Tropical Journal of Pharmaceutical Research September 2025; 24 (9): 1087-1094
ISSN: 1596-5996 (print); 1596-9827 (electronic)

Available online at http://www.tjpr.org
https://dx.doi.org/10.4314/tjpr.v24i9.1

Original Research Article

Antibacterial-enhancing efficacy of aloe vera and honey in salicylic acid topical formulations against acne

Tabarek H Mahmood[1], Ghufran H Mahmood[2], Ali Al-Samydai[3]*

[1]Ibn Sina University of Medical and Pharmaceutical Sciences, Baghdad, [2]Department of Pharmaceutics, College of Pharmacy, University of Baghdad, Baghdad, Iraq, [3]Pharmacological and Diagnostic Research Center, Faculty of Pharmacy, Al-Ahliyya Amman University, Amman 19328, Jordan

For correspondence: **Email: a.alsamydai@ammanu.edu.jo; **Tel:** +962 7 8810 6069*

Sent for review: 3 March 2025 *Revised accepted: 18 September 2025*

Abstract

Purpose: *To compare the antibacterial-enhancing efficacy of aloe vera and honey in salicylic acid topical formulations against acne.*

Method: *Six formulations containing 5 % salicylic acid were developed as creams and gels as follows: Formulations S, V and H were creams containing salicylic acid alone (S), salicylic acid with 28 % aloe vera (V), and salicylic acid with 10 % honey (H). Formulations J, M, and B were gels containing salicylic acid alone (J), salicylic acid with aloe vera 20 % (M) and salicylic acid with 12 % honey (B). Each formula was evaluated for colour, odour, pH, viscosity, spreadability, and stability under different temperatures (25, 30, and 60 ºC) and times (1 hour, 1 day, and 1 week). Furthermore, antibacterial activity was determined using the agar well diffusion method against Escherichia coli, Staphylococcus aureus, Enterobacter spp., Pseudomonas spp., Proteus, and Klebsiella spp.*

Results: *The formulations exhibited distinct colours and odours, with pH values ranging from 4 to 6, viscosities between 3813 and 9813 cP, and spreadability from 10 to 45.5 (g*cm/s). Antibacterial activity, measured by inhibition zone diameters, varied from 0.4 to 2.5 cm against different bacterial strains ($p < 0.001$). Creams (S, V, and H) exhibited high selectivity, showing strong activity against Gram-positive bacteria such as S. aureus but limited effectiveness against Gram-negative rods like Proteus. In contrast, gel formulations (J, M, and B) showed a broader and more consistent spectrum of activity. All formulations showed stability for up to one month, even with temperature fluctuations, while maintaining a skin-compatible pH.*

Conclusion: *Formulations containing aloe vera and honey increased the antibacterial activity of salicylic acid, thereby making them suitable adjuvants in anti-acne formulations.*

Keywords: *Anti-acne cream, Salicylic acid, Anti-bacterial cream, Cream formulation, Gel formulation*

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0) and the Budapest Open Access Initiative (http://www.budapestopenaccessinitiative.org/read), which permit unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited.

Tropical Journal of Pharmaceutical Research is indexed by Scopus, Chemical Abstracts, Embase, Index Copernicus, EBSCO, African Index Medicus, JournalSeek, Directory of Open Access Journals (DOAJ), African Journal Online, Bioline International, Open-J-Gate and Pharmacy Abstracts

INTRODUCTION

Acne vulgaris (acne), a condition affecting ~ 9.5 % of humans, is defined as a disorder of the skin in which oil glands and hair glands become inflamed due to several reasons, but mostly due to microbial imbalance on the skin surface [1,2]. Salicylic acid (SA) is one of the most important medications used for acne due to its anti-inflammatory and anti-bacterial effects [3-5]. Physicians used it as a peeling agent because it affects the epidermis by its anti-hyperplastic effect. Topically, SA causes many side effects, including skin dryness, hives, itching and warm skin [6,7].

© 2025 The authors. This work is licensed under the Creative Commons Attribution 4.0 International License

Honey has potent anti-microbial activity against skin microbes [8]. It also has a wound healing property when applied topically for wound infections and decreasing skin layer thickness that occurs due to acne [9]. Aloe vera (AV) is one of the oldest medicinal plants derived from the tropical cactus of the genus *Aloe* from Liliaceae family. Interestingly, AV gel has been used for skin inflammations as an anti-inflammatory agent against microbes like bacteria and viruses that attack the skin [9]. It acts on the skin by various mechanisms such as moisturizing the skin, cell migration, increasing collagen synthesis and reducing inflammation [10-12].

This study aims to improve the anti-bacterial activity of SA against skin inflammation due to acne by making several formulations consisting of SA as an active ingredient and natural products (aloe vera and honey) to potentiate the anti-inflammatory activity. The addition of honey and aloe vera decreases the dryness that occurs due to SA by moisturizing the skin, making it healthier by increasing collagen production [11].

EXPERIMENTAL

Preparation of formulas

At 60 ℃, anti-acne cream for topical application was prepared in three formulas with 5 % salicylic acid as the basic constituent in all formulas (Table 1) [13]. Basically, a cold cream formula was used and it was adjusted to get the right cream by adding salicylic acid as the active for treating acne. Formula S (which contained only salicylic acid as an active ingredient) was prepared by using three beakers. The first beaker contained oily phase bees wax and paraffin, the second one contained distilled water and borax (preservative) as aqueous phase and the third was for salicylic acid and cetostearyl alcohol. The three beakers were placed in a water bath and the temperature increased to 60 ± 2 °C until all ingredients dissolved. Then, the aqueous phase was added to the oily phase, and the last active ingredients (salicylic acid and alcohol) were added with continuous stirring by the mechanical mixer until a homogeneous cream was formed (oil-in-water emulsion cream). Formulas V (containing salicylic acid and aloe vera as active ingredients) and H (containing salicylic acid and honey) were both prepared by the same method using the ingredients shown in Table 1.

Formula J (containing salicylic acid only as active ingredient) gel was prepared by adding the active ingredient, followed by gelling agents (carbopol 940) and the inclusion of triethanolamine, with continuous stirring by the mechanical mixer until a homogeneous transparent mixture appeared. Formulas M and B were also prepared by the same method using the formula in Table 2.

Table 1: Cream formulations (S, V, and H)

Ingredient	Formula S	Formula V	Formula H
Salicylic acid (g)	2.5	2.5	2.5
Fatty alcohol (g)	8.0	8.0	8.0
Paraffin oil (g)	18.0	18.0	18.0
Beeswax (g)	3.0	3.0	3.0
Borax (g)	3.0	3.0	3.0
Water (mL)	15.5	1.5	10.5
Aloe vera (mL)	-	14.0	-
Honey (g)	-	-	5.0

Table 2: Gel formulations (J, M, and B)

Ingredient	Formula J	Formula M	Formula B
Salicylic acid (g)	2.5	2.5	2.5
Fatty alcohol (g)	6.0	6.0	6.0
Carbopol (g)	2.0	2.0	2.0
Triethanolamine	10 drops	10 drops	10 drops
Glycerol (g)	20.0	20.0	20
Water (g)	18.5	9.0	13.0
Aloe vera (g)	-	10.0	-
Honey (g)	-	-	6.0

Physical evaluations and homogeneity

Visual examination of cream and gel samples was done to observe the colour, odour, sensitivity and washability (ease of removal of cream from the skin). A portion (100 mg) of each cream or gel was applied on the skin, checked for ease of removal after one minute of application and the results were recorded as observed. On the other hand, homogeneity was determined by taking 100 mg of the cream or gel and rubbing it on the skin surface, and thereafter checking for the presence of gritty particles, lumps, or non-uniform flakes [14].

Evaluation of pH

The pH of cream and gel was evaluated by using a digital meter (PHS-3E pH meter). The rod was immersed in 50 mg of each formula (S, V, H, J, M, B) to take the readings.

Stability studies

Stability study was performed for creams and gels. For this evaluation, 1 g of all formulas was kept at varying temperatures (7, 25 and 40 °C) for 1 month. All samples were checked at periodic intervals for pH change, drug content and physical appearance (colour, odour, phase separation). The most stable formula was chosen as the optimized one for further tests and studies [15].

Viscosity measurements

Brookfield viscometer (Metro Digital Brookfield DV- III+ ULTRA) was used for viscosity determination of all creams and gels. Briefly, 200 g of each sample was placed in the beaker and fixed on the instrument. Viscosity of each sample was determined by dipping the spindle into each sample and then the spindle was fixed into the instrument. The test was made on the six samples and the readings were recorded [15].

Spreadability

Spreadability test was optimized by using the glass slide method. Two glass slides with standard dimensions were taken and 0.5 g of each cream and gel was placed on one glass slide and covered using the other glass slide. Then, a standard diameter of the spread samples was set. The time set for each sample to reach the marked diameter was recorded. The test was repeated three times and the average reading was recorded. The time in seconds (t) required to separate the two slides was taken as a measure of spreadability (S), calculated as shown in Eq. 1 [16].

$$S = m(L/t) \quad \ldots\ldots\ldots (1)$$

Where m is the weight tied on the upper slide, and L is the length of the glass slide

Antibacterial assay using the agar well diffusion method

The antibacterial assay was used to evaluate the antibacterial activity of both cream and gel against a group of known or diagnosed bacteria (positive and negative strains) using nutrient agar plates. Bacterial strains (*Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacter, Proteus*, and *Klebsiella*) were taken as a swab from patients with acne in dermatological clinic and the antibacterial activities of all six formulas (cream and gel) were tested against each strain. Antibacterial activities of the formulas were tested using the agar well diffusion method on nutrient agar. The inhibition zones were recorded in centimeters (cm). Agar plates were inoculated with known bacterial strains under aseptic conditions and wells (diameter = 0.5 cm) were filled with 30 µL of each sample and incubated at 37 °C for 24 - 48 hours. After the incubation period, diameters of the growth inhibition zones were recorded.

Drug content test

Salicylic acid content in the formulation was assessed by diluting 1 gram of cream and gel (equivalent to 0.005 gram of the drug) in 10 milliliters of ethanol and water and the volume subsequently adjusted to 100 milliliters using phosphate buffer (pH 7.1). Absorbance was recorded at 275 nm with a UV-visible spectrophotometer and the percentage of drug content was calculated. The average of triplicate readings was recorded [13].

Statistical analysis

One-way Analysis of variance (ANOVA) was determined, and a p-value < 0.05 was considered statistically significant, while Tukey's Honestly Significant Difference (HSD) test was used to analyze the data.

RESULTS

Physical examination

Results of visual examination (colour, odour, sensitivity, washability, texture and homogeneity)

of the cream and gel samples are shown in Table 3. Visual inspection showed that all samples were semi-solid with diverse colours. Formula S was white, formula V was light pink, formula H was off-white, J and M formulas were transparent and the B formula was yellowish transparent. In addition, the washability test revealed that all formulas were easy to wash, but formula V was the easiest, although it had the least water content. The odor of all formulas was characteristic, which reflects the formulas' stability, while formulas J and M were of woody odour. All formulations were homogeneous and of good consistency except formulas S and V, which were of very good consistency. Also, all cream formulas (S, V, H) had an oily texture, while gels (J, M, and B) were of a watery texture. The pH of all formulas was maintained near the pH of the skin (4 - 6 pH is ideal for skin) to avoid any irritation on the skin (Table 4).

pH

The pH of all the samples was comparable to the pH of the skin after a defined period (1 hour, 1 day and 1 week; Table 4). At (25, 30, and 60 ^{o}C), sample V was more acidic (4.6 ± 0.4) at different temperatures. The pH of all formulas decreased as the temperature increased. Although the pH was decreased within the time under consideration, it was still within the range (4 - 6) for all formulas.

Viscosity

A digital rotational viscometer was used for viscosity determination of creams and gels and the readings are recorded in Table 5. The result of viscosity determination, tested at 25 ℃, showed that Formula S (cream) was the most viscous formula (9813 cP) while Formula M (gels) was the least viscous (3855 cP). Other formulas were between the two ranges, viz, formula V spreadability was 4500 cp, H formula was 8845 cp, J formula was 3900 cp, while B formula was 4000 cp, as shown in Table 5.

Spreadability

The results of the spreadability tests are reported in Table 6. Formula M (45.5 ± 1.3 S) was more spreadable because it was less viscous than other formulas, while formula ‘H” (10 ± 1.2 S) was the least spreadable as it was the most viscous formula. Furthermore, formula S spreadability was (16.7 ± 1.5 S), formula V (33 ± 1.6 S), formula J (41.6 ± 1 S), and formula ‘B” (35.7 ± 1.2 S), which reflects each formula’s spreadability.

Table 3: Physical characteristics of the creams and gels

Formulation	Appearance	Colour	Washability	Odour	Homogeneity	Consistency	Texture	Sensitivity
S	Semi-solid	White	Easy	Significant	Yes	Very good	Smooth (oily)	No
V	Semi-solid	Light pink	Very easy	Significant	Yes	Good	Smooth (oily)	No
H	Semi-solid	Off-white	Easy	Significant	Yes	Very good	Smooth (oily)	No
J	Semi-solid	Transparent	Easy	Woody	Yes	Good	Smooth (watery)	No
M	Semi-solid	Transparent	Easy	Woody	Yes	Good	Smooth (watery)	No
B	Semi-solid	Yellowish-transparent	Easy	Significant	Yes	Good	Smooth (watery)	No

Table 4: pH stability evaluation of the formulations (mean ± SD)

Formula code	1 h after formulation			1 day after formulation			1 week after formulation		
	25 ℃	*30 ℃*	*60 ℃*	*25 ℃*	*30 ℃*	*60 ℃*	*25 ℃*	*30 ℃*	*60 ℃*
S	6.0±0.2	6.0±0.2	6.0±0.2	5.9±0.2	5.9±0.3	5.8±0.2	5.8±0.2	5.7±0.2	5.7±0.3
V	4.6±0.2	4.5±0.3	4.4±0.2	4.4±0.3	4.3±0.3	4.4±0.2	4.3±0.3	4.2±0.2	4.2±0.2
H	6.0±0.3	5.9±0.3	5.9±0.2	5.8±0.3	5.7±0.2	5.7±0.3	5.6±0.2	5.5±0.2	5.4±0.3
J	5.5±0.3	5.3±0.3	5.1±0.3	5.5±0.3	5.4±0.3	5.2±0.3	5.6±0.3	5.4±0.3	5.2±0.3
M	5.7±0.2	5.6±0.2	5.3±0.2	5.7±0.2	5.5±0.2	5.2±0.2	5.6±0.2	5.4±0.2	5.2±0.2
B	5.2±0.2	5.0±0.2	4.9±0.2	5.2±0.3	5.1±0.3	4.8±0.2	5.1±0.3	4.8±0.3	4.6±0.3

Table 5: Viscosity of cream and gel samples

Formulation code	Temperature (℃)	Viscosity (Cp)
S	25	9813
V	25	4500
H	25	8845
J	25	3900
M	25	3855
B	25	4000

Table 6: Spreadability of cream and gel samples

Formula	Weight tied to upper slide (g)	Length of glassslide moved (cm)	Time taken (sec)	Mean spreadability ± SD
S	250	2	30	16.7±1.5
V	250	2	15	33.0±1.6
H	250	2	50	10.0±1.2
J	250	2	12	41.6±1.0
M	250	2	11	45.5±1.3
B	250	2	14	35.7±1.2

Antibacterial activity

Three semi-solid preparations were tested using the agar well diffusion method on nutrient agar and the inhibition zones are reported in Table 7 and Figure 1. All the formulas were tested for anti-bacterial activity against bacteria that were found in swabs taken from acne patients in a dermatology clinic (*E. coli*, *S. aureus*, *Enterobacterium*, Pseudomonas, Proteus, and Klebsiella bacteria). The results showed that all formulas were highly active against *S. aureus*, *Enterobacterium,* and *Klebsiella* bacteria, and also against other bacteria at different ranges. Formula S gave the highest anti-bacterial activity against *S. aureus* (2.5 ± 0.5 cm), and the least activity against *Proteus* bacteria (0.2 ± 0.3 cm). Also, it showed an activity of 1.0 ± 0.3 cm against *E. coli*, 2 ± 0.3 cm against *Enterobacterium*, 0.4 ± 0.4 cm against *Pseudomonas* and 1.5 ± 0.3 cm against Klebsiella, while formula V showed high activity against *S. aureus* (1.2 ± 0.5 cm) and the least activity against Proteus (0.3 ± 0.3 cm).

In addition, formula V also showed activities of 0.8 ± 0.3 cm, 1.2 ± 0.3 cm, 0.5 ± 0.3 cm and 1.2 ± 0.3 cm against *E. coli, Enterobacterium*, *Pseudomonas* and *Klebsiella*, respectively, while formula H acted highly against *Enterobacterium* (2.0 ± 0.3 cm) with the least activity against *Proteus* (0.4 ± 0.3 cm). Furthermore, formula H also showed activities of 1.5 ± 0.5 cm against *S. aureus*, 0.6 ± 0.3 cm against *E. coli*, 0.7 ± 0.3 cm against *Pseudomonas,* and 1.3 ± 0.3 cm against *Klebsiella*. On the other hand, the antibacterial activities for the gel formulations showed that formula J had the highest activity against *Klebsiella* (1.4 ± 1.0 cm), while the least activity was against *S. aureus* (0.5 ± 0.3 cm). Formula M acted highly against *Pseudomonas* (1.6 ± 1.2 cm), with the least activity against *E. coli* (1.1 ± 1.1 cm). It also acted effectively against other bacteria, including *S. aureus* (1.2 ± 0.4 cm), *Enterobacterium* (1.4 ± 0.2 cm), Proteus (1.3 ± 0.2 cm) and Klebsiella (1.5 ± 1.1 cm). Finally, formula B showed the highest activity against Pseudomonas (1.8 ± 1.1 cm), but the lowest activity was against Proteus (1.2 ± 0.3 cm); all the results are summarized in Table 7.

Table 7: Antibacterial activity Inhibition zone (cm ± SD)

Formula	*S. aureus*	*E. coli*	*Enterobacterium*	*P. auriginosa*	Protius	Klepselia
S	2.5±0.5	1.0±0.3	2.0±0.3	0.4±0.4	0.2±0.1	1.5±0.3
V	1.2±0.5	0.8±0.3	1.2±0.3	0.5±0.3	0.3±0.1	1.2±0.3
H	1.5±0.5	0.6±0.3	2.0±0.3	0.7±0.3	0.4±0.15	1.3±0.3
J	0.5±0.3	0.6±1.0	1.0±0.3	1.2±1.4	1.3±0.2	1.4±1.0
M	1.2±0.4	1.1±1.1	1.4±0.2	1.6±1.2	1.3±0.2	1.5±1.1
B	1.4±0.6	1.5±1.0	1.7±0.5	1.8±1.1	1.2±0.3	1.3±1.2

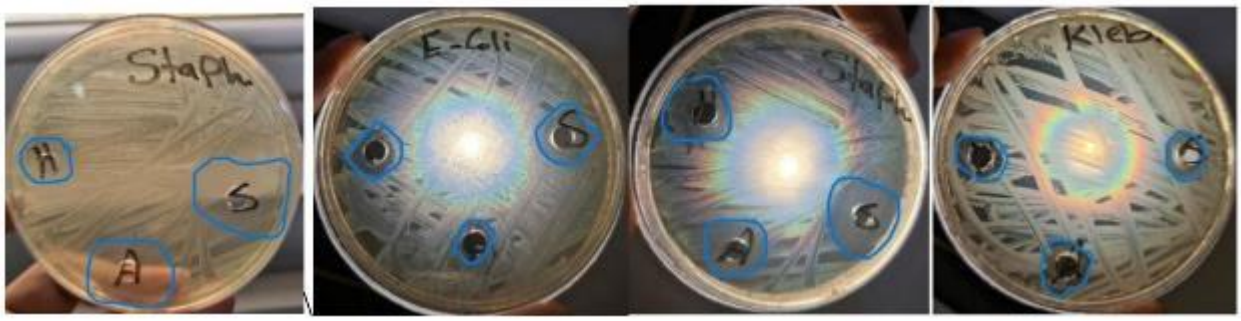

Figure 1: Antibacterial test for the formulas against different bacterial strains

Drug content

From the results shown in Table 8, formula V revealed the highest drug content of 99 % while formulas S, J and M showed drug contents of 98 %, respectively. The least drug content was 96 % for formulas H and B.

Table 8: Drug content in each formula

Formula	Expected amount per 1 g	Actual amount per 1 g	Drug content (%)
S	0.05	0.049	98
V	0.05	0.050	99
H	0.05	0.048	96
J	0.05	0.049	98
M	0.05	0.049	98
B	0.05	0.048	96

DISCUSSION

The rapid emergence of antibacterial resistance, largely attributed to the misuse of antibiotics, has created an urgent need to develop more effective anti-acne products with enhanced antibacterial activity. In recent years, researchers have increasingly turned to natural sources for antimicrobial agents and novel drug candidates to address this growing challenge [16].

The evaluation of the physical examination parameters in the present study demonstrated a high degree of consistency across the tested cream and gel formulations. All developed formulations were semi-solid, homogeneous, and free from sensitivity reactions, suggesting favorable physical stability and an encouraging preliminary safety profile. However, variations were noted in the sensory attributes. Approximately half of the formulations were transparent, while others exhibited off-white, white, light pink, or yellowish-transparent appearances. Odour assessments revealed that two-thirds of the samples presented a strong odour, whereas the remainder exhibited a woody scent. The consistencies were rated equally as good or very good, consistent with findings reported by Shital *et al* and Aditi *et al* in formulations containing salicylic acid [17,18]. Textures were also variable, described as either smooth-oily or smooth-watery, aligning with prior observations in comparable studies [17]. Washability was generally favorable, with one formulation being particularly easy to remove.

The pH values of all formulations were maintained within the physiologically compatible range (4 – 6), which is crucial to minimize the risk of skin irritation. Repeated-measures ANOVA indicated that both temperature and storage duration significantly influenced pH stability, whereas their interaction did not. This suggests that while both factors independently contribute to pH decline, their combined effect is not synergistic. Formulation V consistently exhibited the lowest pH (~4.6 ± 0.4), making it slightly more acidic than the others, yet still within the safe range.

Spreadability is a critical parameter influencing patient compliance and therapeutic performance. The one-way ANOVA revealed highly significant differences among the formulations. Formula H demonstrated the fastest spreadability, followed by Formula S, while Formula M was notably the slowest. The ranking derived from Tukey's post-hoc analysis clearly distinguished between the formulations, highlighting their performance variations. These findings corroborate the work of Shital *et al* [17], who similarly emphasized spreadability as a determinant of formulation acceptability.

The antibacterial activity results further underscore the importance of formulation type. Two-way ANOVA confirmed significant effects of both formulation and bacterial species, as well as their interaction. Semi-solid formulations (S, V, and H) exhibited selective efficacy, showing stronger inhibition against Gram-positive bacteria such as S. aureus but reduced activity against Gram-negative strains like Proteus. In contrast, gel formulations (J, M, and B) displayed broader antibacterial spectra, maintaining activity across multiple bacterial types. This significant

formulation–bacteria interaction highlights the necessity of tailoring antimicrobial preparations to specific pathogens in order to achieve optimal therapeutic outcomes.

The present study demonstrated that all tested formulations were physically stable, safe, and effective to varying degrees, with gel-based systems offering broader antibacterial activity, while semi-solid systems provided stronger selectivity. These insights contribute to the growing body of evidence supporting the rational design of novel anti-acne products with improved antimicrobial performance [19,20].

CONCLUSION

All the formulations demonstrate acceptable physical and stability characteristics; the observed variability in sensory attributes—specifically colour, odour, and texture—may influence consumer acceptability and is a critical consideration. It is of good spreadability, viscosity, and effective antibacterial activity against various bacteria, with minimal differences among them. Each formulation was stable for up to one month, even under increased temperatures and also maintained pH levels compatible with the skin, thereby reducing the risk of sensitivity and allergic reactions.

DECLARATIONS

Acknowledgement/Funding

Authors would like to thank Al-Farahidi University, College of Pharmacy, Baghdad, Iraq, for permitting the use of their laboratories.

Use of Artificial intelligence/Large language models

We also declare that we did not use Generative artificial intelligence (AI) and AI-assisted technologies in writing the manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Tabarek H. Mahmood and Ghufran H. Mahmood designed the experiment, prepared the samples, characterized them, and analyzed the data. Ali Al-Samydai's project administration, data discussion, writing, and finalizing the manuscript.

REFERENCES

1. *Zhu Z, Zhong X, Luo Z, Liu M, Zhang H, Zheng H, Li J. Global, regional and national burdens of acne vulgaris in adolescents and young adults aged 10-24 years from 1990 to 2021: a trend analysis. Br J Dermatol 2025; 192(2): 228-237. doi: 10.1093/bjd/ljae352. PMID: 39271178.*
2. *Alrabiah Z, Abudalo S, Alalwan M, Almuhaydid M, Almuslat K, Alhossain A, Alkhunaizan N, Alzunaydi H, Alsaif S, Alkhalaf M. Prevalence and self-medication for acne among students of Health-Related Science Colleges at King Saud University in Riyadh Region, Saudi Arabia. Medicina 2023; 59(1): 1-10.*
3. *Ricci F, Caaniga S, Gianfranco L, Zangrillo F, Veraldi S. Combination therapy with hydrogen peroxide (4%), salicylic acid (0.5%) and D-panthenol (4%): efficacy and skin tolerability in common acne vulgaris during sun exposure period. Eur Rev Med Pharmacol Sci 2016; 20(2): 232-236.*
4. *Abdel Hay R, Al-Saieed O, Hegazy A, Elhossary N, Mostafa A, El-Khalawany M. Clinical and dermoscopic evaluation of combined (salicylic acid 20% and aelaic acid 20%) versus trichloroacetic acid 25% chemical peel in acne: an RCT. J Dermatolog Treat 2019; 30(6): 572-577.*
5. *Bilal H, Usman M, Naveed M, Shah P, Alsaqufi A, Shah M, Ahmed N, Bilal A. Stabilization of Acne vulgaris-associated microbial dysbiosis with 2% supramolecular salicylic acid. Pharmaceuticals 2023; 16(1): 1-13.*
6. *Madan S, Almalik A, Alwadei S, Alshahrani S, Alam M. Design, preparation, and evaluation of liposomal gel formulations for treatment of acne: in vitro and in vivo studies. Drug Dev Ind Pharm 2019; 45(3): 395-404.*
7. *Gharibi D, Mohammadi S, Sadeghi S, Shokri H, Nazari M. Antibacterial effects of aloe vera extracts on some human and animal bacterial pathogens. J Med Microbiol Infec Dis 2016; 3(1): 6-10.*
8. *Saleem A, Rizwan S, Anjum S, Shahzad M, Shakeel A, Bashir R, Afzal S, Hussain S. Aloe vera gel effect on skin and pharmacological properties. Scholars Int J Anat Physiol 2022; 5(1): 1-8.*
9. *Khater D, Tawfik H, Abdallah H, Shaaban M. Design, preparation, and characterization of effective dermal and transdermal lipid nanoparticles: A review. Cosmetics 2021; 8(2): 1-19.*

10. Purnamawati S, Indrastuti N, Danarti R, Saefudin T. The role of moisturizers in addressing various kinds of dermatitis: A review. Clin Med Res 2017; 15(3-4): 75-87.
11. Almasaudi S. The antibacterial activities of honey. Saudi J Biol Sci 2021; 28(4): 2188-2196.
12. Nong Y, Lin L, Ma H, Song R. A review of the use of beeswax in skincare. J Cosmet Dermatol 2023; 22(8): 2166-2173.
13. Stout E, McKessor A. Glycerin-based hydrogel for infection control. Adv Wound Care 2012; 1(1): 48-51.
14. Swanepoel S. Formulation of cosmetic products for the treatment of acne containing tea tree oil and salicylic acid. 2005.
15. Thorat KJ, Yamgar TS, Shirote PJ, Deshmane B. A Review on stability of Aloe vera gel. Research J Topical Cosmetic Sci 2018; 9(1): 7-11. doi: 10.5958/2321-5844.2018.00003.1
16. Chauhan L, Gupta S. Creams: A review on classification, preparation methods, evaluation and their applications. J Drug Deliv Ther 2020; 10(2): 281-289.
17. Shital P, Poonam T: A comprehensive review on Formulation development of Salicylic acid Ointment. Int J Pharm 2025; 3(4): 3387-3395
18. Aditi K, Yogita T: An advanced review on salicylic acid ointment for treatment of acne. World J Pharma Res 2020; 9(5): 1940-1949
19. Luhaibi DK, Ali HH, Al-Ani I, Shalan N, Al-Akayleh F, Al-Remawi M, Nasereddin J, Qinna NA, Al-Adham I, Khanfar M. The formulation and evaluation of deep eutectic vehicles for the topical delivery of azelaic acid for acne treatment. Molecules. 2023 4; 28(19): 6927.
20. Alrubaye MA, Lafi Z, Hajleh MN, Abuamara TM, Mehdawi A. Co-encapsulation of coumarin and Q10 into solid lipid nanoparticles for wound healing. J Drug Del Sci Technol 2025; 105: 106645.