

# Formulation Optimization and Characterization of a Natural Wax-Based Solid Perfume Containing Lavender Essential Oil for Aromatherapy Applications

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## ABSTRACT

Solid perfumes based on natural waxes offer a convenient and potentially sustainable alternative to conventional liquid perfumes while providing prolonged fragrance delivery. The present study aimed to develop and optimize a natural wax-based solid perfume containing lavender essential oil for aromatherapy applications. Nine formulations (F1–F9) were prepared using beeswax, candelilla wax, and carnauba wax at concentrations of 10, 15, and 20% w/w. Lavender essential oil (10% w/w), vitamin E (2% w/w), and jojoba oil were incorporated as the fragrance, antioxidant, and oil-phase components, respectively. The prepared formulations were evaluated for organoleptic characteristics, homogeneity, apparent pH, melting/softening behavior, spreadability, hardness, fragrance intensity, fragrance retention, and stability. The formulations were statistically analyzed using one-way ANOVA followed by Tukey's multiple-comparison test. All formulations exhibited acceptable appearance, characteristic lavender odor, and good homogeneity. Increasing wax concentration increased the hardness and melting/softening temperatures while reducing spreadability. The carnauba wax-containing formulations demonstrated comparatively higher structural strength and fragrance retention. Among all formulations, F8 (F\*), containing 15% carnauba wax, 73% jojoba oil, 10% lavender essential oil, and 2% vitamin E, demonstrated a favorable balance of physicochemical and performance characteristics. F8 showed a softening temperature of  $49.3 \pm 0.4^\circ\text{C}$ , melting temperature of  $75.1 \pm 0.4^\circ\text{C}$ , spreadability of  $4.86 \pm 0.09$  cm, hardness of  $2.08 \pm 0.07$  N, and maintained a fragrance intensity score of 2.0 after 12 h, corresponding to 40% fragrance retention. The optimized formulation also demonstrated satisfactory physical stability during the storage period. The findings demonstrated that natural waxes can effectively function as structuring agents for the development of lavender essential oil-based solid perfumes. F8 (F\*) provided an appropriate balance between mechanical strength, spreadability, thermal stability, and prolonged fragrance retention. The developed formulation therefore showed promising potential as a convenient natural solid perfume for aromatherapy-oriented applications.

**Keywords:** Solid perfume, Lavender essential oil, Natural wax, Carnauba wax, Jojoba oil, Fragrance retention, Aromatherapy, Formulation optimization

## INTRODUCTION

The growing demand for natural and convenient personal-care products has encouraged the development of alternative fragrance delivery systems using plant-derived ingredients. Solid perfumes are an attractive alternative to conventional liquid perfumes because their wax-based, anhydrous matrix provides portability, ease of application, and the possibility of modifying the evaporation and retention of volatile fragrance compounds. Essential oils are widely used as natural fragrance materials in aromatherapy because of their characteristic volatile constituents.

Lavender essential oil (*Lavandula angustifolia*) is among the most extensively investigated essential oils and is principally characterized by compounds such as linalool and linalyl acetate. Singh et al. reported linalyl acetate and linalool contents of 39.10% and 29.70%, respectively, in lavender oil cultivated in the Garhwal Himalaya [1]. Variations in the chemical composition of lavender oil according to geographical and processing conditions have also been reported [2]. Clinical investigations and systematic reviews have further suggested potential effects of lavender aro-

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mathotherapy on anxiety-related outcomes [3,4]. However, such findings should not be directly interpreted as evidence of therapeutic efficacy of a newly formulated solid perfume.

The performance of a solid perfume depends substantially on its structuring matrix. Natural waxes are particularly suitable because they provide consistency and can influence hardness, melting behavior, spreadability and the retention or release of volatile compounds. Beeswax, candelilla wax, and carnauba wax differ in their chemical composition and thermal and mechanical characteristics, suggesting that their selection and concentration may substantially affect the properties of an essential-oil-based solid formulation [5–7]. Recent research on wax-based encapsulation has also demonstrated that wax type can influence the retention of aromatic compounds, supporting the importance of wax selection in controlling volatile-material behavior [8].

Several studies have already reported solid perfumes containing essential oils. Paragannavar et al. developed a natural solid perfume containing beeswax, coconut oil, citronella oil, and lemongrass oil [9], while Todkar et al. reported a solid perfume containing beeswax, almond oil, and jasmine, lemon and cedarwood essential oils [10]. Although these studies establish the feasibility of essential-oil-based solid perfumes, there remains a need for systematic comparison of different natural waxes and their concentrations with respect to physicochemical properties, fragrance retention/release, and formulation stability.

Therefore, the present study was designed to investigate the influence of beeswax, candelilla wax, and carnauba wax at different concentrations on the characteristics of a natural solid perfume containing

lavender essential oil. The formulations were evaluated for physical characteristics, hardness/consistency, spreadability, melting or softening behaviour, fragrance retention, and stability. The study aimed to identify an optimized natural wax-based formulation with desirable physical and fragrance-retention properties for potential use as a convenient aromatherapy-oriented fragrance delivery system.

## MATERIALS AND METHODS

### MATERIALS

Beeswax, candelilla wax, carnauba wax, jojoba oil, lavender essential oil and vitamin E were selected as the principal formulation ingredients for the development of natural wax-based solid perfume formulations. Beeswax, candelilla wax and carnauba wax were used as natural structuring and consistency-enhancing agents. Jojoba oil was incorporated as the liquid emollient and oil-phase component, while lavender essential oil served as the fragrance and aromatherapeutic component. Vitamin E was incorporated as an antioxidant to improve the oxidative stability of the oil phase and protect the formulation from rancidity. The three natural waxes were investigated individually at concentrations of 10, 15 and 20% w/w to evaluate their influence on the physical properties, consistency, spreadability, melting/softening behaviour and fragrance retention of the developed solid perfumes. All materials used for formulation development were of suitable pharmaceutical/cosmetic grade. The materials were used as received without further purification.

### METHODS

#### Formulation Design

**Table 1: Composition of Natural Solid Perfume Formulations**

| Ingredients (% w/w)    | F1  | F2  | F3  | F4  | F5  | F6  | F7  | F8  | F9  |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Beeswax                | 10  | 15  | 20  | –   | –   | –   | –   | –   | –   |
| Candelilla wax         | –   | –   | –   | 10  | 15  | 20  | –   | –   | –   |
| Carnauba wax           | –   | –   | –   | –   | –   | –   | 10  | 15  | 20  |
| Jojoba oil             | 78  | 73  | 68  | 78  | 73  | 68  | 78  | 73  | 68  |
| Lavender essential oil | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  |
| Vitamin E              | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   |
| Total                  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 2: For a 20-G Laboratory Batch**

| Ingredient (gm) | F1  | F2  | F3  | F4 | F5 | F6 | F7 | F8 | F9 |
|-----------------|-----|-----|-----|----|----|----|----|----|----|
| Beeswax         | 2.0 | 3.0 | 4.0 | –  | –  | –  | –  | –  | –  |

| <b>Ingredient (gm)</b> | <b>F1</b> | <b>F2</b> | <b>F3</b> | <b>F4</b> | <b>F5</b> | <b>F6</b> | <b>F7</b> | <b>F8</b> | <b>F9</b> |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Candelilla wax         | –         | –         | –         | 2.0       | 3.0       | 4.0       | –         | –         | –         |
| Carnauba wax           | –         | –         | –         | –         | –         | –         | 2.0       | 3.0       | 4.0       |
| Jojoba oil             | 15.6      | 14.6      | 13.6      | 15.6      | 14.6      | 13.6      | 15.6      | 14.6      | 13.6      |
| Lavender essential oil | 2.0       | 2.0       | 2.0       | 2.0       | 2.0       | 2.0       | 2.0       | 2.0       | 2.0       |
| Vitamin E              | 0.4       | 0.4       | 0.4       | 0.4       | 0.4       | 0.4       | 0.4       | 0.4       | 0.4       |
| <b>Total</b>           | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> |

### Preparation of Solid Perfume

The solid perfume formulations were prepared by the fusion method. The required quantities of the respective natural wax, jojoba oil, lavender essential oil, and vitamin E were accurately weighed according to the composition given in Table 2. The weighed wax was transferred into a clean, dry glass beaker and heated gradually on a controlled hot plate/water bath until it was completely melted. After complete melting of the wax, the required quantity of jojoba oil was added gradually with continuous stirring to obtain a uniform wax–oil phase. The mixture was maintained under gentle stirring until complete mixing was achieved. The molten mixture was then removed from direct heating and allowed to cool gradually to a lower temperature before incorporation of the volatile fragrance component. Lavender essential oil (10% w/w) was subsequently added slowly with gentle continuous stirring to ensure its uniform distribution while minimizing loss of volatile constituents. Vitamin E (2% w/w) was then incorporated and the mixture was stirred gently until a homogeneous formulation was obtained [11,12]. The final molten formulation was immediately transferred into clean, dry suitable containers and allowed to cool and solidify at room temperature under undisturbed conditions. After complete solidification, the prepared formulations were visually examined for uniformity, surface appearance, oil separation, and other physical defects. The formulations were subsequently stored in tightly closed containers at controlled room temperature and protected from direct light until further evaluation.

### Evaluation of Formulations

#### Organoleptic Evaluation

The prepared natural wax-based solid perfume formulations (F1–F9) were subjected to organoleptic evaluation to assess their general physical appearance and sensory characteristics. Each formulation was visually examined for appearance, color, surface smoothness, texture, and uniformity. The odor of the

formulations was evaluated by sensory observation to confirm the characteristic lavender fragrance and to detect any undesirable or rancid odor. The texture was assessed manually by gently touching the formulation surface to determine its smoothness, firmness, and ease of application. The observations were recorded immediately after preparation and were subsequently compared among the formulations. Organoleptic evaluation was considered an important preliminary assessment for determining the acceptability and physical quality of the developed solid perfume formulations [13].

#### Homogeneity

The homogeneity of the prepared solid perfume formulations was evaluated by visual examination and manual assessment of the formulation surface. A small quantity of each formulation was examined for uniformity of color, texture, and distribution of the formulation components. The formulations were particularly observed for the presence of visible wax particles, agglomerates, grittiness, oil separation, surface crystallization, or any other evidence of phase separation. The formulations showing a smooth and uniform appearance without visible particulate matter or separation were considered homogeneous. The homogeneity assessment was performed under similar environmental and illumination conditions for all formulations [13].

#### Apparent pH

Since the developed solid perfumes consisted predominantly of waxes and oils and did not contain an aqueous phase, direct pH measurement of the intact formulations was not applicable. Therefore, the apparent pH was determined using an aqueous dispersion of each formulation. A predetermined quantity of the solid perfume was dispersed in distilled water under controlled conditions and allowed to equilibrate. The resulting dispersion was then evaluated using a previously calibrated digital pH meter. The

apparent pH was measured in triplicate, and the results were expressed as mean  $\pm$  standard deviation. The apparent pH values were used as an additional indication of the suitability of the formulations for topical application [14].

### **Melting/Softening Behaviour**

The melting and softening behaviour of the prepared formulations was determined using a suitable melting-point or softening-point apparatus. A representative quantity of each solid perfume formulation was placed in the sample holder and subjected to gradual heating under controlled conditions. The temperature at which the formulation initially began to soften and lose its rigid structure was recorded as the softening temperature, while the temperature corresponding to substantial or complete liquefaction was recorded as the melting temperature. The heating rate and sample quantity were kept consistent for all formulations to allow meaningful comparison. The melting behaviour was evaluated to determine the influence of wax type and concentration on the thermal characteristics and physical stability of the solid perfume formulations [15].

### **Spreadability**

The spreadability of the solid perfume formulations was evaluated to determine their ease of application onto the skin. A predetermined quantity of each formulation was placed on a clean glass surface and allowed to equilibrate at room temperature. The formulation was then spread using a standardized procedure, and the extent of spreading was measured after application of a predetermined load or force. The spreading behavior was assessed in terms of the distance or area covered by the formulation under standardized conditions. Formulations exhibiting adequate spreadability were considered more suitable for convenient topical application, whereas formulations with very low spreadability were considered excessively firm. The spreadability measurements were performed in triplicate and expressed as mean  $\pm$  standard deviation [16].

### **Hardness/Consistency**

The hardness or consistency of the prepared solid perfume formulations was determined using a suitable texture analyzer or hardness-testing apparatus. Each formulation was allowed to equilibrate at room temperature before analysis. A standardized probe was

applied to the surface of the formulation under controlled experimental conditions, and the force required to penetrate or deform the formulation was recorded. The measured hardness values were used to assess the effect of wax type and concentration on the mechanical strength of the formulations. Adequate hardness was considered desirable to maintain the integrity of the solid perfume during handling and storage, while excessive hardness could adversely affect its ease of application. The measurements were carried out in triplicate and reported as mean  $\pm$  standard deviation [17].

### **Fragrance Intensity**

The fragrance intensity of the prepared formulations was evaluated to determine the strength and persistence of the lavender aroma following application. A standardized quantity of each formulation was applied to a defined area of a suitable substrate or skin surface, and the intensity of the fragrance was evaluated at predetermined time intervals. A sensory scoring scale ranging from 0 to 5 was used, where 0 represented no detectable fragrance, 1 represented very weak fragrance, 2 represented weak fragrance, 3 represented moderate fragrance, 4 represented strong fragrance, and 5 represented very strong fragrance. The same evaluation conditions and scoring criteria were maintained for all formulations. The fragrance intensity observations were used to compare the ability of different wax bases to retain and gradually release the volatile constituents of lavender essential oil [18].

### **Fragrance Retention/Release Study**

The fragrance retention of the prepared solid perfume formulations was evaluated by applying a fixed quantity of each formulation onto a standardized surface. The lavender fragrance intensity was assessed immediately after application and at predetermined intervals of 0, 1, 2, 4, 6, 8, and 12 h using a 0–5 sensory scoring scale. The percentage fragrance retention was calculated by comparing the fragrance intensity at each time point with the initial intensity. The formulation showing prolonged fragrance intensity and higher fragrance retention was considered superior [19,20].

### **Stability Study**

The prepared formulations were subjected to stability evaluation by storing them in tightly closed containers under controlled conditions for 3 months. Samples

were evaluated at 0, 1, 2, and 3 months for changes in appearance, color, odor, texture, homogeneity, melting/softening behavior, hardness, spreadability, and fragrance intensity. The observations obtained during storage were compared with the initial characteristics to determine the physical stability and fragrance-retention ability of the formulations. All applicable measurements were performed in triplicate and expressed as mean  $\pm$  SD [21,22].

### Statistical Analysis

All experimental measurements were performed in triplicate and the results were expressed as mean  $\pm$  standard deviation (SD). The data obtained for the different formulations (F1–F9) were statistically analysed using one-way analysis of variance (ANOVA) followed by Tukey's multiple comparison test. A value of  $p < 0.05$  was considered statistically significant.

## RESULTS AND DISCUSSION

### Organoleptic Characteristics

The prepared natural wax-based solid perfume formulations (F1–F9) were evaluated for appearance, colour, odour, texture and homogeneity. All formulations exhibited a smooth and compact appearance with a characteristic lavender odour and acceptable physical characteristics. No visible phase separation, oil exudation, cracking, or major surface defects were observed immediately after preparation. The formulations containing beeswax showed comparatively softer and more pliable textures, whereas candelilla wax produced firmer preparations. The carnauba wax-containing formulations demonstrated comparatively greater firmness with increasing wax concentration. Among all formulations, F8 exhibited a smooth, uniform appearance with suitable firmness and a pleasant characteristic lavender fragrance, indicating satisfactory overall organoleptic properties.

**Table 3: Organoleptic Characteristics of Formulations F1–F9**

| Formulation | Appearance      | Colour        | Odour             | Texture         | Homogeneity |
|-------------|-----------------|---------------|-------------------|-----------------|-------------|
| F1          | Smooth, compact | Pale yellow   | Pleasant lavender | Soft            | Good        |
| F2          | Smooth, compact | Pale yellow   | Pleasant lavender | Moderately soft | Good        |
| F3          | Smooth, compact | Pale yellow   | Pleasant lavender | Firm            | Good        |
| F4          | Smooth, compact | Creamy yellow | Pleasant lavender | Moderately firm | Good        |
| F5          | Smooth, compact | Creamy yellow | Pleasant lavender | Firm            | Good        |
| F6          | Smooth, compact | Creamy yellow | Pleasant lavender | Very firm       | Good        |
| F7          | Smooth, compact | Light yellow  | Pleasant lavender | Firm            | Good        |
| F8          | Smooth, compact | Light yellow  | Pleasant lavender | Moderately firm | Good        |
| F9          | Smooth, compact | Light yellow  | Pleasant lavender | Very firm       | Good        |

The differences in texture among the formulations were primarily attributed to variations in wax concentration and the structural characteristics of the individual waxes. Increasing wax concentration increased the rigidity of the formulations, while the comparatively lower wax concentration in F8 provided adequate firmness without excessive hardness. Thus, F8 demonstrated the most desirable organoleptic balance for topical application.

### Homogeneity and Apparent pH

All prepared formulations demonstrated good homogeneity, with no visible wax aggregates, particulate matter, oil separation or phase separation. The apparent pH values of the aqueous dispersions remained within a narrow range across all formulations. The narrow variation in apparent pH indicated that wax

type and concentration had no substantial influence on this parameter. The apparent pH of F8 was  $5.74 \pm 0.03$ , which was considered suitable for a topical preparation. The good homogeneity of F8 further indicated uniform distribution of the formulation components within the wax-oil matrix.

### Melting/Softening Behaviour

The melting and softening characteristics of the formulations varied according to wax type and concentration. Increasing the concentration of the natural wax resulted in an increase in both softening and melting temperatures. The higher thermal values observed with increasing wax concentration were attributed to the formation of a stronger and more organized wax matrix. Carnauba wax-containing formulations demonstrated comparatively higher

thermal resistance. F8 exhibited a softening temperature of  $49.3 \pm 0.4^{\circ}\text{C}$  and melting temperature of  $75.1 \pm 0.4^{\circ}\text{C}$ , indicating adequate thermal stability while avoiding the excessive rigidity associated with F9. The thermal behaviour of F8 was therefore considered favourable for a solid perfume intended to remain stable during normal handling and storage while still permitting application to the skin.

### Spreadability

The spreadability of the formulations decreased with increasing wax concentration. The lower wax concentrations produced softer formulations that spread more readily, whereas higher wax concentrations produced progressively firmer formulations. The spreadability results indicated that the structural rigidity of the formulation increased with increasing wax concentration. F1 exhibited the highest spreadability, whereas F9 exhibited the lowest. F8 showed a spreadability of  $4.86 \pm 0.09$  cm, which represented an appropriate balance between ease of application and structural integrity. Although F9 demonstrated greater hardness, its lower spreadability could negatively affect application. In comparison, F8 provided adequate firmness while maintaining satisfactory

spreading behavior. Therefore, F8 was considered superior in terms of application characteristics.

### Hardness/Consistency

The hardness of the formulations increased progressively with increasing wax concentration. The beeswax formulations exhibited comparatively lower hardness, whereas candelilla and carnauba wax produced firmer preparations. F8 exhibited a hardness of  $2.08 \pm 0.07$  N, indicating sufficient mechanical strength to maintain its shape during handling without becoming excessively hard. The lower hardness of F1–F2 could potentially result in deformation during handling, whereas the higher hardness observed for F9 could reduce ease of application. The intermediate hardness of F8 was therefore considered desirable because the formulation retained adequate structural integrity while remaining sufficiently soft for convenient topical application. This balance contributed to the selection of F8 as the optimized formulation.

**Table 4: Evaluation of Different Parameters for Formulations F1–F9**

| Formulation | Homogeneity | Apparent pH     | Softening temperature ( $^{\circ}\text{C}$ ) | Melting temperature ( $^{\circ}\text{C}$ ) | Spreadability (cm) | Hardness (N)    |
|-------------|-------------|-----------------|----------------------------------------------|--------------------------------------------|--------------------|-----------------|
| F1          | Good        | $5.72 \pm 0.05$ | $39.8 \pm 0.5$                               | $61.4 \pm 0.6$                             | $5.82 \pm 0.12$    | $1.18 \pm 0.05$ |
| F2          | Good        | $5.75 \pm 0.04$ | $42.6 \pm 0.4$                               | $63.8 \pm 0.5$                             | $5.36 \pm 0.10$    | $1.46 \pm 0.06$ |
| F3          | Good        | $5.78 \pm 0.05$ | $45.7 \pm 0.5$                               | $66.2 \pm 0.4$                             | $4.91 \pm 0.11$    | $1.82 \pm 0.07$ |
| F4          | Good        | $5.69 \pm 0.06$ | $43.2 \pm 0.4$                               | $67.8 \pm 0.5$                             | $5.48 \pm 0.12$    | $1.52 \pm 0.05$ |
| F5          | Good        | $5.73 \pm 0.05$ | $46.8 \pm 0.5$                               | $70.4 \pm 0.6$                             | $5.02 \pm 0.11$    | $1.86 \pm 0.06$ |
| F6          | Good        | $5.76 \pm 0.04$ | $49.7 \pm 0.4$                               | $73.1 \pm 0.5$                             | $4.57 \pm 0.10$    | $2.24 \pm 0.08$ |
| F7          | Good        | $5.71 \pm 0.05$ | $46.5 \pm 0.5$                               | $72.4 \pm 0.5$                             | $5.21 \pm 0.11$    | $1.78 \pm 0.06$ |
| F8          | Good        | $5.74 \pm 0.03$ | $49.3 \pm 0.4$                               | $75.1 \pm 0.4$                             | $4.86 \pm 0.09$    | $2.08 \pm 0.07$ |
| F9          | Good        | $5.77 \pm 0.05$ | $52.2 \pm 0.5$                               | $77.6 \pm 0.5$                             | $4.31 \pm 0.10$    | $2.52 \pm 0.09$ |

### Fragrance Intensity

All formulations demonstrated strong initial lavender fragrance intensity due to the incorporation of 10% lavender essential oil. A gradual reduction in fragrance intensity was observed with increasing time. The fragrance intensity gradually decreased over the observation period because of the progressive release and evaporation of volatile lavender essential-oil constituents. Formulations containing higher wax

concentrations demonstrated comparatively prolonged fragrance intensity, suggesting that the stronger wax matrix restricted rapid diffusion of volatile constituents. F8 maintained a fragrance intensity score of 2.0 at 12 h, demonstrating prolonged fragrance persistence. Although F9 exhibited a slightly higher intensity at the final time point, its greater hardness and lower spreadability reduced its overall application suitability. Thus, F8 provided a more favourable balance between fragrance persistence and physical performance.

## Fragrance Retention

The fragrance retention results further demonstrated the influence of wax concentration and wax type on the persistence of lavender fragrance.

**Table 5: Evaluation of Fragrance**

| Formulation | Initial intensity | 12 h intensity | Fragrance retention (%) |
|-------------|-------------------|----------------|-------------------------|
| F1          | 5.0               | 0.9            | 18.0                    |
| F2          | 5.0               | 1.1            | 22.0                    |
| F3          | 5.0               | 1.4            | 28.0                    |
| F4          | 5.0               | 1.1            | 22.0                    |
| F5          | 5.0               | 1.5            | 30.0                    |
| F6          | 5.0               | 1.8            | 36.0                    |
| F7          | 5.0               | 1.5            | 30.0                    |
| F8          | 5.0               | 2.0            | 40.0                    |
| F9          | 5.0               | 2.2            | 44.0                    |

The fragrance retention increased with increasing wax concentration. F1 showed the lowest retention, whereas F9 demonstrated the highest retention. This behaviour was attributed to the increased density and rigidity of the wax matrix, which reduced the mobility and evaporation of volatile essential-oil constituents. F8 demonstrated 40.0% fragrance retention after 12 h, indicating satisfactory prolonged-release behaviour. Although F9 exhibited a higher retention value of 44%, its comparatively high hardness and

lower spreadability were less desirable for topical application. Consequently, F8 provided the most appropriate overall balance between fragrance retention and application performance and was retained as the optimized formulation.

## Stability Study

The prepared formulations were evaluated during storage for changes in physical appearance, colour, odour, texture, homogeneity and fragrance characteristics.

**Table 6: Stability Observations of Formulations (F8)**

| Parameter      | Initial  | 1 Month               | 2 Months              | 3 Months              |
|----------------|----------|-----------------------|-----------------------|-----------------------|
| Appearance     | Smooth   | No significant change | No significant change | No significant change |
| Colour         | Stable   | Stable                | Stable                | Stable                |
| Odour          | Lavender | Stable                | Slight decrease       | Slight decrease       |
| Texture        | Uniform  | Stable                | Stable                | Stable                |
| Homogeneity    | Good     | Good                  | Good                  | Good                  |
| Oil separation | Absent   | Absent                | Absent                | Absent                |

The formulations remained physically stable throughout the storage period, with no major changes in appearance, texture, homogeneity, or evidence of oil separation. A slight decrease in fragrance intensity was observed with increasing storage duration, which was attributed to the gradual loss or alteration of volatile essential-oil constituents.

F8 maintained satisfactory physical integrity throughout the stability study, with no visible cracking, sweating, phase separation, or major alteration in texture. The formulation also retained its characteristic lavender odour, although a slight reduction in intensity was observed during prolonged storage. These

findings supported the suitability of F8 as the optimized formulation for further development.

## CONCLUSION

The present study successfully developed and evaluated a natural wax-based solid perfume containing lavender essential oil for potential aromatherapy applications. Nine formulations were prepared using beeswax, candelilla wax, and carnauba wax at different concentrations, and their physicochemical and performance characteristics were systematically evaluated. The results demonstrated that both the type and concentration of natural wax significantly influenced the hardness, thermal behaviour, spreadability

and fragrance-retention characteristics of the formulations. Among the developed formulations, F8 containing 15% carnauba wax, 73% jojoba oil, 10% lavender essential oil and 2% vitamin E, exhibited the most favourable overall characteristics. The optimized formulation showed adequate mechanical strength, satisfactory spreadability, favourable melting/softening behaviour, prolonged lavender fragrance retention, and good physical stability. Although higher wax concentration improved structural strength and fragrance retention, excessive wax content adversely affected spreadability and ease of application. Overall, the findings suggested that F8 provided an appropriate balance between stability, application properties, and sustained fragrance release and could serve as a promising natural solid perfume formulation. Further studies involving instrumental fragrance-release analysis, comprehensive stability evaluation, sensory acceptability, and assessment of aromatherapy-related effects would strengthen the potential of the optimized formulation for future cosmetic and wellness applications.

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