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(RESEARCH ARTICLE)

Development and formulation of *Aloe vera* emulgel

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Abstract

Aloe vera is most popular in treatment of dermatological disorder in case of burn, tan and wound healing. The study was designed for crude *Aloe vera* extract, development of oil in water (o/w) emulsion, preparation of gel base using *Aloe vera* extract and formulation of the emulgel for topical application. The formulation was prepared by using carbomer 940 as polymer and isopropyl alcohol as penetration enhancer. The p^{H} and viscosity of the *Aloe vera* emulgel were noticed to be 6.8 and 750 centipoise (cps) respectively. The interaction study between phytochemicals and the excipients was carried out using Fourier transform infrared (FTIR) spectroscopy. UV spectrometric analysis of plant extract was carried out. Dynamic light scattering (DLS) was performed to determine the particle size distribution of oil globules in emulsion. Mean particle size (oil globules) was observed to be 481 nm. Zeta potential and polydispersity index (PDI) was recorded to be -13.2 mV and 0.6 respectively.

Keywords: *Aloe vera* gel; Carbomer 940; Emulgel; Fourier transform infrared (FTIR) spectroscopy; Dynamic light scattering (DLS); Dermal preparation

1. Introduction

Topical delivery is an important route for local and systemic treatment. Topical delivery is defined as the application of a formulation containing drug to the skin to directly treat cutaneous disorders (eg. acne) is used both in cosmetic and pharmaceutical preparations. The delivery of drugs onto the skin is recognized as an effective therapy for local dermatologic diseases. It can penetrate deeper into skin and hence give better absorption [1]. Gels are a relatively newer class of dosage form created by entrapment of large amount of aqueous or hydro-alcoholic liquid in a network of colloidal solid particles. In spite of many advantages offered by gels a major limitation is in the delivery of hydrophobic drugs. So to overcome this drawback an emulgel based approach has been appreciated which is the combination of emulsion and gel. Emulgels for dermatological use have several favourable properties such as being thixotropic, greaseless, easily spreadable, easily removable, emollient, long shelf life, transparent [2]. *Aloe vera* has an ancient history in medicine, it is natively from Africa, but widely used in Iran, Egypt, Greece, Rome and India. *Aloe barbadensis* Miller belonging to family Liliaceae was found to grow in subtropical and tropical climates. Recently, only a few species of *Aloe vera* is most popular in treatment of dermatological disorders. *Aloe vera* leaves are formed by a thick epidermis covered with cuticle that can be differentiated into thinner walled cells forming parenchyma with large water storage tissue.

This cells containing a transparent mucilaginous jelly which is referred as *Aloe vera* gel. It contains 99–99.5% water and the remaining 0.5–1.0% solid material is reported to contain over 75 different potentially active compounds including lignin, saponin, salicylic acid, sterols, triterpenoid, various vitamins, minerals, enzymes, polysaccharides, phenolic compounds and organic acids. *Aloe vera* gel has been used for a number of skin issues such as discoloration, pigmentation, tanned skin, rashes and sunburns, premature ageing, dry skin, pimples/acne and scars or any dark spots

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on the skin [3]. *Aloe vera* gel promotes *in vitro* skin penetration of compounds. Some constituents of the *Aloe vera* gel itself also penetrate the skin and this was interestingly dependent on the molecular weight of the co-applied compounds. The higher the molecular weight of the co-applied compound, the less of the gel components were transported across the skin [4]. *Aloe vera* serves for numerous purposes is used both internally and externally for multiple functions. It is widely used for treating various digestive and dermatological disorders. It acts as immunomodulator and is used for skin care applications [5]. Crude *Aloe vera* gel accelerates burn wound healing. Mannose-6-phosphate as the active part of *Aloe vera* consists of linear chains of glucose and mannose molecules that promotes the proliferation and migration of fibroblasts and keratinocytes may play an important roles in wound healing [6].

The study was designed for crude *Aloe vera* extract, development of oil in water (o/w) emulsion, preparation of gel base using *Aloe vera* extract and formulation of the emulgel for topical application. The formulation was prepared by using carbomer 940 as polymer and isopropyl alcohol as penetration enhancer.

2. Preparation of *Aloe vera* extract

A few *Aloe vera* leaves from an *Aloe barbadensis* Miller plant were collected and washed with water thoroughly. A sharp knife was taken and carefully peeled off the yellow layer just beneath the green rind avoiding the vascular bundles and the top rind was removed. The bottom rind was similarly removed to discard the significant amount of mucilage which gets attached onto this. The clear mucilaginous gel was scooped out with a spoon. 50 ml crude clear *Aloe vera* extract was mixed uniformly by using magnetic stirrer and the plant extract was filtered through a Whatman filter paper. Finally, it was transferred into a sterilized, clean glass jar and stored in the refrigerator [6].

3. Formulation of *Aloe vera*emulgel

The gel base was prepared by dispersing 1% carbomer 940 in distilled water at 80°C with constant stirring at a moderate speed using magnetic stirrer and p^H was adjusted to 6-7 using triethanolamine (TEA). 50 ml of *Aloe vera* extract was added into it and gel base using *Aloe vera* extract was prepared. The oil phase of the emulsion was prepared by dissolving 0.5 ml span 20 in 7.5 ml coconut oil. 1% of zinc oxide was added into it. Zinc oxide protects skin from UV-induced damage. The aqueous phase was prepared by dissolving 1 ml tween 20 in purified water. Required amount of methyl paraben was added into aqueous phase and propyl paraben was dissolved in oil phase. Two phases were separately heated to 70-80 °C. The oil phase was added dropwise to aqueous phase and was mixed together with continuous stirring using mechanical stirrer at specified speed until it cooled down to room temperature. The prepared emulsion was mixed with the gel in 1:1 ratio with gentle stirring to obtain the *Aloe vera* emulgel [6].

4. Characterization of formulation

4.1. Viscosity and p^H of emulgel

Viscosity of the prepared *Aloe vera* emulgel was determined using Brookfield viscometer (spindle type) at 10 rpm and was to be 750 cps and p^H of the formulated emulgel was determined to be 6.8[7].

4.2. UV -visible spectroscopy of *Aloe vera* extract

The plant extract was diluted with propylene glycol. Then the sample was analyzed by using UV visible spectrophotometer within the range of 200-500 nm.

4.3. Drug excipients interaction study

4.3.1. Fourier transform infrared (FTIR) spectroscopy

The pure carbomer 940, *Aloe vera* leaf extract and *Aloe vera* emulgel were mixed separately with IR grade KBr and corresponding pellets were prepared by applying specified pressure in a hydraulic press. The pellets were scanned over a wave number range of 4000 to 400 cm^{-1} in FTIR spectroscope [8].

4.4. Size determination and zeta potential measurement

Size distribution was measured using dynamic light scattering (DLS) technique. The size distribution of small particles (oil globules) in emulsion was determined. Zeta potential study was conducted following guidelines [8].

4.5. Optical microscopy of emulsion

The prepared o/w emulsion was observed under optical microscope at magnification of 60X.

5. Results and discussion

IR spectrum of *Aloe vera* extract consists of a single peak at 3327cm^{-1} due to the presence of N-H stretching. Some peaks were observed at 2207 cm^{-1}, 2164 cm^{-1} and 2103 cm^{-1} were associated with C≡C stretching. Absorption band at 1638 cm^{-1} was characteristic of C=O stretching that indicates the presence of carbonyl groups. The absorption band at 970-1250 cm^{-1} corresponds to the stretching vibrations of C-O groups of esters and phenols. A single peak at 690 cm^{-1} was recorded due to the presence of C-H bending (Figure 1) [9].

In case of IR spectrum of carbomer 940, peaks were observed at 2970 cm^{-1} and 2661 cm^{-1} which were associated with alkane C-H stretching. Two peaks were observed at 2211 cm^{-1} and 2180 cm^{-1} due to alkyne C≡C stretching. Another two peaks were observed at 1910 cm^{-1} and 1701 cm^{-1} were associated with alkene C=C stretching and acid C=O stretching. Two peaks were observed at 1451 cm^{-1}, 1415 cm^{-1} due to the presence of aromatic C=C stretching. Another peaks were observed at 1217cm^{-1}, 1230 cm^{-1} and 1115 cm^{-1} were characteristic of alcohol C-O stretching and at 892 cm^{-1}, 798 cm^{-1} and 672 cm^{-1} were associated with amine N-H bending (Figure 2)[11].

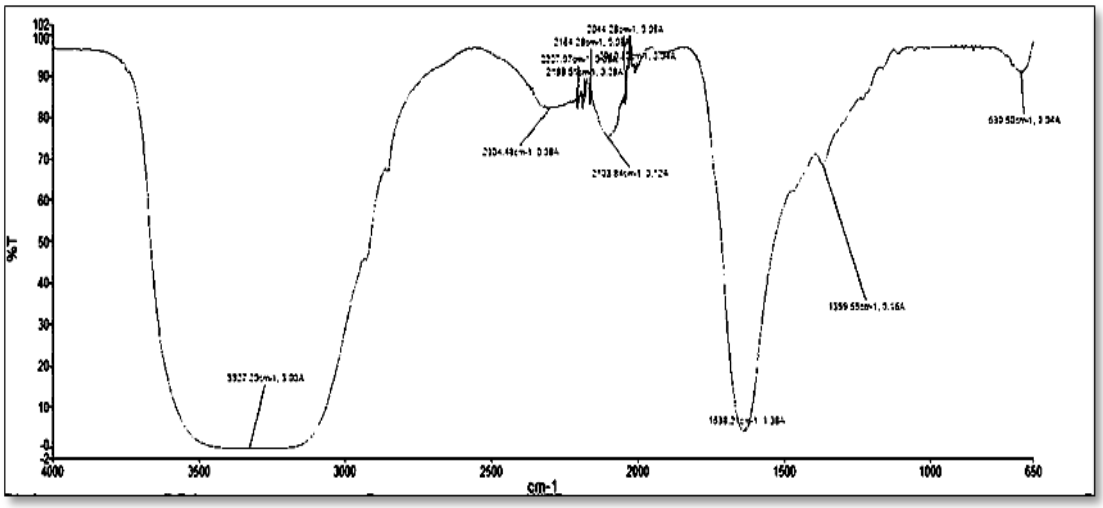

Figure 1 FTIR spectra of *Aloe vera* extract

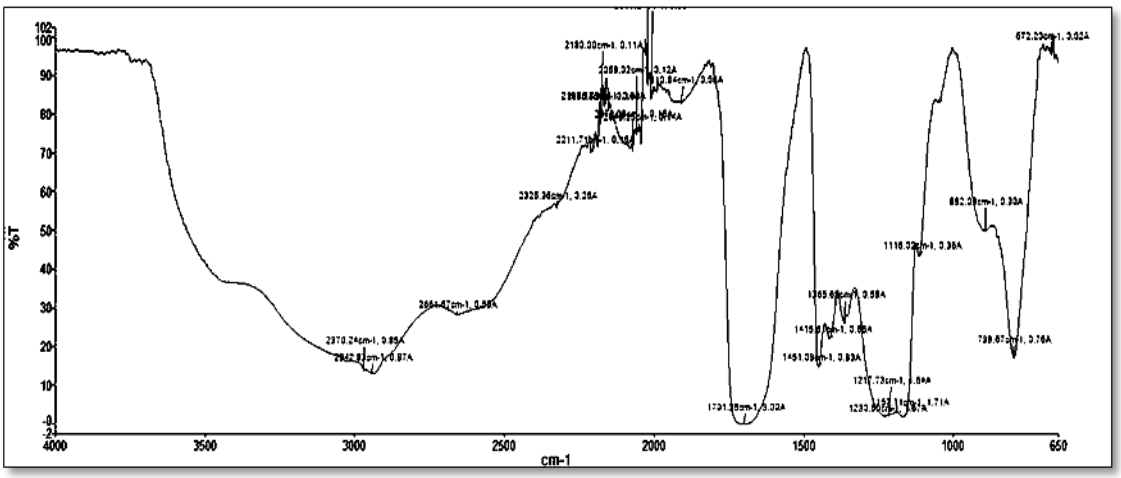

Figure 2 FTIR spectra of carbomer 940

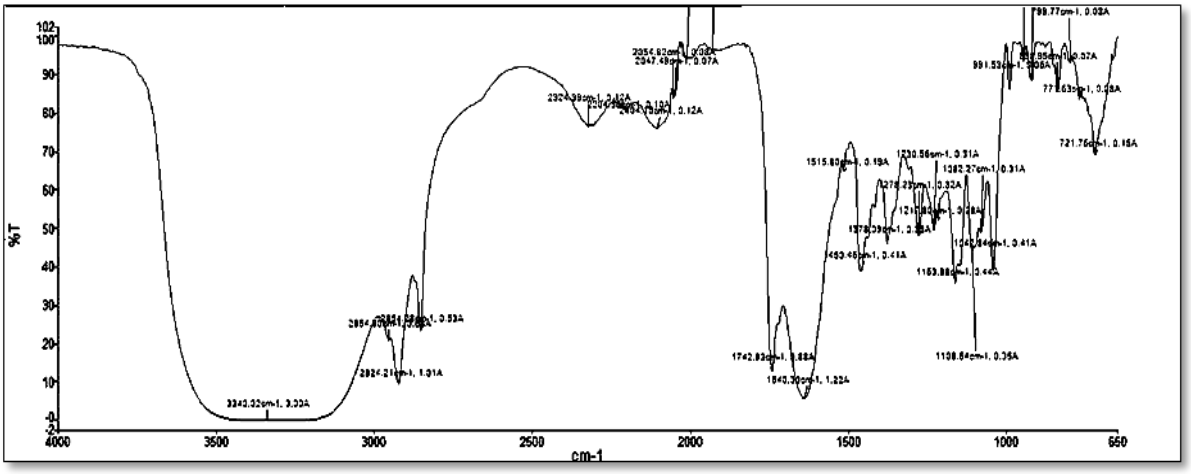

Figure 3 FTIR spectra of *Aloe vera* emulgel

IR spectrum of *Aloe vera* emulgel contains many peaks. Single Peak was recorded at 3340 cm^{-1} due to amine N-H stretching. Two peaks were at 2954 cm^{-1} and 2204 cm^{-1} due to alkane CH_2 and CH_3 stretching and alkyne C≡C stretching. Another two were at 1742 cm^{-1}, 1640 cm^{-1} due to acid C=O stretching and alkene C=C stretching. Some were at 1516 cm^{-1}, 1460 cm^{-1}, 1378 cm^{-1} due to amine N-H bending and alkane CH_3 bending. Another were at 1278 cm^{-1}, 1163 cm^{-1}, 1082 cm^{-1} were characteristic of acid C=O stretching. Some peaks were recorded at 838 cm^{-1}, 799 cm^{-1}, 721 cm^{-1} due to the presence of aromatic C-H bending (Figure 3).

Hence, there was no major interactions between *Aloe vera* extract and excipients except some minor physical interaction which might be due to hydrogen bonding and vander wall forces and/or co-valent bonding [8].

Optical microscopic study showed that the oil globules were well dispersed throughout the external phase (o/w emulsion). Absorption maxima occurred at 222 nm, which indicated the presence of aloin in *Aloe vera* extract [10].

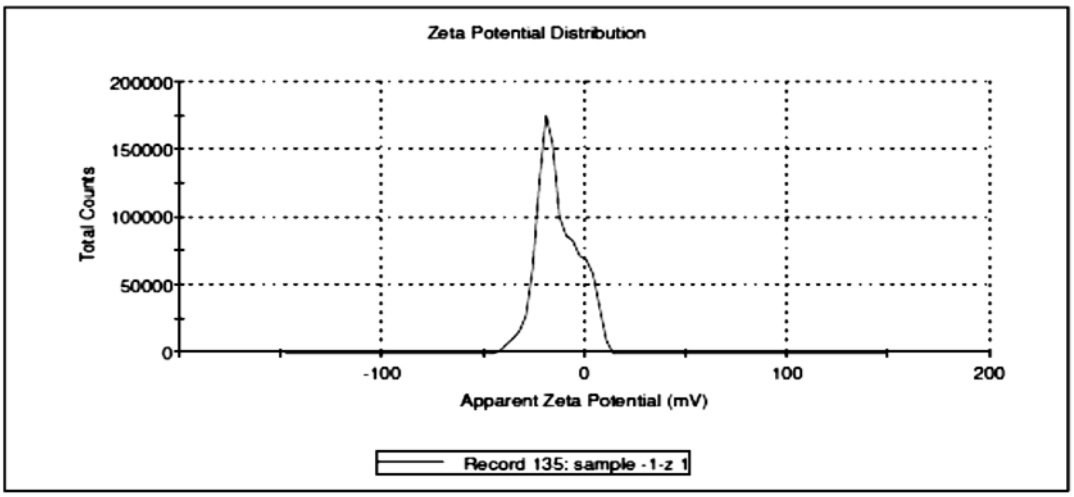

Figure 4 Zeta potential distribution of emulsion

Zeta potential of emulsion was observed to be -13.2 mV indicated the stability of emulsion with no agglomeration (Figure 4). Mean average particle size (oil globules) of emulsion was to be 481 nm. Polydispersity index (PDI) was recorded to be 0.6 which explained the uniformity of oil globules (Figure 5) [12].

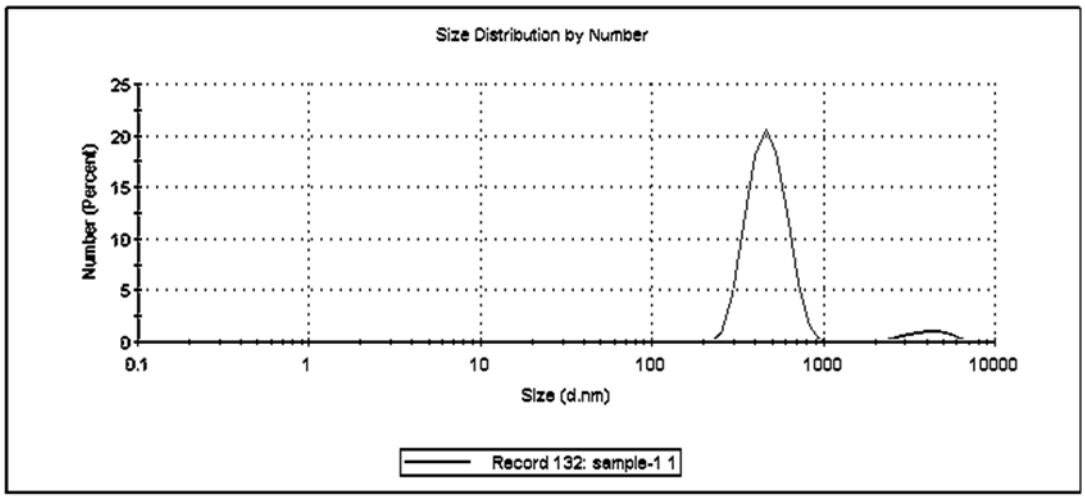

Figure 5 Particle size (oil globule size) distribution of emulsion

6. Conclusion

In conclusion, the emulsion was developed and emulgel was well formulated. The gel base was prepared by using carbomer 940 and *Aloe vera* extract. Zeta potential of emulsion indicated the stability of emulsion with no agglomeration. Average oil globule size (481 nm) of emulsion suggested that the preparation was nanoemulsion and polydispersity index (PDI) explained the uniformity of oil globules in nanoemulsion. *Aloe vera* extract was incorporated into emulgel with compatibility, no chemical interactions were reported. Viscosity and p^H of formulated *Aloe vera* emulgel suggested which could be useful on skin application. Furthermore, extensive studies are required as dermal preparation of emulgel.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The researcher is in a supervisory relationship under corresponding author. The authors report no other conflicts.

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