



# Preparation and Assessment of Sunscreen Cream Containing Extract Acquired from Plant Origin

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### Abstract

The objective of the current study was to formulate and investigate herbal sunscreen cream comprising extracts of plant origin such as *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota*. The petroleum ether, ethanol and aqueous extracts of *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* were prepared. The ethanol and aqueous extracts were performed for total polyphenol and flavonoid content. The sunscreen herbal cream H1, H2 and H3 were formulated by incorporating different ratio of ethanol extracts, and further it was evaluated to check the stability of cream. The *in vitro* SPF values of prepared cream were studied. The stability studies of herbal formulations were performed for the period of three month. The ethanol extracts of *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* exhibited the highest total phenolic and flavonol content. The findings of pH, viscosity, spread ability, irritant study, acid value, saponification value and visualization of physical changing of cream were under limit and acceptable. From results of *in vitro* SPF, it was observed that the H1, H2 and H3 produce moderate to high SPF value ranges from 17.42 to 19.25. The F2 cream demonstrated higher SPF value as compared to H1 and H2 creams. The accelerated stability studies exhibited that formulation H1, H2 and H3 showed no changes in colour, consistency, spreadibility, pH, viscosity and phase separation after storing at different conditions for about 3 months. Therefore, these formulations were considered as stable cream. The formulated sunscreen creams were nontoxic for skin.

### Keywords

*Bacopa monnieri*; *Glycyrrhiza glabra*; *Daucus carota*; Sunscreen; Antioxidant

### Introduction

The cosmetic products are employed globally for wash, prettify, maintaining and improving general appearance of face. The cosmetic products are considered as the any substance intended to be employed in different part of skin [1-4]. Herbal cosmetic are the product incorporating substance obtained from plant origin. The plant have assortment of properties namely antioxidant, anti-inflammatory, antiseptic, antibacterial etc used for the protection of skin from different agents responsible for diseases. Presently the demand of herbal face cream is more compare to synthetic cosmetic

due to fewer side effects. There various herbs used in the preparation of herbal cosmetic for glowing complexion [5,6].

The sun emits UVA and UVB radiation leading to damaging effects of skin cells due to production of reactive oxygen species in skin. Consequently, the regular exposure of skin to UVA and UVB radiation causes sunburn, tanning of the skin, also can cause damage, particularly to very lightly colored or sensitive skin, leads to reduction of skin elasticity and wrinkles. Therefore, the sunscreens products are applied from prevention of burn occur due to sun rays and other skin damage.

Thus Reactive oxygen species plays a prime role in the inception of numerous skin disorders, further proper skin care containing highly antioxidant component can be used to treat these problems. Meanwhile, the natural herbal products are in demand for use to control skin problems. The natural herbs are harmless as they don't have side effects. They also have low mammalian toxicity and can be handled safely [7]. Correspondently, the present study features a novel herbal skin care formulation alleviating sunburn, and thereby improves the appearance of the skin. The current study was intended to prepare herbal sunscreen cream contains combinations of herbal ingredients that were formulated to combat and reduce oxidative stress to prevent sunburn. The plant material employed in herbal sunscreen cream was selected accordingly scientifically reported property. As per this concern the following plants *Bacopa monnieri* (Whole plant), *Glycyrrhiza glabra* (Rhizome) and *Daucus carota* (Rhizome) for the formulation of herbal sunscreen cream.

### Materials and Methods

#### Preparation of extracts

500 gram of powdered of *Bacopa monnieri* (Whole plant), *Glycyrrhiza glabra* (Rhizome) and *Daucus carota* (Rhizome) were extracted with petroleum ether, ethanol and distilled water successively. The ethanol and aqueous extract were selected for further study.

#### Quantitative analysis

**Total polyphenol content:** Mix 1.0 ml of the extract with 2.5 ml of Folin-Ciocalteu reagent, and 2.0 ml of sodium carbonate solution (75 g/l) was then added to the reaction mixture.

- The mixture was kept for 2 h at room temperature and measure absorbance at 760 nm.
- Concentration of polyphenol was calculated by the help of gallic acid calibration curve [8].

**Total flavonol content:** Mix 9.8 ml of the extract with a 10% solution of aluminum chloride (200 µl)

- Absorbance of sample was measured at 425 nm wavelength after 30 min.
- Concentration of polyphenol was calculated by the help of quercetin calibration curve [8,9].

#### Formulation of herbal sunscreen cream

The oil in water (O/W) emulsion-based cream was prepared by dissolving ethanol extract of (*Bacopa monnieri*, *Glycyrrhiza glabra*

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and *Daucus carota*) with emulsifier (stearic acid) and other oil soluble components (Cetyl alcohol, almond oil) at 75°C. The preservatives and other water soluble components were also added before cooling. The formula for the cream is given in Table 1 [10-12].

### Evaluation of cream

The prepared cream was evaluated for pH, Viscosity, Dye test, Homogeneity, Appearance, After feel, Type of smear, Removal, Acid value, Saponification value, Irritancy test and Rheological studies. The methods applied for above parameters are discussed by Rajvanshi and Singh [13,14].

### In vitro SPF assay of formulation

The *in vitro* Sun protection factor (SPF) screening method was studied by Kaur et al, 2011 and Ashawat et al, 2006. 10% solution of herbal cream was prepared in 95% ethanol. Absorbance was measured for each sample at 290-320 nm at the interval of 5 nm, using UV-Visible spectrophotometer [15-19].

The SPF values were calculated by using formula:

$$SPF_{Spectrophotometr} = CF \times \sum_{290}^{320} [EE(\lambda)] \times 1(\lambda) \times (\lambda) \times Abs(\lambda)$$

Where,

CF – correction factor,

EE (λ) – erythmogenic effect of radiation with wavelength λ

Abs (λ) – spectrophotometric absorbance values at wavelength λ

Values of EE (λ) x I (λ) are constants

### Accelerated stability testing

The stability studies were performed by keeping the formulations at refrigerator temperature (4°C), 25°C ± 2°C/60% relative humidity (RH) ± 5% RH and 40°C ± 2°C/75% RH ± 5% RH for the period of three month. The following parameters such as homogeneity, appearance, spreadibility, after feel, type of smear, removal, pH, viscosity and phase separation were observed [20,21].

### Results and Discussion

*Bacopa monnieri* (Whole plant), *Glycyrrhiza glabra* (Rhizome) and *Daucus carota* (Rhizome) were selected for preparation and evaluation of herbal sunscreen cream.

### Quantitative analysis

The ethanol and aqueous extract of *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* were subjected to quantify the total polyphenol and total flavonoid.

**Total phenolic content:** The total phenolic content of ethanol and aqueous extract of *Bacopa monnieri* were 56.19 ± 1.23 and 50.32 ± 0.65 GAE mg/gm, respectively. The total phenolic content of ethanol and aqueous extract of *Glycyrrhiza glabra* were 49.64 ± 0.42 and 47.25 ± 1.08 GAE mg/gm, respectively. The total phenolic content of ethanol and aqueous extract of *Daucus carota* were 68.57 ± 0.72 and 56.29 ± 0.52 GAE mg/gm, respectively (Table 2). The total polyphenol was determined by using calibration curve of gallic acid (Figure 1). The ethanol extracts exhibited highest amount of total polyphenol content compared to aqueous extracts.

**Total flavonol content:** The total flavonoid content of ethanol and aqueous extract of *Bacopa monnieri* were 51.29 ± 0.68 and 42.38 ± 0.89 QE mg/gm, respectively. The total flavonoids content

of ethanol and aqueous extract of *Glycyrrhiza glabra* were 65.43 ± 1.32 and 58.94 ± 0.79 QE mg/gm, respectively. The total flavonoids content of ethanol and aqueous extract of *Daucus carota* were 53.87 ± 0.46 and 44.68 ± 1.14 QE mg/gm, respectively (Table 3). The total flavonoid content was determined by using calibration curve of gallic acid (Figure 2). The ethanol extracts exhibited highest amount of flavonoids content compared to aqueous extracts.

The flavonoids and polyphenols of plants are considered as free radical scavenging and antioxidants activity. The antioxidant components are employed for the prevention and remedy of skin disorders, which are produce by free radicals. The sun burn arises in skin due to excitation and proliferation of free radicals, approaching in contact with UV rays of sun. The topical application of antioxidant components obtained from plants alleviates production of free radicals and proliferate the normal cells.

The findings suggest that the presence of the different ratio of plant extracts could decrease the oxidative stress prompted by UV rays. The antioxidant study was performed for the proper selection of extracts from different plant, to make effective herbal sunscreen cream. Hence the ethanol extracts of *Bacopa monnieri*, *Glycyrrhiza glabra*, and *Daucus carota* were selected for further study due to highest amount of polyphenol and flavonoids content compared to aqueous extracts.

### Formulation of herbal cream

Three plants of ethanol extract namely *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* were selected for study. The herbal cream was formulated by incorporating different ratio of extracts, by using selected cream base. The creams were categorized in three distinct formulations, i.e. H1, H2 and H3. Here the ratio of extracts in different proportion was selected on the basis of antioxidant property for formulation of herbal cream. The prepared herbal creams were assessed for *in vitro* SPF.

### Evaluation of herbal cream

**pH:** The pH of the prepared cream was in between 6 – 7 (Table 4). Further the pH of the cream was nearer to skin pH.

**Viscosity:** The viscosity of prepared cream was 27956 – 28123 cps (Table 4). All formulations show worthy spreadable property.

**Dye test:** The dye indorse that all formulation belongs to o/w type emulsion cream (Table 4).

**Acid value:** The satisfactorily values of acid value were obtained

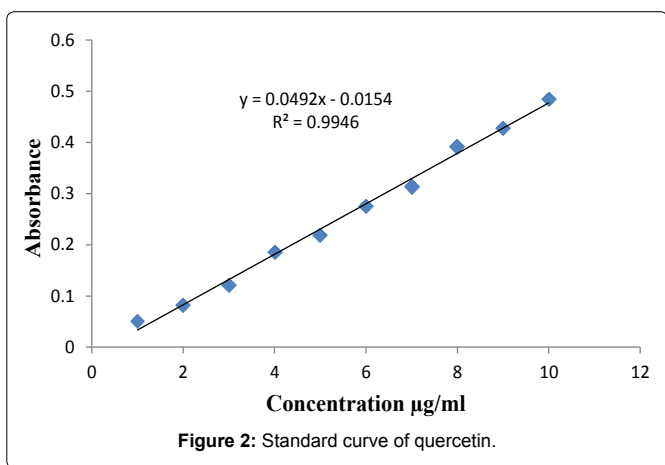
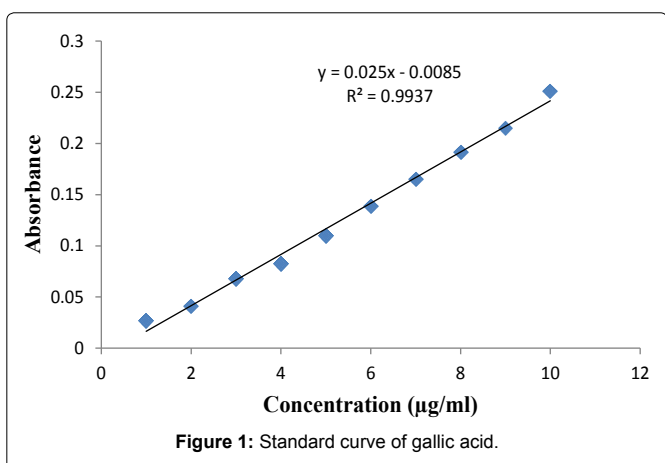
Table 1: Composition of herbal face cream.

| Ingredients                       | Formula % w/w |      |      |
|-----------------------------------|---------------|------|------|
|                                   | H1            | H2   | H3   |
| <i>Bacopa monnieri</i> extract    | 2             | 1    | 2    |
| <i>Glycyrrhiza glabra</i> extract | 1             | 2    | 2    |
| <i>Daucus carota</i> extract      | 2             | 2    | 1    |
| Stearic acid                      | 7             | 7    | 7    |
| White beeswax                     | 4             | 4    | 4    |
| Triethanolamine                   | 1.5           | 1.5  | 1.5  |
| Almond oil                        | 6             | 6    | 6    |
| Propylene glycol                  | 4             | 4    | 4    |
| Methyl paraban                    | 0.01          | 0.01 | 0.01 |
| Propyl paraban                    | 0.02          | 0.02 | 0.02 |
| Cetyl alcohol                     | 5             | 5    | 5    |
| Water, qs, 100                    | qs            | qs   | qs   |

**Table 2:** Data of total polyphenol content in various extract.

| Extract                                   | Total polyphenol content (GAE mg/gm) |
|---|--------------------------------------|
| <i>Bacopa monnieri</i> ethanol extract    | 56.19 ± 1.23                         |
| <i>Bacopa monnieri</i> aqueous extract    | 50.32 ± 0.65                         |
| <i>Glycyrrhiza glabra</i> ethanol extract | 49.64 ± 0.42                         |
| <i>Glycyrrhiza glabra</i> aqueous extract | 47.25 ± 1.08                         |
| <i>Daucus carota</i> ethanol extract      | 68.57 ± 0.72                         |
| <i>Daucus carota</i> aqueous extract      | 56.29 ± 0.52                         |

Values are in gallic acid equivalent (GAE) mg per gm of the extract, Values are mean ± SEM of triplicate determinations



**Table 3:** Data of total flavonol content in various extract.

| Extract                                   | Total flavonol content (QE mg/gm) |
|---|-----------------------------------|
| <i>Bacopa monnieri</i> ethanol extract    | 51.29 ± 0.68                      |
| <i>Bacopa monnieri</i> aqueous extract    | 42.38 ± 0.89                      |
| <i>Glycyrrhiza glabra</i> ethanol extract | 65.43 ± 1.32                      |
| <i>Glycyrrhiza glabra</i> aqueous extract | 58.94 ± 0.79                      |
| <i>Daucus carota</i> ethanol extract      | 53.87 ± 0.46                      |
| <i>Daucus carota</i> aqueous extract      | 44.68 ± 1.14                      |

Values are in quercetin equivalent (QE) mg per gm of the extract, Values are mean ± SEM of triplicate determinations

from prepared cream (Table 4).

**Saponification value:** The findings of saponification value of prepared creams are displayed in Table 4, and exposed satisfactorily

values.

**Physical parameter of cream at room and accelerated temperature:** At room temperature all formulations had good appearance. None of them had color change during study period of cycles. All formulations produce good spreadibility, easy to remove and emollient property (Table 5). Further to check the sensitivity of formulations under high temperature, the physical parameter study has conducted under accelerated temperature. From Table 6 it has been observed that the results of the physical parameters of all formulations at the accelerated temperatures were similar to results of room temperature. Moreover, formulations can resist the higher climatic temperatures.

**Irritancy test:** Non irritancy and nontoxic were observed during irritancy studies (Table 7). These creams were safe to use for skin.

**Rheological studies:** The finding of rheological studies indicates that the cream had pseudo plastic flow behavior.

**In vitro SPF assay**

The SPF values of herbal creams achieved by carrying out the UV spectrophotometric technique applying Mansur mathematical equation, and results are revealed in Table 8. It indicates that H2 cream produce 19.25 SPF values, which is maximum value as compared to prepared SPF creams. The H3 cream produces lowest SPF value 17.42. The extent of SPF value of all the formulations is very appreciating when we compare with that of other herbal extracts as reported by various authors [22,23]. The findings suggest that *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* had high amounts of phenolic and flavonoids compounds which could be the cause for their high SPF. So here we also concluded that the H2 cream has high amount of phenolic and flavonoids due to synergistic action after combining the different extracts of plant. While other creams also produce synergistic action but their efficacy of phenolic and flavonoids are not up to level of H2 cream.

**Stability study studies as per ICH guidelines**

Stability of a drug product refers to the chemical and physical integrity of the dosage unit and when appropriate, the ability of the drug product to maintain protection against microbiological contamination. An ideal drug product must be fully characterized physically, chemically and microbiologically at the start of study and throughout the intended shelf-life period. According to ICH guidelines, a drug substance should be evaluated under storage conditions for its thermal stability. The formulations namely H1, H2 and H3 were subjected to stability studies at 4°C, 25°C ± 2°C/60% RH ± 5% RH and 40°C ± 2°C/75% RH ± 5% RH for three month. The product was evaluated for homogeneity, appearance, consistency, spreadibility, removal, pH, viscosity and phase separation.

From the stability studies, formulation H1, H2 and H3 showed no changes in colour, consistency, spreadibility, pH and phase separation after storing at different conditions for about 3 months. The pH of creams stored at 4°C, 25°C and 40°C for 90 days was nearer to pH of freshly prepared cream. It was found that the viscosity of formulations was slightly changed when it stored at 4°C, 25°C and 40°C for 90 days (Tables 9-11). However, there was a not significant difference from the freshly formulated cream. Therefore these formulations were considered as stable cream. The formulated herbal cream is expected to reduce the ROS from skin. Hence results of studies indicate that

**Table 4:** Estimation of pH, Viscosity, dye test, acid value and saponification of various herbal sunscreen creams.

| Formulation | pH  | Viscosity (in cps) | Emulsion | Acid value | Saponification value |
|-------------|-----|--------------------|----------|------------|----------------------|
| H1          | 6.7 | 28123              | O/W      | 6.3        | 26.7                 |
| H2          | 6.9 | 27956              | O/W      | 5.9        | 26.2                 |
| H3          | 6.6 | 28108              | O/W      | 5.7        | 25.4                 |

**Table 5:** Physical parameter of cream on room temperature.

| Formulation | Parameter   |            |               |            |               |         |
|-------------|-------------|------------|---------------|------------|---------------|---------|
|             | Homogeneity | Appearance | Spreadibility | After feel | Type of smear | Removal |
| H1          | ***         | NCC        | ***           | E          | NG            | ES      |
| H2          | ***         | NCC        | ***           | E          | NG            | ES      |
| H3          | **          | NCC        | **            | E          | NG            | ES      |

\*\*\*: Excellent, \*\*: Good, \*: Satisfactory, E: Emollient, NG: Non greasy, ES: Easy, NCC: Not change in colour

**Table 6:** Physical parameter of cream on accelerated temperature.

| Formulation | Parameter   |            |               |            |               |         |
|-------------|-------------|------------|---------------|------------|---------------|---------|
|             | Homogeneity | Appearance | Spreadibility | After feel | Type of smear | Removal |
| H1          | **          | NCC        | **            | E          | NG            | ES      |
| H2          | ***         | NCC        | ***           | E          | NG            | ES      |
| H3          | **          | NCC        | **            | E          | NG            | ES      |

\*\*\*: Excellent; \*\*: Good; \*: Satisfactory; E: Emollient; NG: Non greasy; ES: Easy; NCC: Not change in colour

**Table 7:** Type of Adverse effect of formulations.

| Formulation | Irritant | Erythema | Edema |
|-------------|----------|----------|-------|
| H1          | NIL      | NIL      | NIL   |
| H2          | NIL      | NIL      | NIL   |
| H3          | NIL      | NIL      | NIL   |

**Table 8:** SPF determination of herbal cream.

| Formulation | SPF value    |
|-------------|--------------|
| H1          | 18.16 ± 0.83 |
| H2          | 19.25 ± 0.71 |
| H3          | 17.42 ± 1.28 |

Values are mean and SEM of three determinants

**Table 9:** Stability study of formulations after one month at different temperature.

| Formulation | Temperature | Parameter |     |     |     |    |    |    |    |    |
|-------------|-------------|-----------|-----|-----|-----|----|----|----|----|----|
|             |             | pH        | H   | A   | S   | AF | TS | R  | PS | V  |
| H1          | 4°C         | 6.6       | **  | NCC | **  | E  | NG | ES | NC | ++ |
|             | 25°C        | 6.6       | *** | NCC | *** | E  | NG | ES | NC | +  |
|             | 40°C        | 6.7       | **  | NCC | *** | E  | NG | ES | NC | +  |
| H2          | 4°C         | 6.8       | *** | NCC | **  | E  | NG | ES | NC | ++ |
|             | 25°C        | 6.9       | *** | NCC | *** | E  | NG | ES | NC | +  |
|             | 40°C        | 6.9       | **  | NCC | *** | E  | NG | ES | NC | +  |
| H3          | 4°C         | 6.6       | **  | NCC | **  | E  | NG | ES | NC | ++ |
|             | 25°C        | 6.6       | **  | NCC | *** | E  | NG | ES | NC | +  |
|             | 40°C        | 6.5       | **  | NCC | *** | E  | NG | ES | NC | ++ |

H: Homogeneity; A: Appearance; S: Spreadibility; AF: After feel; TS: Type of smear; R: Removal; PS: Phase separation; V: Viscosity  
 Viscosity of freshly prepared cream (VFPC) ± 1 - Little; VFPC ± 3 - Moderate; VFPC ± 6 – Much; VFPC ± 11 – Very much  
 \*\*\*: Excellent; \*\*: Good; \*: Satisfactory; E: Emollient; NG: Non greasy; ES: Easy; NCC: Not change in colour; + = Little; ++ = Moderate; +++ = Much; ++++ = Very much

this formulation can be used to alleviate skin disorders such as sun burn. Moreover, it is herbal formulation; the chance of side effects to skin is less.

## Conclusion

The plant *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* has been studied to compare and give a report on antioxidant activity

and sunscreen cream. The ethanol extracts of *Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* exhibited the highest total phenolic and flavonol content. The H2 cream exhibited highest SPF values, compared to prepared H1 and H3 SPF creams. The higher efficacy of H2 may be due to synergistic action of cream depends on nature of plant extracts and concentration of extracts present in cream. Hence the herbal formulations H1, H2 and H3 consisting

Table 10: Stability study of formulations after two month at different temperature.

| Formulation | Temperature | Parameter |     |     |     |    |    |    |    |    |
|-------------|-------------|-----------|-----|-----|-----|----|----|----|----|----|
|             |             | pH        | H   | A   | S   | AF | TS | R  | PS | V  |
| H1          | 4°C         | 6.8       | *** | NCC | **  | E  | NG | ES | NC | ++ |
|             | 25°C        | 6.6       | *** | NCC | *** | E  | NG | ES | NC | +  |
|             | 40°C        | 6.8       | *** | NCC | *** | E  | NG | ES | NC | ++ |
| H2          | 4°C         | 6.8       | **  | NCC | **  | E  | NG | ES | NC | ++ |
|             | 25°C        | 6.7       | *** | NCC | *** | E  | NG | ES | NC | ++ |
|             | 40°C        | 6.7       | **  | NCC | *** | E  | NG | ES | NC | ++ |
| H3          | 4°C         | 6.5       | **  | NCC | **  | E  | NG | ES | NC | ++ |
|             | 25°C        | 6.6       | *** | NCC | *** | E  | NG | ES | NC | +  |
|             | 40°C        | 6.6       | **  | NCC | *** | E  | NG | ES | NC | ++ |

H: Homogeneity; A: Appearance; S: Spreadibility; AF: After feel; TS: Type of smear; R: Removal; PS: Phase separation; V: Viscosity  
 Viscosity of freshly prepared cream (VFPC) ± 1 - Little; VFPC ± 3 - Moderate; VFPC ± 6 - Much; VFPC ± 11 - Very much  
 \*\*\*: Excellent; \*\*: Good; \*: Satisfactory; E: Emollient; NG: Non greasy; ES: Easy; NCC: Not change in colour; + = Little; ++ = Moderate; +++ = Much; ++++ = Very much

Table 11: Stability study of formulations after three month at different temperature.

| Formulation | Temperature | Parameter |     |     |     |    |    |    |    |     |
|-------------|-------------|-----------|-----|-----|-----|----|----|----|----|-----|
|             |             | pH        | H   | A   | S   | AF | TS | R  | PS | V   |
| H1          | 4°C         | 6.7       | **  | NCC | *** | E  | NG | ES | NC | +++ |
|             | 25°C        | 6.7       | *** | NCC | *** | E  | NG | ES | NC | ++  |
|             | 40°C        | 6.8       | *** | NCC | *** | E  | NG | ES | NC | +++ |
| H2          | 4°C         | 6.7       | **  | NCC | **  | E  | NG | ES | NC | ++  |
|             | 25°C        | 6.8       | *** | NCC | *** | E  | NG | ES | NC | ++  |
|             | 40°C        | 6.7       | *** | NCC | *** | E  | NG | ES | NC | ++  |
| H3          | 4°C         | 6.5       | **  | NCC | **  | E  | NG | ES | NC | +++ |
|             | 25°C        | 6.7       | *** | NCC | **  | E  | NG | ES | NC | ++  |
|             | 40°C        | 6.6       | *** | NCC | *** | E  | NG | ES | NC | +++ |

H: Homogeneity; A: Appearance; S: Spreadibility; AF: After feel; TS: Type of smear; R: Removal; PS: Phase separation; V: Viscosity  
 Viscosity of freshly prepared cream (VFPC) ± 1 - Little; VFPC ± 3 - Moderate; VFPC ± 6 - Much; VFPC ± 11 - Very much  
 \*\*\*: Excellent; \*\*: Good; \*: Satisfactory; E: Emollient; NG: Non greasy; ES: Easy; NCC: Not change in colour; + = Little; ++ = Moderate; +++ = Much; ++++ = Very much

*Bacopa monnieri*, *Glycyrrhiza glabra* and *Daucus carota* extract could be used safely and effectively for preserving the beauty of the skin, and at the same time reversing the adverse effects caused to the skin.

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