved in oil phase. Menthol and clove oil were also mixed in oil phase. The aqueous phase of emulsion was prepared by dissolving a water soluble emulsifier (Tween 20) in purified water. Both oil and aqueous phases were separately heated to 70° to 80 °C. The oil phase was added to the aqueous phase and the mixture was stirred using silverson homogenizer with a speed of 2500 rpm until it got cooled to room temperature. The gel base was mixed with the obtained emulsion in 1:1 ratio with gentle stirring by spatula to obtain the emulgel. Above mentioned steps were applied while preparing all eight batches [16,24,25].

2.8. Assessment of all batches

All the eight batches were assessed for their physical appearance like colour, odor, homogeneity, consistency, grittiness, stickiness, oily feel, phase separation, spreadability and pH. On these parameters, the final batch was selected for further study. All the batches were prepared using the above standard method which made them similar in regard gel base, oil phase and aqueous phase along with other steps. The difference among the batches was of the percentage of ingredients involved in preparing the batch.

2.9. Evaluation of emulgel

2.9.1. Organoleptic properties

- *Appearance*: the emulgel was tested visually for appearance to identify the presence of any aggregates.
- *Colour*: colour of the emulgel was observed visually.
- *Odor*: odor was observed by smelling the emulgel directly.
- *Consistency*: consistency was checked visually.
- *Homogeneity*: emulgel was checked visually to identify any non-homogeneity.
- *Oily feel*: oily feel was checked by spreading on skin surface and by washing with tap water.
- *Stickiness*: stickiness was also checked by spreading on skin surface.
- *Grittiness*: emulgel was checked for grittiness by spreading on skin surface.
- *Phase separation*: emulgel was observed visually for phase separation.

2.9.2. Determination of viscosity

Viscosity of emulgel was determined by using a Brookfield DV-II+ Pro viscometer by using different spindle number from 07 to 02 [26].

2.9.3. Spreadability study

Mutimer et al. apparatus was used to determine the spreadability [27,28].

2.9.4. Extrudability test

The emulgel formulation was filled into collapsible aluminum tube and sealed by crimping the end. The tubes were pressed to extrude the material and the extrudability of the emulgel was checked [29].

2.9.5. Determination of pH

Five gram of emulgel was dissolved in 45 mL of distilled water and then the pH was determined by using digital pH meter (Eutech Instrument Sr. No. 1544421) [30].

2.9.6. Water content by toluene distillation

The water content of emulgel was determined by Toluene Distillation method. In this method, 10 gm of emulgel was taken in a flask and 75 mL of Toluene was added to it. Distillation was carried out for 5 h. The volume of water collected in the receiver tube (graduated in ml) was noted and the percentage of water was calculated with reference to the weight of the emulgel [22].

2.9.7. Rancidity test

Rancidity was determined by the method given in Unani Pharmacopoeia of India [12].

2.9.8. Microbial contamination

Microbiological analysis of emulgel was carried out as per the methodology described in USP [31].

2.9.9. Quantitative estimation of psoralen by HPLC

Quantitative estimation of psoralen in *zulal*, hydro-alcoholic extract of SB and newly developed emulgel was carried out by HPLC at Natural Remedies, Bengaluru.

2.9.10. Stability studies

The prepared emulgels were packed in aluminum collapsible tubes and stability studies were carried out for a period of 3 months at three different temperature viz. 5 °C, 25 °C/60% RH, and 40 °C/75% RH. Samples were evaluated for physical appearance, pH, and spreadability studies at interval of 15-days [16].

3. Results

3.1. Monographic analysis of raw drug

Monographic analysis of all the four ingredients of *Safoof-e-Bars* was done to check the authenticity of ingredients and the results of the laboratory investigations were compared with the limits given in Unani Pharmacopoeia of India (UPI). The results are given in Table 1.

3.2. Physico-chemical evaluation of Safoof-e-Bars

Safoof-e-Bars was evaluated on various parameters. The results are given in Table 2.

3.3. Phytochemical analysis

Phytochemical screening of hydro-alcoholic extract & *Safoof-e-Bars* confirm the presence of various phytoconstituents like alkaloids, carbohydrates, flavonoids, glycosides, phenols, proteins, saponins and tannins as shown in Table 3.

3.4. Development of emulgel

All eight batches were evaluated on various parameters like appearance, colour, odor, spreadability, consistency, homogeneity, oily feel, stickiness, grittiness, phase separation, and pH as shown in Table 4. After keen observation on these parameters, it was possible to finalize one batch among all the batches.

3.5. Characterization of final batch

Among the eight batches, Batch F7 was selected as final batch. This finalization was done because this batch was found to be more pleasing in appearance, colour and odor as compared to other batches. Spreadability, consistency and homogeneity were also found excellent as compared to other batches. Oily feel and stickiness were found to be absent. Formulation was found to be free from any grittiness. No phase separation was observed. However, pH of all formulations was found to be in range of 5.10–5.67 that complies with the human skin (pH 4.5–6.5). This final batch was evaluated further on other parameters like spreadability, extrudability, water content, rancidity, viscosity, microbial contamination, quantification of psoralen and stability studies. Results of spreadability, extrudability, water content and rancidity are mentioned in Supplementary Table S2.

3.6. Viscosity

Viscosity of emulgel was carried out by Brookfield viscometer at different RPM as shown in Supplementary Table S3.

3.7. Microbial contamination

No growth of yeast and mould was found. No growth of total viable aerobic was found.

3.8. Quantification of psoralen by HPLC method

Highest percentage of psoralen was found in hydro-alcoholic extract of *Safoof-e-Bars* (0.2%) while negligible amount was found in *zulal* (0.004%) and emulgel showed 003% as shown in Supplementary Figs. S1–4.

3.9. Stability studies

Formulation was found to be stable for a period of 3 months (Table 5).

4. Discussion

In the present study, different batches of emulgel were prepared as preliminary batches and final study batches. In preliminary batches, two different types of gelling agents i.e., carbopol-934 and carbopol-940 were used in batches and were analyzed. Carbopol-940 was found better in terms of consistency and appearance and therefore selected for further study. After finalizing the carbopol-940 as a gelling agent, further batches were prepared with different concentration of carbopol-940. In these batches, concentration of carbopol-940 was increased from 0.5% to 5% with the increment of 0.5%. It was noted that as concentration of gelling agent increases, consistency of formulation also increases. At 0.5% concentration, formulation was very thin in consistency while at 5% concentration, the formulation was found to be very stiff. At 2% concentration, the formulation was found to be most suitable in term of consistency for emulgel. An emulsion formulation required the inclusion of emulsifying agents to ensure the emulsion stability, the choice of which is determined by the type of emulsion required [32]. The ionic nature of emulsifier is an important consideration when selecting an emulsifier for an emulsion. Anionic and cationic emulsifiers may be irritating when applied to the skin [33]. Therefore in the present study, non-ionic emulsifiers (Span 20 and Tween 20) were used because they are effective over wide range of pH and moreover they are compatible with many drug substances and tend to be stable and non-irritant.

Table 1
Monographic analysis of Babchi, Chaksu, Panwar and Anjeer-khushk[a].

Parameters	As per laboratory test (%)		As per UPI	Inference
Alcohol soluble matter	Babchi	22.583 ± 0.23	Not less than 13%	Comply with standard limit
	Chaksu	7.741 ± 0.066	Not less than 7%	Comply with standard limit
	Panwar	11.957 ± 0.14	Not less than 5%	Comply with standard limit
	Anjeer-khushk	25.596 ± 0.090	Not less than 20%	Comply with standard limit
Total ash	Babchi	7.687 ± 0.110	Not more than 8%	Comply with standard limit
	Chaksu	3.852 ± 0.016	Not more than 4%	Comply with standard limit
	Panwar	5.695 ± 0.139	Not more than 6%	Comply with standard limit
	Anjeer-khushk	3.571 ± 0.214	Not more than 4%	Comply with standard limit
Acid insoluble ash	Babchi	1.857 ± 0.025	Not more than 2%	Comply with standard limit
	Chaksu	0.265 ± 0.016	Not more than 1.5%	Comply with standard limit
	Panwar	0.033 ± 0.008	Not more than 0.2%	Comply with standard limit
	Anjeer-khushk	0.944 ± 0.001	Not more than 1%	Comply with standard limit

[a] Done in laboratory by own.

Table 2
Physico-chemical evaluation of *Safoof-e-Bars*.

S. no.	Parameters		Results
1	Appearance		Powder of uniform particles
2	Colour		Yellowish brown
3	Odor		Aromatic odor
4	Taste		Bitter
5	Alcohol soluble matter (%)		29.44 ± 0.144
6	Water soluble matter (%)		35.607 ± 0.160
7	pH	1% Solution	4.976 ± 0.059
		10% Solution	4.113 ± 0.049
8	Successive extractive values	Petroleum ether (%)	8.38 ± 0.098
		Chloroform (%)	3.573 ± 0.029
		Ethyl alcohol (%)	16.936 ± 0.387
9	Hydro-alcoholic extractive value		26.7 ± 0.294
10	Ash values	Total ash (%)	4.712 ± 0.018
		Acid insoluble ash (%)	0.818 ± 0.035
		Water soluble ash (%)	1.761 ± 0.298
11	Los on drying at 105 °C (%)		9.135 ± 0.034
12	Moisture content by T.D method (%)		5.866 ± 0.033
13	Bulk density (g/mL)		0.532 ± 0.003
14	Tapped density (g/mL)		0.647 ± 0.004
15	Compressibility index		19.2982
16	Hausner's ratio		1.215 ± 0.013
17	Angle of repose		46.7843 ± 0.126

Different penetration enhancers like clove oil and menthol were used in different batches. Initially 8% of clove oil and menthol were used separately. At this concentration, smell was found to be very strong and not pleasant. Therefore, concentration was decreased with the decrement of 2%. At 2%, smell of emulgel was agreeable and pleasant. SB was extracted in ethanol and water in the ratio of 1:1 by soxhlet extractor. The extractive value of single dose (10 gm) of SB was found to be 26.7%. So, initially this extractive value was used in the formulation of emulgel, but problem occurred with the formulation as phase separation was noticed in the next morning. This phase separation might be due to the exceeding percentage of the internal phase i.e., oil phase beyond 74%, because the maximum volume that may be occupied by internal phase (oil phase) in o/w system to form a stable product is 74% [19,32]. So, the concentration of extract was reduced from 26.7% to 23.5% and this was used in the formulation of various batches of emulgel by maintaining the oil phase up to 74%. The finding of this preliminary study formed the basis for selecting the composition and concentration of excipients and extract for the final study batches. In final study batches, eight batches designated as F1, F2, F3, F4, F5, F6, F7 and F8 were prepared with active ingredient i.e., extract and using different excipients in different concentrations. In semi-solid preparations like emulgel, organoleptic properties serve number of function such as appearance can be used as a vital mean of instant identification of homogeneity, phase separation, bleeding, flocculation or coalescence etc.

Appearance of emulgel was found to be opaque, smooth and glossy.

Colour was visualized simply by means of naked eyes in day light and found to be dark brown.

Odor serves as a vital function regarding quality of formulation and acceptability by patient. Change in odor from pleasant to unpleasant may indicate microbial growth. Odor was judged by smelling the emulgel directly and found to be pleasant.

Homogeneity of emulgel was checked visually for bleeding, flocculation or coalescence etc. The emulgel was found to be homogenous.

Consistency was found to be excellent. Emulgel was found to be free from any oily feel and stickiness and complete absence from any particle grittiness on texture analysis.

No any phase separation was present in the emulgel.

Viscosity of the formulation has a significant role in the performance of topically applied product and is closely linked to the product characteristics, such as, ease of application, spreadability, drug release and stability [34]. The viscosity of emulgel at different RPM was found to be 5320, 2520–3700 and 2232–3280 in centipoises with spindles no. 07, 06 and 05 respectively.

Ease with which semi-solid spreads over the skin is designated as spreadability [35]. It is an important criterion for evaluating a topical formulation, since it determines the ease of its application. Spreadability is the term expressed to denote the extent of area over which the formulation readily spreads upon application to

Table 3
Qualitative analysis of *Safoof-e-Bars* & *zulal*.

Phytochemical constituents	Phytochemical test	Results	
		Safoof-e-Bars	*Hydro-alcoholic extract of Safoof-e-Bars*
Alkaloids	Dragendroff's test	+ve	+ve
	Mayer's test	+ve	+ve
Carbohydrates	Benedict's test	+ve	+ve
	Fehling's Test	+ve	+ve
Flavonoids	Flavonoid test	+ve	+ve
Glycosides	Glycosides test	+ve	+ve
Phenols	Phenol test	+ve	+ve
Proteins	Millon's test	+ve	+ve
Saponin	Foam test	+ve	+ve
Tannins	Lead acetate test	+ve	+ve

Table 4
Comparative assessment of emulgel.

Organoleptic parameters	F1	F2	F3	F4	F5	F6	F7	F8
Appearance	Opaque liquid	Opaque liquid	Opaque liquid	Opaque liquid	Opaque, smooth and glossy semi-solid	Opaque, smooth and glossy semi-solid	Opaque, smooth and glossy semi-solid	Opaque, smooth and glossy semi-solid
Colour	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
Odor	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
Spreadability[a]	+	+	+	+	++	++	+++	++
Consistency	Poor	Poor	Poor	Poor	Satisfactory	Satisfactory	Excellent	Good
Homogeneity[a]	0	0	0	0	++	++	+++	++
Oily feel	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Stickiness	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Grittiness	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Phase separation	Present	Present	Present	Present	None	None	None	None
pH	5.24 ± 0.005	5.106 ± 0.006	5.34 ± 0.003	5.123 ± 0.008	5.67 ± 0.005	5.633 ± 0.008	5.66 ± 0.005	5.603 ± 0.003

[a] Excellent +++, good ++, satisfactory +, unavailable 0.

skin or in the affected part. Thus, it also affects the therapeutic benefit derived from the formulation. Spreadability is inversely proportional to its viscosity. The mean value of spreadability was found to be 275.885 ± 2.255 gm cm/s.

Ease with which semi-solid comes out from tube is designated as Extrudability [35]. More quantity is extruded, better is extrudability [36]. The extrudability of emulgel was found to be excellent.

pH of the emulgel was done by the method mentioned in Bureau of Indian Standards (BIS). According to BIS specifications, skin creams should have pH value 4.0–9.0. The mean pH value of emulgel was found to be 5.66 ± 0.005 which is in accordance with the standard value [30].

Water content was determined by distilling emulgel with toluene. The mean percentage value of water content was found to be 58.333 ± 0.333.

Rancidity test depends upon the formation of a red colour, when oxidized fat is treated with conc. hydrochloric acid and a solution of phloroglucinol in ether. All oxidized fats respond to the Kreis test and the intensity of the colour produced is roughly proportional to the degree of oxidative rancidity [12]. This test was found to be negative.

The major therapeutic effect of *Safoof-e-Bars* may be attributed to its chief ingredients *P. corylifolia*. The seeds of *P. corylifolia* are reported to contain psoralen which is pharmacologically active constituent in treating vitiligo [37,38]. Therefore in the present study psoralen was used as a marker compound and quantitative estimation of psoralen was done for therapeutic purpose and also for quality control purpose. Quantitative estimation of psoralen was done in (1) Hydro-alcoholic extract of *Safoof-e-Bars*, which was used to prepare emulgel; (II) *Zulal*, which was prepared as recommended procedure in UPI and (III) In emulgel. It was done by HPLC. The percentage of psoralen in SB extract was found to be 0.2. In emulgel, 0.03, it is because only 23.5% of extract was used in the emulgel with excipients. However, as expected because of very slightly soluble nature of psoralen in water, the percentage of psoralen was found to be only 0.004 and hence proved that it is practically insoluble in water. It is also proved that almost whole part of psoralen comes in the *sufl* and only minute part comes in the *zulal*. It is clear by above mentioned discussion that use of *sufl* in the treatment of vitiligo is more important as compared to *zulal* because of psoralen. It is already discussed various disadvantages of using *sufl*, application of *sufl* is practically impossible on various parts like on face and on eyebrows. Therefore it is recommended that emulgel may be used with *zulal* instead of *sufl* and *zulal* for better efficacy in vitiligo.

Ten gram of SB is recommended clinically for *zulal* and *sufl*, but it is clinically observed that the amount of *zulal* of 10 gm of *Safoof-e-Bars* is only followed by patients easily. However, the quantity of 10 gm *sufl* is very bulky and it is not easily used in this quantity and only 2–3 gm of *sufl* could be used with difficulty on the patches. Extractive value of *Safoof-e-Bars* was found to be 26.7%. So, only 0.534 gm of extract is equal to 2 gm of *sufl*, as discussed above. 23.5% of extract was used, while preparing emulgel. Therefore 0.534 gm of extract is equivalent to 2.27 gm (emulgel) and hence this may be concluded that 2–3 gm of emulgel may be used for small patches of vitiligo. Moreover, it is also concluded at this point that this emulgel could be more potent as compared to *sufl*, because hydro-alcoholic extract was used to extract the majority of constituents for the preparation of emulgel. It is also important to discuss here that as per quantitative estimation of psoralen and after comparison between psoralen present in *Safoof-e-Bars* extract and emulgel, it is concluded that only 15% of extract is present in the emulgel. This lesser percentage of extract was found is due to that the extract was added in the semi-solid form and not in dry form.

Stability of each and every product is must therefore short duration of stability study was done i.e., of 3 months and formulation was found to be stable. Total microbial count and total yeast and mould count were also done on prepared emulgel and no growth was found in both the cases.

Table 5
Stability studies of emulgel.

Parameters	Appearance	Colour	Odor	pH	Spreadability
0 days	Semi-solid & homogenous	Dark brown	Pleasant	5.66 ± 0.005	Easily spreadable
15 days	Semi-solid & homogenous	Dark brown	Pleasant	5.47 ± 0.024	Easily spreadable
30 days	Semi-solid & homogenous	Dark brown	Pleasant	5.45 ± 0.201	Easily spreadable
45 days	Semi-solid & homogenous	Dark brown	Pleasant	5.35 ± 0.020	Easily spreadable
60 days	Semi-solid & homogenous	Dark brown	Pleasant	5.45 ± 0.021	Easily spreadable
75 days	Semi-solid & homogenous	Dark brown	Pleasant	5.25 ± 0.066	Easily spreadable
90 days	Semi-solid & homogenous	Dark brown	Pleasant	5.12 ± 0.021	Easily spreadable

5. Conclusion

Emulgel is emerging as one of the most interesting topical delivery system of the present decade that is convenient, effective, portable, free of side effects and easy to use. Emulgel provides better release of drugs as compared to other topical drug delivery system due to its non-greasy nature. The percentage of psoralen in SB extract and emulgel were found to be 0.2 and 0.03 respectively. Because of very slightly soluble nature of psoralen in water, the percentage of psoralen in *zulal* was found to be only 0.004 and hence proved that it is practically insoluble in water. So, it can be concluded that most of the part of psoralen remains in *sufl*. It can be concluded that newly developed emulgel may be recommended with *zulal* instead of traditionally used *sufl* with *zulal*. In future emulgel will provide a solution for topical delivery of hydrophobic drugs. Such drugs can be delivered in the form of emulgel, where they can be incorporated in oil phase of emulsion and combined with gel.

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Conflicts of Interest

None.

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Appendix A. Supplementary data

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