Research Article

Synthetic Fixative in Perfume Formulation: Evaluating Longevity, Stability, and Cost

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Abstract: *This study was conducted to evaluate the effects of fixative on fragrance longevity, pH stability, formulation stability, and cost-effectiveness in perfume formulation. The comparison Ambroxane (synthetic fixative) and a control sample without fixative aimed to determine its role in enhancing perfume performance while maintaining formulation integrity. Experimental analyses included evaporation rate testing, pH measurement, stability assessment, and cost evaluation. The evaporation rate test measured fragrance longevity, while pH analysis was conducted using pH strips and a digital pH meter. Stability testing assessed the physical integrity of formulations under room temperature (27°C), high temperature (50°C), and low temperature (4°C) over 14 days. The cost analysis compared the economic feasibility of Ambroxane in large-scale production. The evaporation rate test showed that Ambroxane had a slower evaporation rate at 0.010 mg/hour, while the control sample evaporated the fastest at 0.017 mg/hour. pH analysis revealed that Ambroxane resulted in a lower pH (7.04), followed by the Control (7.11), with statistical significance confirmed ($p < 0.05$). Stability testing confirmed that both formulations remained clear and homogeneous across all conditions, with no visible phase separation or discoloration. Cost analysis indicated that the Ambroxane formulation (RM 6.61 per 50 mL) was cheaper compared to the control formulation (RM 7.41 per 50 mL). The findings confirm that fixative significantly impacts fragrance longevity, stability, and cost. Ambroxane provided superior longevity and cost-effectiveness, making it suitable for large-scale production, with minimal impact on stability and pH. This study successfully met its objective by providing a comprehensive comparison of fixative material, offering valuable insights for perfumers and manufacturers in selecting Ambroxane as an optimal fixative based on market positioning, cost constraints, and fragrance performance requirements.*

Keywords: Perfume formulation; fixative material; fragrance longevity.

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1. INTRODUCTION

Perfume, recognized as a cosmetic product by the Ministry of Health Malaysia, is a blend of essential oils, fixatives, and solvents used to provide a pleasant scent (Ahmed et al., 2019; PORTAL MyHEALTH, 2019). In Malaysia's hot and humid climate, body odour becomes a common issue, boosting demand for long-lasting fragrances (Department of Information Malaysia, 2016). The fragrance market is growing steadily, with revenue expected to hit USD 0.42 billion by 2027 (Statista Research Department, 2023). Fixatives, natural or synthetic play a key role in slowing down fragrance evaporation and extending scent duration, offering a solution to reduce the overuse of essential oils, which can cause skin irritation or allergic reactions (Sarkic & Stappen, 2018). While branded perfumes are often pricey and local ones overly strong due to high essential oil content, exploring more efficient fixatives like synthetic alternatives could improve scent longevity without compromising skin safety or cost (Bondge et al., 2018). Research also suggests fixative materials, like Sandalwood, significantly affect perfume performance depending on concentration, making their selection crucial in creating stable, pleasant, and long-lasting scents (Al-Bayati, 2016).

2. METHOD & MATERIAL

This study used an experimental research design to compare the performance of a perfume formulation containing Ambroxane, a synthetic fixative, with a control sample that had no fixative. The main goal was to evaluate scent longevity through evaporation rate, pH compatibility with skin, formulation stability, and cost-effectiveness. Both samples were formulated using rambutan and cucumber essential oils, polysorbate-20, dipropylene glycol, distilled water, and ethanol as the main solvent. The Ambroxane and control samples were prepared under identical conditions and stored for 48–72 hours before testing. Evaporation rate was measured by placing 3 mL of each sample in petri dishes inside a hot air oven at 27°C, with weight readings taken every hour over eight hours using an electronic analytical balance (Teixeira et al., 2009). pH was measured using both test strips and a digital pH meter to check for skin-friendliness. To assess physical stability, the samples were stored for 14 days under various temperature conditions; cold (4°C), room temperature (27°C), and hot (50°C) and monitored for any visible changes. A basic cost analysis was also done by comparing ingredient prices and usage per formulation. Data was collected using standard lab tools and analyzed statistically through ANOVA and post-hoc tests to identify significant differences in performance between the two formulations (SPSS ANOVA with Post Hoc Tests - the Ultimate Guide, n.d.).

Table 1. Formulation of Perfume.

Component	Ambroxan Sample (mL)	Control Sample (mL)
Rambutan Essential Oil	1.5	1.75
Cucumber Essential Oil	1.0	1.25
Fixative	0.5 (Ambroxan)	-
Polysorbate-20	3.0	3.0
Dipropylene Glycol	2.5	2.5

Distilled Water	1.5	1.5
95% Denatured Alcohol	40.0	40.0

3. FINDINGS

3.1 Evaporation rate

The results showed that Ambroxane significantly slowed down the rate of perfume evaporation compared to the control sample with no fixative. The mean evaporation rate for Ambroxane was 207.46 mg/hour, while the control had a higher rate of 241.67 mg/hour. The standard deviation was slightly higher for Ambroxane (19.41) than for the control (10.47), indicating more variability in the Ambroxane group. Shapiro-Wilk test results confirmed that both datasets followed a normal distribution ($p > 0.05$), and Levene's test showed that the variances were equal across both groups, justifying the use of ANOVA. A one-way ANOVA revealed a statistically significant difference in evaporation rates between the samples ($p = 0.047$), and a post-hoc Tukey HSD test confirmed that the difference between Ambroxane and control was significant ($p = 0.045$). Visualizations such as box plots and bar charts supported these findings by clearly showing that Ambroxane had the lowest evaporation rate, while the control had the highest, reinforcing the effectiveness of Ambroxane as a synthetic fixative

3.2 pH measurement

The pH of perfume formulations containing Ambroxane and the control (no fixative) was assessed using both pH strips and a digital pH meter. pH strips failed to detect any differences, giving identical readings of 5.00 for both samples, indicating their limited sensitivity. In contrast, the digital pH meter captured more precise variations: Ambroxane had a lower mean pH of 7.04, while the control sample recorded a slightly higher mean of 7.11. Both fixative types showed consistent measurements with low standard deviations (±0.015), and the Shapiro-Wilk test confirmed that the data were normally distributed ($p > 0.05$), making them suitable for parametric analysis. Levene's test showed no significant differences in variance between the two groups ($p > 0.05$), validating the use of ANOVA. The one-way ANOVA revealed a statistically significant difference in pH between the groups ($p < 0.001$), and a follow-up Tukey HSD test confirmed that Ambroxane had a significantly lower pH than the control (mean difference = -0.070, $p = 0.002$), suggesting measurable impact on the pH level of the formulation.

3.3 Stability testing

Stability testing was conducted over 14 days to observe how the perfume samples with Ambroxane and the control held up under different storage conditions; room temperature (27°C), high temperature (50°C), and cold storage (4°C). Throughout the testing period, both the Ambroxane-based and control formulations remained visually stable, showing no signs of phase separation, cloudiness, crystallization, or sedimentation across all temperature conditions. From the initial observation on Day 0 until Day 14, both samples remained clear and homogeneous, indicating that neither the synthetic fixative nor the absence of a fixative led to physical instability. These consistent results suggest that the perfume formulations maintained their integrity under various environmental conditions, including heat and refrigeration, with no adverse effects on their physical appearance or texture.

3.4 Cost analysis

The cost analysis compared a synthetic fixative-based perfume formulation using Ambroxane with a control sample containing no fixative. The Ambroxane formulation included 1.5mL of rambutan and 1.0mL of cucumber essential oils, contributing RM 2.70 and RM 1.80 to the total cost, respectively. Whereas, the control sample contained 1.75mL of rambutan EO and 1.25mL of cucumber EO respectively to compensate for the absence of volume of fixative. The main cost difference came from the addition of Ambroxane, which was used at 0.5 mL and added RM 1.00 to the formulation. The control sample, without any fixative, did not include this additional cost. Other ingredients such as ethanol, distilled water, dipropylene glycol, and polysorbate-20 were used in equal amounts and contributed minimally to the total expense. Overall, the Ambroxane-based formulation cost RM 6.61 per 50 mL batch, while the control sample was slightly cheaper at RM 6.51. The results highlight that incorporating Ambroxane into a perfume formulation increases the cost modestly but remains economical overall.

Table 2. Cost Analysis for Perfume Formulation with Natural and Synthetic Fixative

Ingredient	Price per Unit (RM/mL)	Synthetic fixative sample		Control sample	
		Amount Used (mL)	Total Cost (RM)	Amount Used (mL)	Total Cost (RM)
Rambutan EO	1.80	1.50	2.70	1.75	3.15
Cucumber EO	1.80	1.00	1.80	1.25	2.25
Sandalwood EO	3.80	-	-	-	-
Ambroxan	2.00	0.50	1.00	-	-
Ethanol	0.02	40.00	0.80	40.00	0.80
Distilled Water	0.01	1.50	0.02	1.50	0.02
Dipropylene glycol (DPG)	0.03	2.50	0.08	2.50	0.08
Polysorbate-20	0.07	3.00	0.21	3.00	0.21
TOTAL (RM/50mL)		6.61		6.51	
PRICE (RM/mL)		0.13		0.13	

4. DISCUSSION

The findings from this study clearly show that Ambroxane performs better than the control sample in nearly every aspect tested. As a synthetic fixative, Ambroxane significantly reduced the perfume's evaporation rate, helping the fragrance last longer on the skin which was an effect that was statistically confirmed through ANOVA and post-hoc tests ($p = 0.045$). In terms of pH, Ambroxane also showed a slightly lower but consistent pH value compared to the control, which may suggest better skin compatibility, especially for users sensitive to more alkaline products. Both the Ambroxane and control samples remained physically stable throughout the 14-day testing period, even under varying temperatures, indicating that neither fixative use nor its absence led to formulation breakdown or separation. Cost-wise, although the Ambroxane-based perfume was marginally more expensive (RM 6.61 vs. RM 6.51), it still proved to be a cost-effective fixative considering its improved performance in scent retention and overall formulation stability. These outcomes reinforce Ambroxane's potential as a practical and economical fixative choice for large-scale perfume production without compromising quality.

5. CONCLUSION

In conclusion, this study confirmed that Ambroxane is a highly effective synthetic fixative for perfume formulations, offering clear advantages over a control sample with no fixative. Ambroxane significantly slowed down fragrance evaporation, maintained a stable and slightly more skin-friendly pH, and held up well under various storage conditions without any visible signs of instability. While it added a small increase in formulation cost, the benefits in scent longevity and overall product stability make that extra cost justifiable. Altogether, the results support Ambroxane as a practical, efficient, and cost-effective fixative option that is ideal for scalable perfume production without compromising on quality or user comfort.

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