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# Formulation and Evaluation of Pomegranate and Marigold Infused Melting Serum Candle: A Novel Approach to Skin Care

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**A B S T R A C T**

In this study, we developed and assessed a melting serum candle enriched with pomegranate and marigold extracts, targeting the issue of skin aging. These ingredients were selected for their well-known antioxidant and skin-rejuvenating properties. With the growing demand to counteract visible signs of aging- such as fine lines, wrinkles, and age spots- the anti-aging market has been expanding rapidly. This research introduces a novel cosmeceutical melting serum candle, crafted with cocoa butter to offer a luxurious, soothing experience while delivering anti-aging and moisturizing benefits. The natural antioxidants and calming properties of pomegranate and marigold extracts help diminish signs of aging and enhance skin texture and luminosity. The cocoa butter base deeply nourishes and hydrates, resulting in skin that feels exceptionally soft and supple. This innovative skincare product presents an effective and unique approach for individuals aiming to achieve a smoother, more radiant complexion. The study covers the formulation, characterization, and evaluation of the serum candle, emphasizing its promise as a natural and indulgent skincare alternative. The formulated candle was analyzed for its bioactive content, and its physical, biological, and phytochemical properties were assessed, along with stability testing. All evaluation parameters and stability results were within acceptable standards. Phytochemical analysis confirmed the presence of bioactive compounds that contribute to skin health.

**Keywords:** Pomegranate extract, Marigold extract, Melting serum candle, Skin rejuvenating, Anti-aging.

## 1. Introduction

The study of human skin plays a crucial role in the fields of dermatology, toxicology, pharmacology, and cosmetology, as it helps to evaluate the impact of external agents, their interactions, mechanisms of absorption, and potential toxicity on various skin structures [1]. The significance of beautification has been recognized since prehistoric times, with the pursuit of beauty and health becoming deeply ingrained in society. Face serums have emerged as an effective solution for delivering valuable active ingredients directly into the skin, offering a safer alternative to the use of harmful chemicals that promise instant results [2].

Face serums are specialized skincare formulations designed to address specific concerns by delivering potent active ingredients deep into the skin. These lightweight, highly concentrated products typically feature beneficial components such as retinol, hyaluronic acid, Vitamin C, and alpha-hydroxy acids. Depending on their formulation, face serums can offer a range of benefits, including hydration, anti-aging effects, brightening, exfoliation, soothing, and oil control. Similar to creams but more concentrated, serums are generally water- or oil-based and are formulated with minimal ingredients to enhance the availability of key actives, such as growth factors, vitamins, or botanical extracts. Thanks to their low viscosity, serums absorb quickly and penetrate deeper into the skin, effectively targeting various skin concerns and delivering intensive nourishment. Their ability to hydrate, reduce signs of aging, brighten the complexion, exfoliate, calm irritation, and regulate oil production makes face serums vital elements of modern skincare regimens. The lightweight texture, rapid absorption, and non-greasy finish of serums allow active ingredients to reach deeper skin layers, optimizing their effectiveness. Moreover, serums help counteract the adverse effects of photodamage and UV exposure, such as wrinkles and premature skin aging, making them indispensable for maintaining a healthier, more radiant complexion [3].

### Overview of Skin Aging

The primary indicators of aging skin include the development of wrinkles, uneven pigmentation, dark spots, thinning, sagging, and a rougher texture. These changes can result from either intrinsic or extrinsic factors. Several theories attempt to explain the mechanisms behind skin aging, with the most widely accepted focusing on DNA damage and the body's subsequent repair processes. These processes lead to epigenetic alterations across the genome, promoting cellular senescence, functional decline, and genomic instability. Extrinsic aging is primarily driven by environmental influences, such as ultraviolet (UV) radiation and pollution, which trigger the generation of reactive oxygen species (ROS). In contrast, intrinsic aging is associated with the

body's natural biological timeline and involves programmed aging and cellular senescence, largely due to internal oxidative stress and accumulated cellular damage [4].

Prolonged exposure to ultraviolet (UV) radiation and cigarette smoke can independently accelerate the aging of the skin. UV exposure generates reactive oxygen species (ROS), leading to damaging oxidative stress. Since oxygen ($O_2$) can easily accept electrons, it forms highly reactive chemical species known as ROS. When the skin encounters photoaging factors, it produces ROS, which in turn activate dermal enzymes such as chemical species known as ROS. When the skin encounters photoaging factors, it produces ROS, which in turn activate dermal enzymes such as

collagenase and elastase. These enzymes contribute to premature skin aging by breaking down collagen and elastin, key structural proteins. The visible effects of this degradation include the formation of deep wrinkles, pronounced skin atrophy, freckles, sallowness, skin laxity, and a coarse, leathery texture [4].

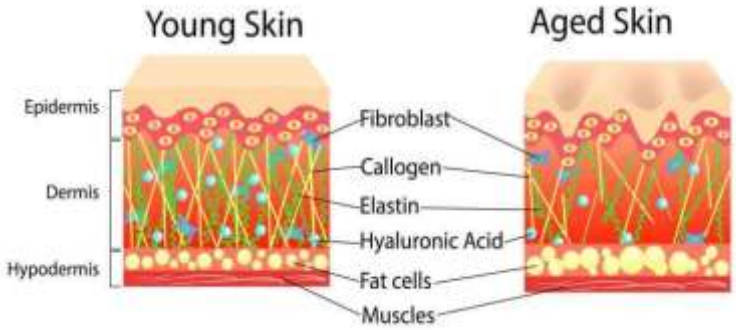



**Fig. 1 Difference between Young skin and aged skin**

**Need of herbal ingredients over synthetic chemicals:**

In today's world, the use of cosmetics has significantly increased, and many skincare, haircare, face-care, nailcare, and fragrance products contain chemicals that are known to cause adverse reactions. Common ingredients such as parabens, formaldehyde, sodium lauryl sulfate, and phthalates in skincare products; sulfates, isopropyl alcohol, and silicones in haircare items; lead, triclosan, and hydroquinone in face-care products; and dibutyl phthalate, toluene, and formaldehyde in nailcare formulations, along with acetone, benzaldehyde, and methylene chloride in fragrances, have been associated with conditions like contact dermatitis and allergic reactions [5]. In the quest for natural alternatives to address aging, traditional herbal medicine has gained attention as a promising solution. Historically celebrated for their roles in enhancing vitality and longevity, herbs are now being increasingly validated by modern scientific research for their anti-aging potential [4].

*Punica granatum* (PG) or pomegranate has been extensively studied for its numerous positive effects on overall skin health. Due to the high concentration of polyphenolic compounds, phenolic acids, anthocyanins, and flavonoids as potent antioxidants [6].

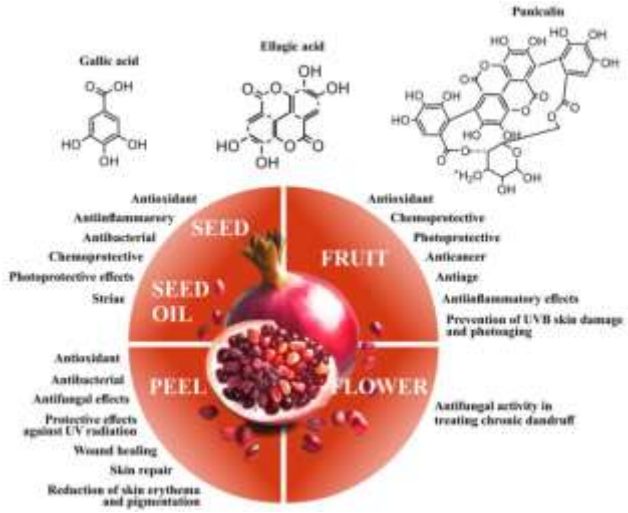



**Fig. 2 Bio actives of various parts of Pomegranate and their activity**

From ancient times, PG has been used for treating skin inflammation in the Middle East, India and Iran. Ayurvedic medicine uses different parts of PG to nourish and to restore the balance of the skin. PG has demonstrated healthy skin (preventing UV-induced photoaging and skin cancer, preventing chrono-aging, improving wrinkle appearance, etc.). PG fruit extract also prevented the UVB-induced reduction in glutathione levels and tissue inhibitor metalloproteinase 1 levels and the UVB-mediated increase in lipid peroxidase and matrix metalloproteinase protein expression. In addition, PG fruit

extract induced the inhibition of UVB-mediated phosphorylation of c-jun and mitogen-activated protein kinases. The outcomes of this investigation indicate that PG fruit extract confers protective effects against UVB-induced oxidative stress and markers associated with photoaging [6].

*Tagetes erecta L.*, commonly referred to as marigold, is a popular garden plant recognized for its medicinal properties, particularly its anti-inflammatory, analgesic, and anti-edematous effects. These attributes make it highly valuable in phytotherapy, dermatological treatments, and cosmetic formulations [7].


**Fig. 3 Antioxidant potential of lutein dyed fabric cloth against UV radiation**

Research has demonstrated that marigold essential oil acts as an effective free radical scavenger, while its ethanol extract shows efficacy against parakeratosis. Thanks to its rich polyphenol content, marigold extract promotes collagen synthesis and helps prevent collagen breakdown in human dermal fibroblasts. These benefits suggest that marigold extract may protect skin from photoaging by inhibiting MMP expression and/or activity and stimulating collagen production, supporting its potential as a significant anti-aging agent for the skin [7].

**Melting Serum Candle Format- Aromatherapy and enhanced delivery**

The introduction of serum candles and hot-melt serum pools provides innovative methods for delivering skincare treatments while offering therapeutic effects and a sense of luxury. Unlike regular candles, a serum candle melts into a warm, nourishing serum that can be directly massaged into the skin. The gentle heat helps soften the skin, enhancing the penetration of active ingredients and allowing a gradual release during application. Similarly, hot-melt serum pools maintain a continuous warmth to keep serums in liquid form, facilitating efficient microcirculation through local vasodilation and smoothing the skin layers, which can improve the absorption of cosmeceutical or therapeutic compounds. These formulations are typically rich in ingredients compatible with natural skin oils, such as lipophilic molecules and essential oils, enhancing absorption while delivering therapeutic benefits and pleasing aromas.

As the wax burns, it steadily releases aromatic vapors into the air, providing an additional inhalation therapy. Common essential oils used in aromatherapy candles include rose, lavender, and neroli, among others. Lighting such candles offers an excellent way to unwind, as the aromatic oils create a soothing and calming atmosphere [8]. Wax serves as an ideal aromatherapy medium due to its high melting point, its ability to encapsulate aromas efficiently, and its clean combustion without producing harmful toxins [9]. A cocoa butter candle infused with pomegranate and marigold extract serum, therefore, offers multiple advantages- supporting skin health, enhancing relaxation, and delivering a luxurious experience.

## 2. General Composition

 **Pomegranate**: The peel of pomegranate contains ellagic acid, a potent antioxidant that offers photoprotective benefits. It also helps reduce skin inflammation and improves skin elasticity by leveraging its lipid structure and enhancing collagen synthesis.

 **Marigold**: Rich in lutein, a carotenoid found in its petals, marigold acts as a photoprotective agent, alleviates oxidative stress, and supports skin firmness and flexibility.

 **Cocoa Butter**: Known for its moisturizing properties, cocoa butter helps diminish wrinkles and combats free radical damage.

**Excipients:**

**Table 1: Excipients profile**

| Sr. No | Ingredients | Category |
|---|---|---|

| | | |
|---|---|---|
| **1** | Carbopol | Thickening agent |
| **2** | Glycerin | Penetration enhancer |
| **3** | Tween 80 | Preservative |
| **4** | Triethanolamine | Emulsifier/ pH adjuster |
| **5** | Lemon oil | Fragrance |
| **6** | Distilled Water | Vehicle |
| **7** | Cocoa butter | Nourishing agent |
| **8** | Soya wax | Consistency agent |

## 3. Materials

PlantExtracts:

Pomegranate (*Punica granatum* L.) extract and marigold (*Tagetes erecta* L.) extract were procured from Shamantak Enterprises, Pune, Maharashtra, India. Both extracts were supplied with a Certificate of Analysis (CoA) and were prepared using a standardized extraction processes.

Excipients:

The excipients used in the formulation, including Carbopol, glycerin, Tween 80, triethanolamine, cocoa butter, and soy wax, were of analytical grade. All excipients were handled and stored according to standard laboratory procedures to ensure their quality and suitability for cosmetic formulations.

## 4. Methodology

**Formulation of serum base:**

Procedure: Carbopol was dispersed in water and allowed to hydrate by keeping overnight. Triethanolamine was added at last for desired consistency after adding remaining ingredients given in the table one by one [10].

**Table 2: Serum base trial batches**

| **Sr. No.** | **Ingredients** | **F1** | **F2** | **F3 (optimised batch)** |
|---|---|---|---|---|
| **1** | Carbopol | 0.3 % | 0.16% | 2% |
| **2** | Glycerin | 7 % | 7% | 7% |
| **3** | Tween 80 | 2% | 2% | 2% |
| **4** | Vitamin E | 1% | 1% | 0.4% |
| **5** | Triethanolamine | 0.3% | 0.3% | 0.4% |
| **6** | Lemon oil | 0.3% | 0.3% | 0.3% |
| **7** | Distilled water | Qs. 100% | Qs. 100% | Qs. To 100% |
| | | Highly viscous | Low viscosity | Desired consistency |

**Formulation of Extract-Infused Serum:**

Propylene glycol was selected as the solvent for both pomegranate and marigold extract due to its solubilizing and penetration-enhancing properties. The extracts were dissolved in propylene glycol using a hot water bath, maintaining a temperature of 60°C to ensure complete dissolution. The resulting extract solution was then incorporated into the serum base along with benzoic acid as a preservative agent. After mixing, the consistency of the serum was checked to ensure proper formulation texture and stability.

| **Sr. No** | **Ingredients** | **F1** | **F2** | **F3** | **F4 (optimized batch)** |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **1** | Carbopol | 0.2% | 0.25 % | 0.275 % | 0.30 % |
| **2** | Triethanolamine | 0.4% | 0.4 % | 0.4 % | 0.4 % |
| **3** | Glycerin | 7% | 7 % | 7 % | 7 % |
| **4** | Vitamin E | 0.5 % | 0.5 % | 0.5 % | 0.5 % |
| **5** | Tween 80 | 2 % | 2 % | 2 % | 2 % |
| **6** | Lemon oil | 0.3 % | 0.3 % | 0.3 % | 0.3 % |
| **7** | Benzoic acid | 0.1 % | 0.1 % | 0.1 % | 0.1 % |
| **8** | Extract solution | 3 % | 3 % | 4 5 | 4 % |
| **9** | Distilled water | Qs. To 100 % | Qs. To 100 % | Qs. To 100% | Qs. To 100 % |
| | | Watery | Not desired consistency | Not desired consistency | Desired consistency |

**Table 3: Extract-infused serum trial batches**

**Formulation of Extract-Infused Melting Serum Candle:**

The melting serum candle was formulated with a combination of soy wax, cocoa butter, and the previously prepared extract-infused serum. Soy wax and cocoa butter were combined in a clean beaker and gently heated using a water bath until fully melted at a temperature of approximately 70-75°C. Once the wax and cocoa butter mixture had melted, the prepared serum (containing pomegranate extract and marigold extract) was added to the mixture. The serum was added while stirring to ensure even distribution. The final mixture was then poured into molds and allowed to cool and solidify at room temperature, forming the melting serum candle.

**Table 4: Melting serum candle trial batches**

| **Sr. No.** | **Ingredients** | **F1** | **F2** | **F3 (optimized batch)** |
|---|---|---|---|---|
| **1** | Serum | 30 ml | 40 ml | 40 ml |
| **2** | Soy wax | 20 g | 5 g | 10 g |
| **3** | Cocoa Butter | 50 g | 55 g | 50 g |
| | | Greasy | Quick solidification | Desired physical state |

## 5. Evaluation Tests

**Evaluation of herbal extracts:**

### *5.1. Ultra-violet spectrophotometric method*

#### *5.1.1Pomegranate Extract (Ellagic acid)*

Solution of Pomegranate extract (10 µg/ml) was in concentration range of 10 to 50µg/ml were prepared with methanol. UV absorbance of Ellagic Acid (EA) was measured using a UV spectrophotometer (Jasco V-730) at 255 nm using 1 cm quartz cuvette [11]. The absorbance of resulting solutions was measured at 255 nm against methanol as blank.

5.1.2 Marigold extract (Lutein)

Solution of Marigold extract (10 µg/ml) was in concentration range of 10 to 50µg/ml were prepared with n-hexane. UV absorbance of Lutein was measured using a UV spectrophotometer (Jasco V-730) at 444 nm using 1 cm quartz cuvette. The absorbance of resulting solutions was measured at 444 nm against n-hexane as blank.

### *5.2. Fourier Transform Infrared Spectroscopy (FT-IR)*

5.2.1 Identification of ellagic acid by Fourier transforms Infrared spectroscopy (FT-IR)

To identify the functional groups of the active compound, an infrared spectroscopy using FT-IR (Shimadzu UV-1780) was performed in the infrared field region. The extract of Ellagic Acid (1–2 mg) was ground to a powder with mortar and mixed with KBr (3–4 mg) [12].

5.2.2 Identification of Lutein by Fourier transforms Infrared spectroscopy (FT-IR)

To identify the functional groups of the active compound, an infrared spectroscopy using FT-IR (Shimadzu UV-1780) was performed in the infrared field region. The extract of Lutein (1–2 mg) was ground to a powder with mortar and mixed with KBr (3–4 mg).

### *5. 3. Phytochemical screening*

Some important types of phytochemicals include alkaloids, flavonoids, phenolics, tannins, saponins, steroids, glycosides, and terpenes were screened using various phytochemical tests.

**Evaluation of serum:**

### *5.4. Physical Evaluation*

The colour and appearance of the formulation was observed visually. The formulation produces uniform distribution of extracts. This test was confirmed by visual appearance and by touch [16].

### *5.5. pH Value*

A pH meter (Auto digital pH meter Labtronics LT-11) was calibrated using a standard buffer solution. Nearly 1 ml of the face serum was properly weighed and dissolve in 50 ml of distilled water and finally its pH was calculated. The skin has an acidic range and the pH of the skin serum should be in the range of 4.1-6.7 [16].

### *5.6. Rheological studies*

Viscosity of the formulation was determined by Brookfield Viscometer (DV- II + Pro) at 50rpm, using spindle number 4. The formulation **F3** was optimized as it produced the desired viscosity and texture, which aligned with the intended characteristics of serum while formulation **F4** for extract infused serum. 100 ml of the serum was taken in a beaker and the spindle was dipped in it for about 5 minutes and then the readings were taken.

### *5.7. Spreadability*

Spreadability refers to the ability of the serum to distribute over a surface area when applied to the skin or a target site. To mimic the characteristics of human skin, Fisher brand filter paper was selected due to its consistent weight across sheets of the same type and size. A Becton Dickinson & Co. 5 mL latex syringe, with the needle removed, was utilized for dispensing the serum, producing highly uniform drops, each weighing approximately 0.03 grams. Standard aluminum foil was used as a base during testing to support the filter paper.

Testing Procedure:

a. Place a clean, larger-than-filter-paper sheet of aluminum foil on a leveled laboratory surface.

b. Select either P5 or P2 filter paper, accurately weigh it, and record this initial weight as W1.

c. Measure the total area of the filter paper and label this measurement as A1.

d. Carefully center the filter paper on the aluminum foil without bending or folding it to avoid uneven spreading.

e. Fill the B-D syringe with the serum formulation under evaluation.

f. Dispense precisely 20 drops onto the center of the filter paper.

g. Start a timer as soon as the 20th drop makes contact with the paper, allowing the liquid to spread for exactly 10 minutes.

h. After 10 minutes, remove the filter paper and carefully cut out the saturated section along the visible spread line using scissors or a single-edged razor blade for greater accuracy.

i. Weigh the remaining dry portion of the filter paper and record this weight as W2.

j. Measure the diameter of the saturated area; if the spread isn't perfectly circular, take several measurements and calculate the average diameter. Record this as A2.

Calculation of Percent Spread by Area:

The percentage spread can be calculated using the formula:

% Spread by Area = (A2 / A1) × 100 [17].

### *5.8. Cyclical Temperature Test*

This test does not adhere to fixed temperature and humidity settings. Instead, the formulation was subjected to daily cyclic temperature variations, alternating between room temperature and freezing conditions, to assess any changes in stability or characteristics [16].

### *5.9.MicrobialContaminationAnalysis*

The presence of microbial contamination within the formulation was evaluated using the agar dilution method. This technique enables even distribution of the inoculum and provides a clear visual representation of microbial growth [18].

### *5.10. DPPH radical scavenging activity*

The antiradical activity against DPPH was assessed with minor adjustments to sample preparation and reaction volume [19]. Stock solutions of the peel extracts (10 µg/mL) were prepared in methanol. A DPPH solution was also prepared using absolute methanol, and 200 µL of this solution was added to various dilutions of the extract. A positive blank was prepared similarly, replacing the extract with the corresponding solvent. After a 30-minute incubation at 37 °C, absorbance was measured at 517 nm using a UV spectrophotometer. The percentage inhibition of the DPPH radical was calculated using the following formula:

DPPH scavenging activity (%) = $[(A_{blank} - A_{sample}) / A_{blank}] \times 100$

Where, $A_{blank}$ is the absorbance value of the control reaction and $A_{sample}$ is the absorbance value of the extract.

### *5.11. Stability studies*

A critical phase in the development of a pharmaceutical product involves stability testing to ensure its physical and chemical integrity, thereby guaranteeing its safety. Accelerated stability analysis, which involves exposing the formulation to elevated temperatures, is a common predictive method. Stability testing for this formulation was conducted in accordance with ICH guidelines. A short-term accelerated stability study was performed over one month, with samples stored under various conditions: 3–5 ℃, 25 °C with 60% relative humidity, and 40 °C ± 2% with 75% relative humidity. Samples were withdrawn at designated intervals for analysis [17].

**Evaluation of Melting serum candle:**

Re-tests for physical evaluation parameters, such, pH, viscosity, microbial contamination, and spreadability were conducted for the body serum candle, following the same procedures previously used for the serum.

### *5.12. Melting Point Test*

The melted wax was introduced into a capillary tube and refrigerated at a temperature between 4–10 °C for 16 hours. After this cooling period, the capillary tube was secured to a thermometer and placed in a 500 mL beaker containing water up to the halfway mark. The beaker was then gradually heated, and the temperature at which the first drop of wax emerged from the capillary tube was recorded [20].

### *5.13. Burn Time Test*

For the burn time test, the aromatherapy candle sample was ignited, and the duration for which the candle burned was monitored. The burn time refers to the total time interval from when the wick was initially lit until the flame extinguished due to wick burnout. It was calculated by recording the difference between the starting time of ignition and the time the flame naturally went out [20].

### *5.14. Stability studies*

A short-term accelerated stability study was conducted over a one-month period to assess the formulation's stability. Samples were stored under different conditions, including refrigeration at 3–5 °C, ambient conditions at 25 °C with 60% relative humidity, and elevated conditions at 40 °C ± 2 °C with 75% relative humidity. Samples were collected at predetermined intervals for analysis [17].

## 6. Results and Discussions

### *6.1. UV-vis Spectrophotometric method*

#### *6.1.1. Ellagic acid*

The proposed UV method allows rapid and economical quantification of EA. In methanol, EA showed absorbance maximas at wavelength of 255 and 360 nm while it exhibits additional maxima at 276 nm in phosphate buffer pH 7.4 due to the ionization of phenolic hydroxyl group [11]. The Beer's law was obeyed between concentration range of 10-50µg/ml and the equation of line and $R^2$ was found to be y=0.0171x – 0.0486 and 0.9928 respectively.

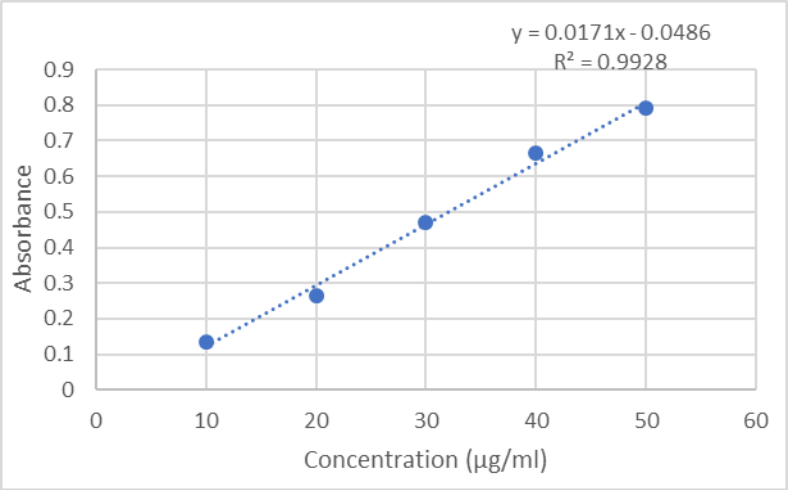



**Fig. 4 Plot of concentration vs absorbance for ellagic acid**

#### *6.1.2 Lutein*

In n-hexane, lutein showed absorbance maxima's at wavelength of 421,444 and 473 nm. The Beer's law was obeyed between concentration range of 10-50µg/ml and the equation of line and $R^2$ was found to be y=0.0174x – 0.0299 and 0.9832 respectively.

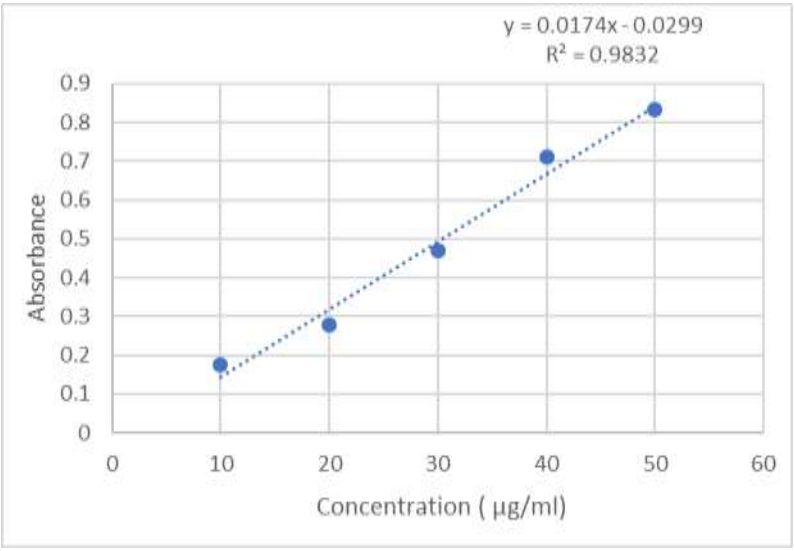


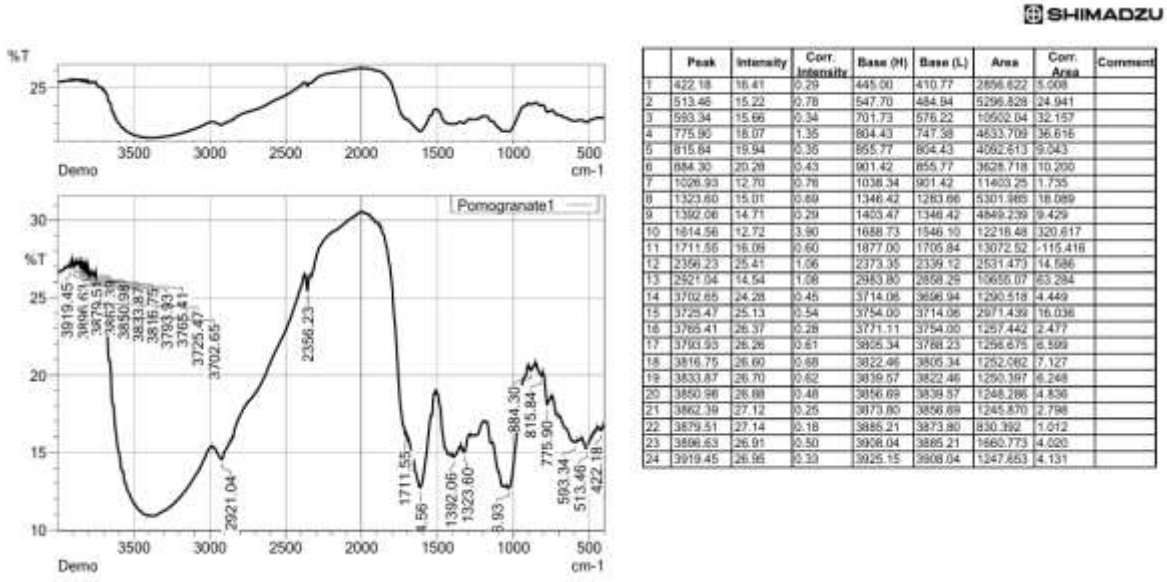

**Fig. 5 Plot of concentration vs absorbance for lutein**

### *6.2. FT-IR Spectroscopy*

#### *6.2.1. Pomegranate Extract*

The FT-IR spectrum of ellagic acid displays a broad absorption band around 3400 $cm^{-1}$, which is attributed to O-H stretching vibrations. Characteristic aromatic ring vibrations are identified at 1614 $cm^{-1}$ and 1392 $cm^{-1}$. Peaks at 1256 $cm^{-1}$ and 1052 $cm^{-1}$ correspond to C-O stretching vibrations associated

with ester linkages. Additionally, the band appearing at 775 $cm^{-1}$ is attributed to aromatic C-H bending. Vibrational bands at 2921 $cm^{-1}$ and 2356 $cm^{-1}$ are related to aromatic C-H stretching [13].

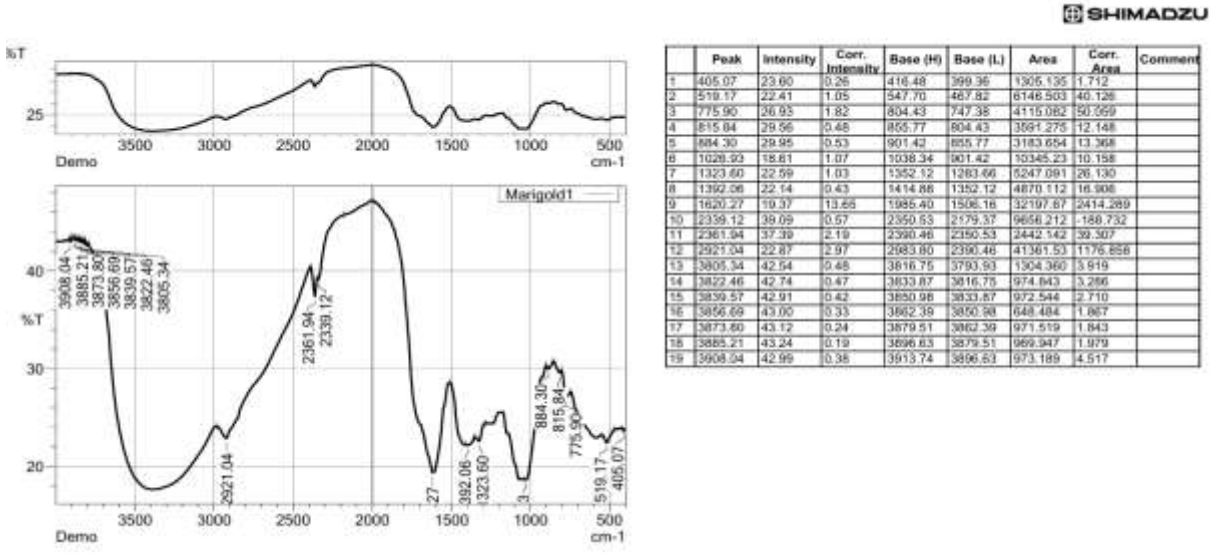



| | Peak | Intensity | Corr. Intensity | Base (H) | Base (L) | Area | Corr. Area | Comment |
|---|---|---|---|---|---|---|---|---|
| 1 | 422.18 | 16.41 | 0.29 | 445.00 | 410.77 | 2856.622 | 5.008 | |
| 2 | 513.46 | 15.22 | 0.78 | 547.70 | 484.94 | 5296.828 | 24.941 | |
| 3 | 593.34 | 15.66 | 0.34 | 701.73 | 576.22 | 10502.04 | 32.157 | |
| 4 | 775.90 | 18.07 | 1.35 | 804.43 | 747.38 | 4833.709 | 36.616 | |
| 5 | 815.84 | 19.94 | 0.35 | 855.77 | 804.43 | 4092.613 | 9.043 | |
| 6 | 884.30 | 20.28 | 0.43 | 901.42 | 855.77 | 3628.718 | 10.200 | |
| 7 | 1026.93 | 12.70 | 0.76 | 1038.34 | 901.42 | 11403.25 | 1.755 | |
| 8 | 1323.60 | 15.01 | 0.69 | 1346.42 | 1283.66 | 5301.985 | 18.089 | |
| 9 | 1392.06 | 14.71 | 0.29 | 1403.47 | 1346.42 | 4849.239 | 9.429 | |
| 10 | 1614.56 | 12.72 | 3.90 | 1688.73 | 1546.10 | 12218.48 | 320.617 | |
| 11 | 1711.55 | 16.09 | 0.60 | 1877.00 | 1705.84 | 13072.52 | -115.416 | |
| 12 | 2356.23 | 25.41 | 1.06 | 2373.35 | 2339.12 | 2531.473 | 14.586 | |
| 13 | 2921.04 | 14.54 | 1.08 | 2983.80 | 2858.29 | 10655.07 | 63.284 | |
| 14 | 3702.65 | 24.28 | 0.45 | 3714.06 | 3696.94 | 1290.518 | 4.449 | |
| 15 | 3725.47 | 25.13 | 0.54 | 3754.00 | 3714.06 | 2971.439 | 16.036 | |
| 16 | 3765.41 | 26.37 | 0.28 | 3771.11 | 3754.00 | 1257.442 | 2.477 | |
| 17 | 3783.93 | 26.26 | 0.61 | 3805.34 | 3788.23 | 1298.675 | 6.599 | |
| 18 | 3816.75 | 26.60 | 0.68 | 3822.46 | 3805.34 | 1252.092 | 7.127 | |
| 19 | 3833.87 | 26.70 | 0.62 | 3839.57 | 3822.46 | 1250.397 | 6.248 | |
| 20 | 3850.98 | 26.88 | 0.48 | 3856.69 | 3839.57 | 1248.286 | 4.836 | |
| 21 | 3862.39 | 27.12 | 0.25 | 3873.80 | 3856.69 | 1245.870 | 2.798 | |
| 22 | 3879.51 | 27.14 | 0.18 | 3888.21 | 3873.80 | 830.392 | 1.012 | |
| 23 | 3896.63 | 26.91 | 0.50 | 3908.04 | 3885.21 | 1660.773 | 4.020 | |
| 24 | 3919.45 | 26.96 | 0.33 | 3925.15 | 3908.04 | 1247.853 | 4.131 | |

**Fig.6 IR spectra of Pomegranate extract**

### *6.2.2. Marigold Extract*

The FT-IR spectrum of lutein reveals a broad band at 3315 $cm^{-1}$, indicative of O-H stretching vibrations. Peaks at 2920 $cm^{-1}$ and 2852 $cm^{-1}$ correspond to asymmetric and symmetric stretching of $CH_2$ and $CH_3$ groups, respectively. The band at 1440 $cm^{-1}$ is associated with $CH_2$ scissoring, while the peak at 1363 $cm^{-1}$ corresponds to splitting of dimethyl groups. A prominent peak at 1026 $cm^{-1}$ is assigned to out-of-plane deformation of trans-conjugated -CH=CH- bonds. The multiple bands between 2800–3000 $cm^{-1}$ represent C-H stretching vibrations, and those within 650–1200 $cm^{-1}$ are related to vibrational modes of C-O, C-C, and C-O-H groups [13].




| | Peak | Intensity | Corr. Intensity | Base (H) | Base (L) | Area | Corr. Area | Comment |
|---|---|---|---|---|---|---|---|---|
| 1 | 405.07 | 23.60 | 0.26 | 416.48 | 399.36 | 1305.135 | 1.712 | |
| 2 | 519.17 | 22.41 | 1.05 | 547.70 | 487.82 | 6146.503 | 40.126 | |
| 3 | 775.90 | 26.93 | 1.82 | 804.43 | 747.38 | 4115.082 | 50.099 | |
| 4 | 815.84 | 29.56 | 0.48 | 855.77 | 804.43 | 3591.275 | 12.148 | |
| 5 | 884.30 | 29.95 | 0.53 | 901.42 | 855.77 | 3183.654 | 13.368 | |
| 6 | 1026.93 | 18.61 | 1.07 | 1038.34 | 901.42 | 10345.23 | 10.158 | |
| 7 | 1323.60 | 22.59 | 1.03 | 1352.12 | 1283.66 | 5247.091 | 26.130 | |
| 8 | 1392.06 | 22.14 | 0.43 | 1414.88 | 1352.12 | 4870.112 | 16.906 | |
| 9 | 1620.27 | 10.37 | 13.65 | 1985.40 | 1506.16 | 32197.87 | 2414.289 | |
| 10 | 2339.12 | 38.09 | 0.57 | 2350.53 | 2179.37 | 9656.212 | -188.732 | |
| 11 | 2361.94 | 37.39 | 2.19 | 2390.46 | 2350.53 | 2442.142 | 39.307 | |
| 12 | 2921.04 | 22.87 | 2.97 | 2983.80 | 2390.46 | 41361.53 | 1176.858 | |
| 13 | 3805.34 | 42.54 | 0.48 | 3816.75 | 3793.93 | 1304.360 | 3.919 | |
| 14 | 3822.46 | 42.74 | 0.47 | 3833.87 | 3816.75 | 974.843 | 3.266 | |
| 15 | 3839.57 | 42.91 | 0.42 | 3850.98 | 3833.87 | 972.544 | 2.710 | |
| 16 | 3856.69 | 43.00 | 0.33 | 3862.39 | 3850.98 | 648.484 | 1.867 | |
| 17 | 3873.80 | 43.12 | 0.24 | 3879.51 | 3862.39 | 971.519 | 1.843 | |
| 18 | 3885.21 | 43.24 | 0.19 | 3896.63 | 3879.51 | 969.947 | 1.979 | |
| 19 | 3908.04 | 42.99 | 0.38 | 3913.74 | 3896.63 | 973.189 | 4.517 | |

**Fig.7 IR Spectra for Marigold Extract**

### *6.3. Phytochemical screening*

Phytochemicals are natural chemical compounds found in plants. They can have both positive and negative effects on health. Medicinal plants, which are used to treat various diseases, are rich in these phytochemicals. The medicinal properties of these plants come from their phytochemical content. Some important types of phytochemicals include alkaloids, flavonoids, phenolics, tannins, saponins, steroids, glycosides, and terpenes. These compounds are found in different parts of the plant [14][15].

**Table 5: Results of phytochemical screening**

| Sr.no | Test | Result | |
|---|---|---|---|
| | | **Pomegranate extract** | **Marigold extract** |
| **1** | Alkaloid | + | + |
| **2** | Flavonoid | + | + |
| **3** | Glycoside | + | + |
| **4** | Phenolic Compounds | + | + |
| **5** | Carbohydrates | + | + |
| **6** | Protein | + | + |
| **7** | Saponin | + | + |

**Serum:**

***6.4. Physical appearance***

Serum formulation was Brownish in color, viscous liquid preparation with a smooth homogeneous texture and glossy appearance. Consistency was found to be good. It is shown in Figure 8.

**Fig. 8 Herbal extract infused serum**

***6.5. pH Value***

The pH of the formulation was found to be 6.06. As the skin is having an acidic pH of around 4.5–6.5, this pH range of the formulation is suitable.

***6.6. Viscosity***

Viscosity is a critical parameter for topical formulation. Topical solutions with low viscosity have faster clearance than viscous solutions. In addition, highly viscous solutions can have an undesirable effect on the skin [16]. The viscosity of the formulation was found to be 546 cps.

***6.7. Spreadabilty***

Spreadability of liquid formulation that is ability of the face serum to spread over the skin and play important role in administration of standard dose of medicament formulation on skin [16]. The percentage spread by area was found to be 51.83%.

***6.8. Cyclical Temperature test***

**Table 6: Results of Cyclical temperature test**

| Sr.no | Parameter | Stability |
|---|---|---|
| **1.** | Freezer temperature | Unstable |
| **2.** | Room temperature | Stable |

### *6.9. Microbial examination of product*

The formulation exhibited no signs of microbial contamination, as indicated by the complete absence of microbial growth on the petri dishes. Additionally, no zones of inhibition were noted around the inoculated areas, suggesting that the formulation does not possess antimicrobial properties that could have otherwise masked contamination. These findings demonstrate that the formulation retains sterility and does not facilitate microbial proliferation under the tested conditions. Such results are crucial, especially for dermocosmetic and pharmaceutical products, as they confirm adherence to sterility standards and ensure user safety [18].

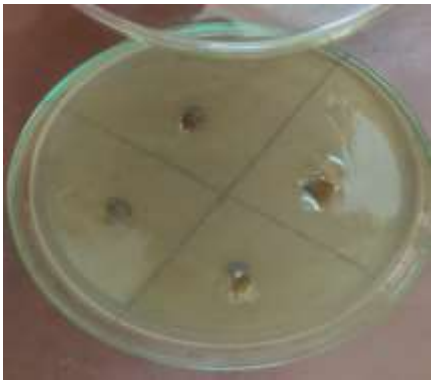


**Fig.9 Microbial examination of product**

### *6.10. DPPH radical scavenging activity of Pomegranate and Marigold extracts*

DPPH is a stable free radical, characterized by its purple color and a distinct absorption peak at 517 nm. When an antioxidant donates an electron or hydrogen atom, DPPH is reduced to 2,2-diphenyl-1-picrylhydrazine, which appears yellow. Due to its sensitivity, the DPPH assay is widely used to detect and measure low concentrations of antioxidant compounds present in various extracts [19].

#### *6.10.1. Pomegranate Extract*

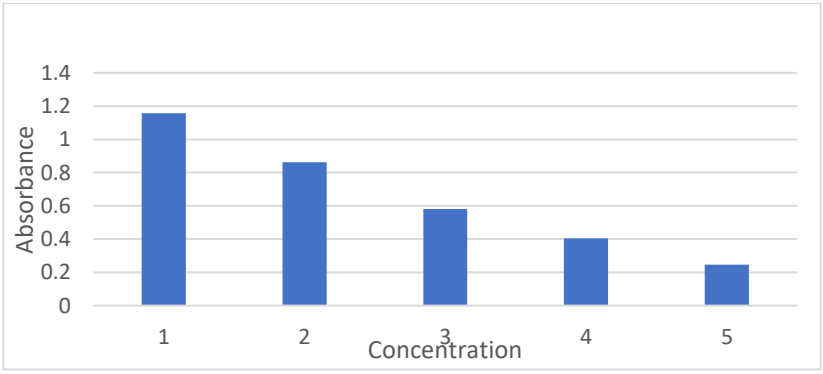



**Fig 10. Plot of concentration vs absorbance**

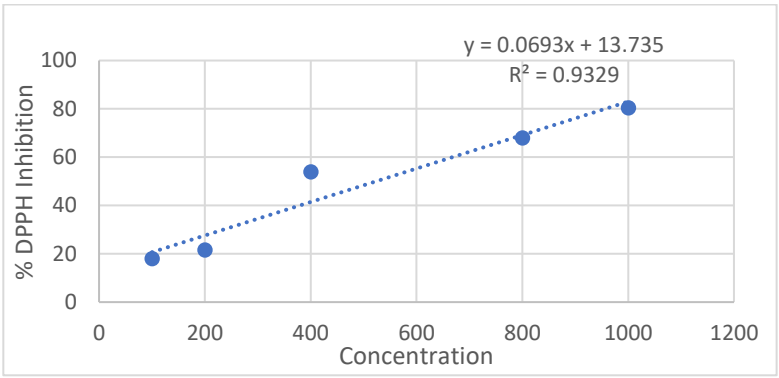



**Fig 11. Plot of concentration vs % DPPH inhibition**

Highest percent inhibition by DPPH is obtained at 80.45%.

***6.10.2. Marigold Extract***

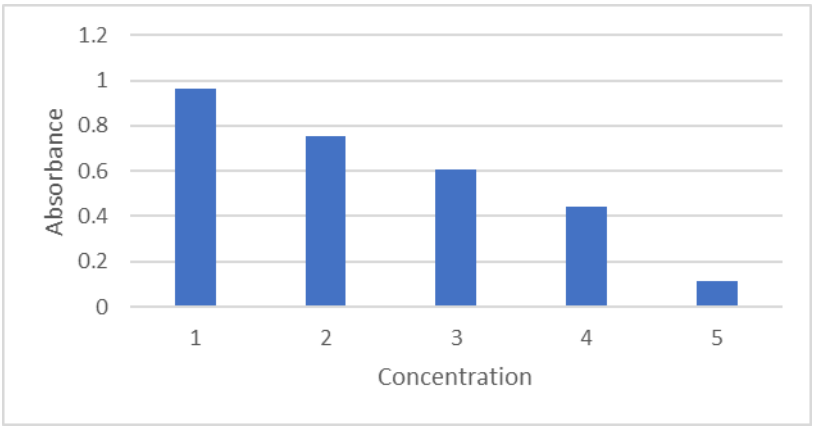



**Fig 12. Plot of concentration vs absorbance**

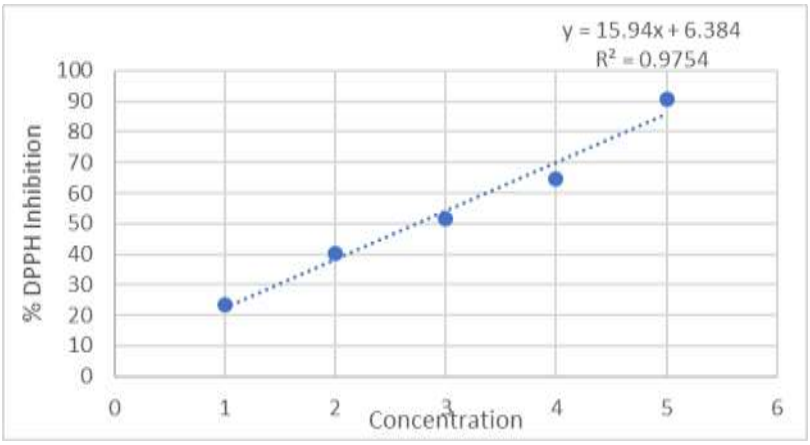



**Fig 13. Plot of concentration vs % DPPH inhibition**

Highest percent inhibition by DPPH is obtained at 90.89%.

***6.11. Stability studies***

**Table 7. Results of stability study of serum formulation**

| **Temperature** | **Evaluation parameters** | **Observation (days)** | | |
|---|---|---|---|---|
| | | 0 | 15 | 30 |
| **3-5ºC** | Visual Appearance | Brown | Brown | Brown |
| | Phase Separation | Nil | Nil | Nil |
| | Homogeneity | Good | Good | Good |
| **Room temperature (25ºC RH=60%)** | Visual Appearance | Brown | Brown | Brown |
| | Separation | Nil | Nil | Nil |

| | | | | |
|---|---|---|---|---|
| | Homogeneity | Good | Good | Good |
| **40ºC±2% RH=75%.** | Visual Appearance | Brown | Brown | Brown |
| | Phase Separation | Nil | Nil | Nil |
| | Homogeneity | Good | Good | Good |

**Body serum candle:**

Physical evaluation of the **F3** body serum candle revealed that it was whitish-brown in color, homogeneous in nature, and glossy in appearance. The product exhibited an aromatic odor, with a pH of approximately 5.94. The spreadability, measured by the percentage of area covered, was found to be 63.76% and the viscosity was found to be 688cps. Additionally, the product was free from microbial contamination.

**Fig 14. Melting serum candle**

### *6.12. Melting Point Test*

This test focused on determining the melting point of the aromatherapy wax, following the standards outlined in SNI 0386-1989-A/SII 0348-1980, which specify that the melting point for wax should fall between 50°C and 58°C [20]. Research findings revealed a melting point of 50°C, aligning well within the acceptable range set by the SNI standard.

### *6.13. Burn Time Test*

Additionally, the burn time test evaluated the duration it takes for the candle to completely burn out, with longer burn times indicating better candle quality [20]. The observed burn time for the tested candles averaged between 6 to 8 hours.

### *6.14. Stability studies of the body serum candle formulation*

**Table 7. Results of stability study of melting serum candle formulation**

| **Temperature** | **Evaluation parameters** | **Observation (days)** | | |
|---|---|---|---|---|
| | | 0 | 15 | 30 |
| **3-5ºC** | Visual Appearance | Whitish Brown | Whitish Brown | Whitish Brown |
| | Phase Separation | Nil | Nil | Nil |
| | Homogeneity | Good | Good | Good |

| | | | | |
|---|---|---|---|---|
| **Room temperature (25ºC RH=60%)** | Visual Appearance | Whitish Brown | Whitish Brown | Whitish Brown |
| | Separation | Nil | Nil | Nil |
| | Homogeneity | Good | Good | Good |
| **40ºC±2% RH=75%.** | Visual Appearance | Whitish Brown | Whitish Brown | Whitish Brown |
| | Phase Separation | Nil | Nil | Nil |
| | Homogeneity | Good | Good | Good |

## 7. Conclusion

The formulated body serum candle, enriched with the powerful natural extracts of pomegranate and marigold, offers a unique dual-function skincare experience by blending therapeutic skin nourishment with the calming ritual of candle use. Pomegranate extract, recognized for its high antioxidant content, aids in promoting skin regeneration, improving elasticity, and shielding the skin from oxidative damage caused by environmental pollutants. Meanwhile, marigold extract, rich in bioactive compounds such as lutein, provides potent anti-inflammatory, soothing, and healing properties, making it particularly beneficial for sensitive, irritated, or stressed skin. This innovative formulation not only supports enhanced hydration, collagen production, and skin barrier repair but also transforms a routine skincare regimen into a luxurious, sensorial self-care ritual. Upon melting, the serum candle releases a warm, aromatic serum that can be massaged into the skin, facilitating deeper absorption of active ingredients due to the mild heat. By combining skin treatment with aromatherapeutic relaxation, the serum candle stands out as a multifunctional cosmeceutical solution that meets the evolving consumer demand for natural, holistic, and experience-driven skincare products. Its potential extends beyond personal use to professional spa and wellness applications, where sensory indulgence and efficacy are both highly valued.

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