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OPTIMIZATION AND PHYSICAL QUALITY EVALUATION OF SACHA INCHI (*Plukenetia volubilis* L.) SEED OIL EMULGEL FORMULATED WITH VARYING CONCENTRATIONS OF TWEEN 80 AND SPAN 80 USING THE SIMPLE LATTICE DESIGN (SLD) METHOD

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ABSTRACT

Sacha inchi (*Plukenetia volubilis* L.) seed oil is a promising bioactive ingredient for topical applications due to its high content of essential fatty acids and antioxidants; however, its hydrophobic nature limits formulation stability and performance. This study aimed to develop and optimize an emulgel delivery system using a systematic mixture design approach to enhance its physicochemical characteristics. A Simplex Lattice Design (SLD) was applied to evaluate the combined effects of Tween 80 (1-5%) and Span 80 (1-5%) on key responses, including pH, viscosity, and adhesion. Emulgel formulations were prepared using a conventional emulsification method followed by incorporation into a gel base, then evaluated accordingly. Data were analyzed using Design Expert® software and ANOVA. The results showed that all formulations met the acceptable criteria for topical application, with pH (5.40–6.30), viscosity (25.1–61.2 P), and adhesion (1.46–3.5 s). Statistical analysis revealed a significant ($p < 0.05$) and non-linear interaction between surfactants across all responses, indicating the critical role of compositional balance. The optimized formulation, containing 5% Tween 80 and 1% Span 80, achieved a desirability value of 1.00. Overall, the SLD approach proved effective for optimizing emulgel formulations and enhancing the potential of sacha inchi oil as a stable topical delivery system.

Keyword : *emulgel, sacha inchi, simplex lattice design, span 80, tween 80*

INTRODUCTION

Topical preparations have been increasingly developed in the cosmetic industry, particularly in formulations designed for facial skin care. Topical dosage forms are widely preferred in cosmetic products due to their ability to deliver active ingredients directly to the target site with minimal systemic effects. One of the most extensively developed topical systems is emulgel. Emulgel is a semisolid system that combines the advantages of both emulsions and gels, including the ability to incorporate lipophilic active compounds, good physical stability, and improved user acceptability on the skin (Patel *et al.*, 2020).

Sacha inchi oil (*Plukenetia volubilis* L.) is a plant-derived oil obtained from the

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seeds of a tropical plant and is known for its high content of unsaturated fatty acids, particularly α-linolenic acid (omega-3), linoleic acid (omega-6), and oleic acid (omega-9) (Jamaludin, 2025; Tanjung, Akmal and Kawu, 2025). In addition, this oil contains natural antioxidant compounds such as tocopherols, which have the potential to protect the skin from oxidative stress and help maintain skin moisture and barrier (Maya *et al.*, 2023). Several recent studies have demonstrated that plant oils rich in essential fatty acids have significant potential as active ingredients in topical cosmetic formulations (Maya *et al.*, 2023; Putri Immelia *et al.*, 2025). However, the hydrophobic nature of Sacha inchi oil poses a challenge in formulation development, requiring a delivery system capable of stably dispersing the oil phase.

Emulgel is an appropriate system to address this limitation; however, the success of emulgel formulation is highly dependent on the selection and concentration of emulsifiers. Emulsifiers function by reducing interfacial tension between the oil and water phases and play a critical role in determining the physical stability, viscosity, and adhesion of the formulation. A combination of nonionic emulsifiers such as Tween 80 (hydrophilic) and Span 80 (lipophilic) is commonly used to achieve an appropriate Hydrophilic–Lipophilic Balance (HLB) for oil-in-water (O/W) emulsions (Maulina, 2022). Variations in the ratio of these emulsifiers can significantly influence the characteristics and quality of the emulgel.

Optimization of the emulsifier composition can be performed using the Simplex Lattice Design (SLD) method implemented in Design-Expert software (Abo-Neima *et al.*, 2024; Badruddoza *et al.*, 2024). This statistical mixture design enables the systematic evaluation of the individual effects of formulation components and their interactions on formulation responses while reducing the number of experimental runs required compared with conventional optimization approaches (Abo-Neima *et al.*, 2024; Primadana *et al.*, 2024). Accordingly, the present study aimed to optimize a sacha inchi seed oil emulgel formulation by varying the proportions of Tween 80 and Span 80 as emulsifying agents and assessing their effects on the physical quality attributes of the formulation.

METHODS

Tools and Materials

The instruments used in this study included an analytical balance (Ohaus, USA), homogenizer, hot plate with magnetic stirrer, pH meter (Eutech Instruments, Singapore), Brookfield viscometer (DV-I Prime, USA), adhesion test apparatus, stopwatch, glassware (Pyrex, Japan), and other non-glass laboratory equipment available in the laboratory. The materials used in this study were Sacha Inchi oil (*Plukenetia volubilis* L.) (PT Lawu Flora, Indonesia), Tween 80 (Sigma-Aldrich, USA), Span 80 (Sigma-Aldrich, USA), Carbopol 940, triethanolamine (TEA), propylene glycol, methylparaben (Nipagin), and distilled water (aquadest). All materials used were of pharmaceutical or analytical grade.

Research Procedure

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Simplex Lattice Design for optimization of emulgel sacha inchi oil components and ratio

The optimization of the sacha inchi seed oil emulgel formulation was performed using Design-Expert® software version 13 with the Simplex Lattice Design method. Two independent formulation variables were evaluated, namely Tween 80 and Span 80. The lower and upper limits of both components were entered into the Design-Expert program, while pH, viscosity, and adhesion were set as response parameters. The concentration ranges for the lower and upper limits are presented in Table 1. The initial formulation design generated eight experimental runs, with the emulsifier ratios shown in Table 2.

Table 1. The concentration ranges for the lower and upper limits of Tween 80 and Span 80.

Ingredients	Lower limits (%)	Upper limits (%)
Tween 80	1	5
Span 80	1	5

Table 2. The concentration of Tween 80 and Span 80 based on Design-Expert software runs using the SLD method.

STD	Run	Tween 80 (%)	Span 80 (%)
7	1	1	5
5	2	2	4
6	3	5	1
8	4	3	3
4	5	4	2
2	6	1	5
1	7	5	1
3	8	3	3

Procedure for emulgel preparation

The emulgel was prepared using a conventional emulsion method combined with a gel system. The basic formulation was based on a modified previous study (Dahlizar *et al.*, 2022). The oil phase was prepared by mixing sacha inchi oil and Span 80, followed by heating to approximately ±70°C. The aqueous phase was prepared by dissolving Tween 80, methylparaben, propylparaben, propylene glycol, and distilled water, then heating to approximately ±70°C. The oil phase was slowly added to the aqueous phase under continuous homogenization until a stable emulsion was formed. The gel base was prepared by dispersing Carbopol in distilled water, followed by neutralization with triethanolamine to form a gel structure. The formed emulsion was then gradually incorporated into the gel base with continuous mixing until a homogeneous emulgel preparation was obtained (Badruddoza *et al.*, 2024).

Table 3. The formula of sacha inchi seed oil emulgel

Ingredients	Concentration (%)
Sacha inchi seed oil	5
Tween 80	1-5
Span 80	1-5
Metil Paraben	0.1
Propil paraben	0.2
Propilen glikol	6
Carbopol	1
TEA	1
Aquadest	Ad 100

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Evaluation of the Physical Characteristics of Sacha Inchi Oil Emulgel

Organoleptic and homogeneity test

Observations were carried out visually to evaluate the color, odor, consistency, and homogeneity of the formulation (Ogedengbe and Kolawole, 2024).

pH test

pH measurement was performed using a calibrated pH meter at room temperature. This test aimed to ensure that the formulation pH was within the physiological skin pH range (4.5–6.5) (Ningrat *et al*., 2024).

Viscosity test

Viscosity was measured using a Brookfield viscometer with an appropriate spindle and rotation speed. The spindle was immersed into the sample container up to the marked level, the rotor was then activated, and the system was allowed to stabilize until a constant reading was obtained. This parameter was used to evaluate the consistency and physical stability of the emulgel system (Feronika *et al*., 2020).

Adhesion test

The adhesion was evaluated by measuring the separation time between two glass plates after the application of a 1 kg load, which reflects the ability of the formulation to adhere to the skin surface (Robby *et al*., 2022).

Data analysis

The evaluation data were analyzed using the Simplex Lattice Design method to determine the effects of each emulsifier and their interactions on the observed responses. The values of the dependent parameters, including pH, viscosity, and adhesion, were entered into the response column of the software. Subsequently, statistical analysis using ANOVA was performed to compare the individual responses. The determination of the optimal formulation was based on the highest desirability value that satisfied all response criteria (Ting and Kumar, 2017). The selected optimal formula was then subjected to verification by preparing and testing the recommended optimal formulation.

RESULT AND DISCUSSION

Organoleptic and Homogeneity Test

The organoleptic and homogeneity evaluation of the sacha inchi (*Plukenetia volubilis* L.) seed oil emulgel included observations of physical form, odor, color, and uniformity. The formulation is expected to exhibit an appealing color, a pleasant odor, appropriate consistency, and good homogeneity.

The emulgel formulation described above resulted in a semisolid consistency with a milky white color, which was produced by the combination of emulsion and gel phases. This structure formed a preparation with higher viscosity than conventional gel, resulting in longer adhesion time on the skin. A characteristic odor was observed, derived from the inherent scent of the sacha inchi seed oil used in the formulation. The homogeneity test was conducted to determine whether the formulation was uniformly mixed across all components (Iriani, Dehi and Damar, 2022).

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This evaluation involved spreading the emulgel on a glass slide (object glass), which showed a homogeneous distribution without any visible lumps. These results indicate that all components of the emulgel were evenly dispersed throughout the system.

Table 4. Results of organoleptic and homogeneity test

Run	Organoleptic			Homogenity
	Odor	Color	Shape	
1	Aromatic	Milky white	Semisolid	Homogeneous
2	Aromatic	Milky white	Semisolid	Homogeneous
3	Aromatic	Milky white	Semisolid	Homogeneous
4	Aromatic	Milky white	Semisolid	Homogeneous
5	Aromatic	Milky white	Semisolid	Homogeneous
6	Aromatic	Milky white	Semisolid	Homogeneous
7	Aromatic	Milky white	Semisolid	Homogeneous
8	Aromatic	Milky white	Semisolid	Homogeneous

The primary objective of this study was to develop and evaluate various emulsifier compositions with different concentrations of Tween 80 and Span 80 to obtain a single optimized formulation with desirable physicochemical properties. An optimization approach was employed using the Simple Lattice Design (SLD) method, due to its efficiency in requiring a relatively small amount of materials and a limited number of experimental runs. The SLD methodology generated eight experimental runs with varying emulsifier ratios, and the corresponding dependent variable responses are presented in Table 5.

Table 5. Result of dependent variable testing of sacha inchi oil emulgel

Run	pH	Viscosity (Poise)	Adhesion (seconds)
1	5.43	29.2	1.57
2	5.40	51.3	2.74
3	5.62	61.2	3.5
4	5.71	44.1	2.81
5	6.30	14.96	1.46
6	5.50	25.1	1.56
7	5.55	56.2	3
8	5.86	39.4	2.72

Based on the results of the dependent variable analysis, the Simple Lattice Design (SLD) method identifies a model that best describes the relationship between the independent and dependent variables, namely the model that most closely

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corresponds to the experimental data or demonstrates statistical significance with a p-value < 0.05. The optimum formulation is determined by defining the goal, criteria, and relative importance during the SLD optimization process. Dependent variables that yield statistically significant models can be used as a basis for selecting the optimal formulation.

Table 6. Goals and criteria of the dependent variables

Name	Goal	Criteria	Importance
pH	In range	5.4-6.3	3
Viscosity	In range	14.96-61.2 P	3
Adhesion	In range	1.46-3.5 s	3

The goal for the pH test was set to "in range" with a criterion of 5.4–6.3. This range was selected based on the observed pH values of the formulations and is still within the acceptable pH range for human skin (Wahyudi *et al*., 2023). For the viscosity test, the goal was also set to "in range" with a criterion of 14.96–61.2 Poise, in accordance with the experimental results and within the acceptable viscosity range for a good emulgel, ensuring an appropriate semisolid texture. The adhesion (bioadhesive strength) goal was set to "in range" with a criterion of 1.46–3.5 seconds, aligned with the requirement for a suitable topical formulation, which generally should exhibit at least 1 second of adhesion (Salima and Nurwaini, 2023). The importance level for each test was set equally, as all evaluated properties play a critical role in determining the overall performance of the emulgel formulation.

pH

The pH test was conducted to determine the acidity level of the prepared emulgel formulation and to ensure its safety and effectiveness for topical application. A suitable emulgel should exhibit a pH within the range of 4.5–6.4 to prevent irritation and maintain user comfort upon application to the skin (Wahyudi *et al*., 2023). A pH that is too acidic or too alkaline may disrupt the skin's natural protective barrier (stratum corneum); therefore, the formulated emulgel is expected to have a pH close to that of natural skin (Wulandari *et al*., 2022).

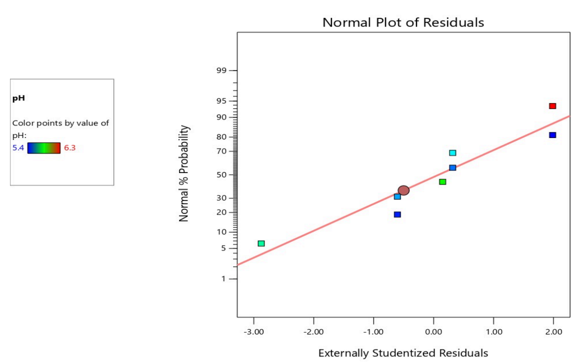

Figure 1. Normal plot of residuals for pH

Based on the normal probability plot of residuals (Figure 1), the distribution of the pH response data is observed to lie close to the linear line and generally follows a linear trend. This indicates that the residuals of the pH response are normally distributed.

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In the two-component mixture plot (Figure 2), the relationship between Tween 80 and Span 80 with respect to pH exhibits a non-linear pattern, indicating the presence of interaction between the components. An initial increase in Tween 80 concentration may lead to a decrease in pH; however, further increases subsequently elevate the pH until it reaches a maximum at a certain concentration, after which the pH decreases again at higher concentrations. Tween 80 is a chemically stable nonionic surfactant with a broad pH stability range; therefore, it does not significantly affect pH variations in emulgel formulations (Rowe *et al*., 2009). In contrast, Span 80 is a lipophilic non-ionic surfactant that influences the emulsion system properties and contributes to pH stabilization (Wulandari *et al*., 2022). The optimum pH value was obtained at a higher concentration of Tween 80 compared to Span 80. ANOVA analysis yielded a p-value of 0.0069 ($p < 0.05$), indicating that variations in the concentrations of Tween 80 and Span 80 produced a statistically significant effect on the pH response.

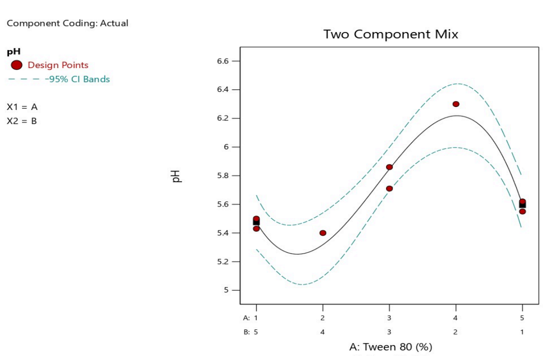

Figure 2. Plot of two component mix emulgator versus pH

In contrast, the lack-of-fit analysis showed a p-value of 0.1414 ($p > 0.05$), indicating that there was no significant difference between the experimental pH values and those predicted by the model equation. Based on the SLD approach, Equation (1) was obtained. The equation represents Y as the pH response, where A denotes Tween 80 and B denotes Span 80.

$$Y = 5.595A + 5.4752B + 1.24392AB + 4.48AB(A - B) \quad (1)$$

Equation (1) indicates that both Tween 80 and Span 80 contribute positively to the increase in pH value of the formulation. Based on this equation, Tween 80 exhibits a greater effect compared to Span 80, which may be attributed to its higher concentration and greater dominance within the formulation.

Viscosity

The viscosity test aims to determine the resistance of a formulation to flow and plays an important role in enhancing the stability of emulgel preparations. A good semisolid formulation typically exhibits a viscosity range of 20–500 Poise (Chandra, 2022). Based on the experimental results, the lowest viscosity was observed in Run 6, with a value of 25.1 Poise, while the highest viscosity was obtained in Run 3, with a value of 61.2 Poise. Further analysis of the viscosity response was conducted using Design Expert software version 13 employing the SLD method. The resulting response surface model generated by the software was identified as a cubic model.

Based on the normal probability plot of residuals (Figure 3), the distribution of the viscosity response data is observed to lie

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close to the linear line and generally follows a linear trend. This indicates that the residuals of the viscosity response are normally distributed. In the two-component mixture plot (Figure 4), the relationship between Tween 80 and Span 80 with respect to viscosity exhibits a non-linear pattern, indicating the presence of interaction between the components. An increase in Tween 80 concentration leads to an increase in viscosity until it reaches a maximum value at approximately 2% concentration (around 50–60 Poise), suggesting a synergistic effect between the two surfactants in enhancing system viscosity. However, within a certain concentration range, viscosity decreases considerably before increasing again at the highest Tween 80 concentration combined with the lowest Span 80 concentration. This phenomenon is attributed to the dominance of the hydrophilic surfactant, which promotes the formation of a stable oil-in-water (O/W) emulsion system (Wikantyasning and Indianie, 2021).

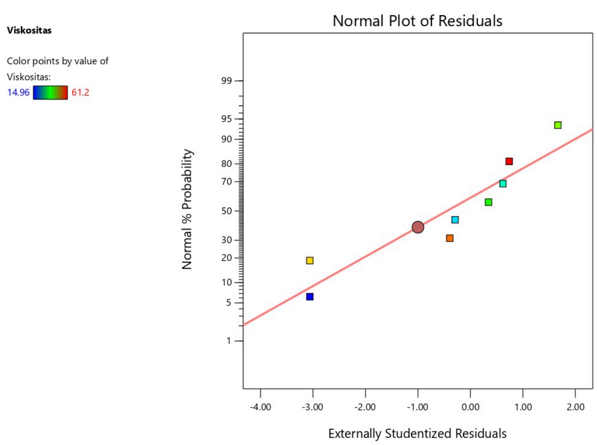

Figure 3. Normal plot of residuals for viscosity

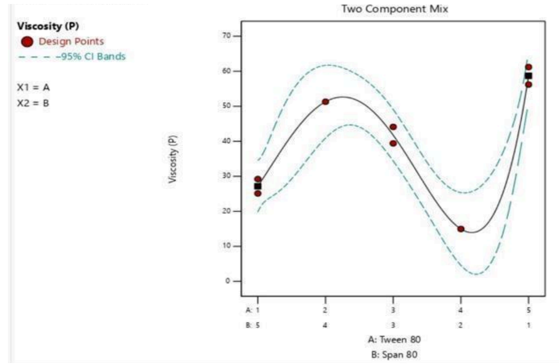

Figure 4. Plot of two component mix emulgator versus viscosity

ANOVA analysis yielded a p-value of 0.0095 ($p < 0.05$), indicating that variations in the concentrations of Tween 80 and Span 80 produce a statistically significant effect on the viscosity response. In contrast, the lack-of-fit test resulted in a p-value of 0.055 ($p > 0.05$), indicating that there is no significant difference between the experimentally obtained viscosity values and those predicted by the model equation. Based on the SLD approach, Equation (2) was obtained. The equation defines Y as the viscosity response, where A represents Tween 80 and B represents Span 80.

$$Y = 58.0009A + 26,4509B - 18,6824AB - 277,947AB(A - B) \quad (2)$$

Equation (2) indicates that both Tween 80 and Span 80 contribute positively to the increase in viscosity of the formulation. Based on this equation, Tween 80 exerts a greater influence than Span 80, which may be attributed to its higher and more dominant concentration within the system. The negative AB coefficient suggests that the interaction between Tween 80 and Span 80 slightly reduces the magnitude of the viscosity-enhancing effect

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compared to their individual contributions. This may be explained by the ability of Tween 80 to form a strong interfacial layer and produce smaller globule sizes, thereby increasing particle interactions within the system. In combination, Span 80 at low concentration contributes to stabilizing the interfacial layer, which ultimately enhances the overall viscosity of the formulation (Irianto *et al*., 2020; Salima and Nurwaini, 2023).

Adhesion

The adhesion test for semisolid formulations is related to the ability of the preparation to maintain contact with or adhere to the skin after application, which influences both efficacy and user comfort. Adequate adhesion is required to prevent the formulation from being easily removed from the skin, thereby allowing the active compound to diffuse optimally. A suitable topical formulation is required to exhibit an adhesion time of more than one second (Zhang *et al*., 2022). The results of the adhesion test showed that Run 5 had the lowest adhesion time of 1.46 seconds, while Run 3 exhibited the highest adhesion time of 3.5 seconds. These results indicate that all formulations met the required specification as reported in the literature, namely >1 second.

Based on the normal probability plot of residuals (Figure 5), the distribution of the adhesion time response data is observed to lie close to the linear line and generally follows a linear trend. This indicates that the residuals of the adhesion time response are normally distributed. In the two-component mixture plot (Figure 6), the relationship between Tween 80 and Span 80 with respect to adhesion time exhibits a non-linear pattern, indicating the presence of interaction between the components. An increase in Tween 80 tends to enhance adhesion time due to its hydrophilic properties, which promote hydration and improve interaction with the gel matrix. In contrast, Span 80 at higher concentrations reduces adhesion time as a result of its lipophilic nature, which decreases system cohesion (Irianto *et al*., 2020; Zhang *et al*., 2022).

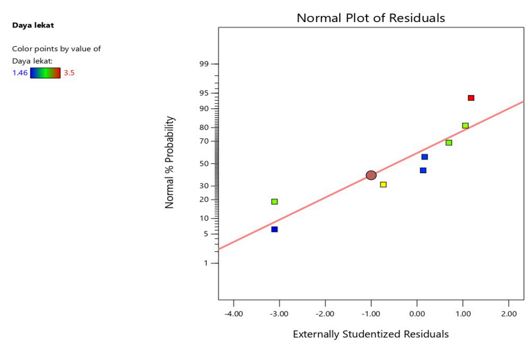

Figure 5. Normal plot of residuals for adhesion

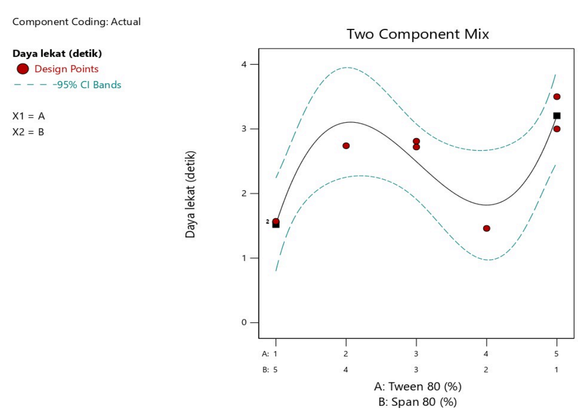

Figure 6. Plot of two component mix emulgator versus adhesion

ANOVA analysis yielded a p-value of 0.0297 ($p < 0.05$), indicating that variations in the concentrations of Tween 80

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and Span 80 produce a statistically significant effect on the adhesion time response. In contrast, the lack-of-fit analysis resulted in a p-value of 0.0529 ($p > 0.05$), indicating that there is no significant difference between the experimentally obtained adhesion time values and those predicted by the model equation. Based on the SLD approach, Equation (3) was obtained. The equation defines Y as the adhesion time response, where A represents Tween 80 and B represents Span 80.

$$Y = 3.20485A + 1.51985B + 0.527059AB - 11.32AB(A - B) \quad (3)$$

Equation (3) indicates that both Tween 80 and Span 80 contribute positively to the formulation response. Based on this equation, Tween 80 exhibits a greater effect than Span 80, which may be attributed to its higher and more dominant concentration within the formulation. However, the interaction between Tween 80 and Span 80 shows a negative coefficient, suggesting that their combination tends to reduce adhesion time. This indicates that, although each component individually contributes to increasing the response, their combined effect results in a decrease in adhesion.

Results of Formula Optimization

The optimization analysis identified the optimum formulation consisting of 5% Tween 80 and 1% Span 80. Based on this optimal formulation, the predicted responses were pH 5.5952, viscosity 58.0009 Poise, and adhesion time 3.20485 seconds, with a desirability value of 1.00 (Figure 7). The selection and determination of the optimum formulation should consider the desirability value. Desirability is a parameter that reflects the software's ability to meet predefined criteria for the final product. A desirability value closer to 1.0 indicates a better optimization outcome, reflecting the program's ability to achieve the most ideal formulation with the desired characteristics (Zai *et al*., 2026).

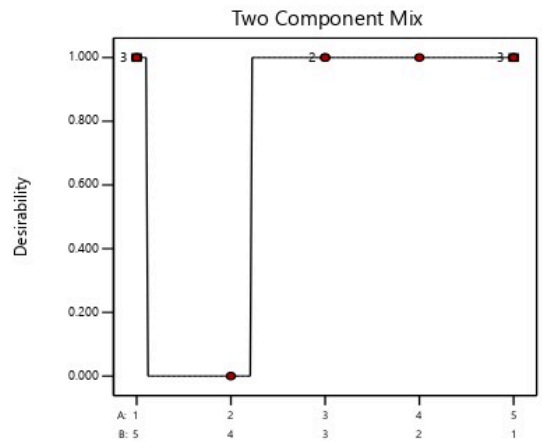

Figure 7. Optimization results (desirability value) of Tween 80 and Span 80 in sacha inchi seed oil emulgel.

CONCLUSION

The results of this study demonstrate that the Simple Lattice Design (SLD) method is highly effective. This is evidenced by the successful identification of an optimal formulation based on predictive analysis. In addition, the comparison between the SLD-generated predictions and the experimental verification results showed no statistically significant differences, indicating that the optimized formulation is suitable for further development as an emulgel system. The formulation containing 5% Tween 80 and 1% Span 80 was identified as the most optimal, as it achieved a desirability value of one and exhibited the most favorable overall characteristics.

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REFERENCES

Abo-Neima, S.E. et al. (2024) ‘Simplex-lattice design and decision tree optimization of endophytic Trichoderma-multi-walled carbon nanotube composite for enhanced methylene blue removal’, *Heliyon*, 10(21). doi: 10.1016/j.heliyon.2024.e39949.

Badruddoza, A.Z.M. et al. (2024) ‘Topical drug delivery by Sepineo P600 emulgel: Relationship between rheology, physical stability, and formulation performance’, *International Journal of Pharmaceutics*, 658, p. 124210. doi: 10.1016/j.ijpharm.2024.124210.

Chandra, D. (2022) ‘Uji fisikokimia sediaan emulsi, gel, emulgel ekstrak etanol goji berry (Lycium barbarum L.)’, *Jurnal Farmasi dan Kesehatan*, 11(2), pp. 219–228.

Dahlizar, S. et al. (2022) ‘Formulasi emulgel gamma oryzanol dengan menggunakan Carbopol sebagai gelling agent’, *Jurnal Sains Farmasi & Klinis*, 9(2), pp. 129–137. doi: 10.25077/jsfk.9.2.129-137.2022.

Feronika, E., Rahayu, S. and Lucida, H. (2020) ‘Formulation and characterization of emulgel containing tomato’s lycopene (Solanum lycopersicum L.)’, *World Journal of Pharmacy and Pharmaceutical Sciences*, 9, pp. 1072–1088. doi: 10.20959/wjpps202012-17646.

Iriani, F.A., Dehi, R.I. and Damar, A.C. (2022) ‘Uji mutu fisik emulgel kulit kayu manis (Cinnamomum burmanii) dan kulit jeruk purut (Citrus hystrix)’, *Jurnal Multidisiplin Madani*, 2(10), pp. 3767–3771. doi: 10.55927/mudima.v2i10.1449.

Irianto, I.D.K., Purwanto, P. and Mardan, M.T. (2020) ‘Aktivitas antibakteri dan uji sifat fisik sediaan gel dekokta sirih hijau (Piper betle L.) sebagai alternatif pengobatan mastitis sapi’, *Majalah Farmaseutik*, 16(2), pp. 202–208. doi: 10.22146/farmaseutik.v16i2.53793.

Jamaludin, J. (2025) ‘The Sacha Inchi (Plukenetia volubilis) research trends for health’, *Jurnal Eduhealth*, 16, pp. 344–351. doi: 10.54209/eduhealth.v16i01.

Maulina, D. (2022) ‘Variasi nilai hydrophylic-lipophylic balance campuran Span 80-Tween 80 dan creaming index pada emulsi coconut oil’, *Indonesian Journal of Health Science*, 2(1), pp. 24–27.

Maya, I. et al. (2023) ‘Physicochemical characteristics, fatty acid profile, and in vitro antioxidant activity evaluation of Sacha Inchi seed oil from Indonesia’, *Cosmetics*, 10(6). doi: 10.3390/cosmetics10060171.

Ningrat, A.W.S., Setianto, A.B. and Kintoko (2024) ‘Formulation and testing of emulgel preparations from purified fraction of papaya (Carica papaya L.)

Submitted : 25 April 2026
Revised : 12 Mei 2026
Accepted : 10 Juni 2026
Published : 30 Juli 2026

leaves as anti-acne', *Jurnal Ilmiah Farmasi Akademi Farmasi Jember*, 7(1), pp. 36–43. doi: 10.53864/jifakfar.v7i1.166.

Ogedengbe, O.T. and Kolawole, O.M. (2024) 'Formulation and evaluation of fluconazole emulgels for potential treatment of vaginal candidiasis', *Heliyon*, 10(6). doi: 10.1016/j.heliyon.2024.e28206.

Patel, H.R. et al. (2020) 'Emulgel: A comprehensive review for novel topical drug delivery system', *International Journal of Recent Scientific Research*, 11. doi: 10.24327/ijrsr.2020.1104.5247.

Primadana, P. F. I. et al. (2024) 'Application of the simplex lattice design method to determine the optimal formula nanoemulsion with virgin coconut oil and palm oil', *Jurnal Farmasi dan Ilmu Kefarmasian Indonesia*, 11(3), pp. 395–401. doi: 10.20473/jfiki.v11i32024.395-401.

Putri Immelia, R. et al. (2025) 'Formulation and physical stability evaluation of Sacha Inchi (Plukenetia volubilis L.) oil-based body lotion as skin moisturizer', *Indonesian Journal of Health Research and Development*, 3(3), pp. 102–109. doi: 10.58723/ijhrd.v3i3.462.

Robby, O., Gloria, F. and Saptawati, T. (2022) 'Pengaruh variasi konsentrasi ekstrak daun kelor (Moringa oleifera Lamk) terhadap efek antiinflamasi sediaan emulgel', *Jurnal Penelitian Kesehatan Suara Forikes*, 13(2). doi: 10.33846/sf13231.

Rowe, R.C., Sheskey, P.J. and Quinn, M.E. (2009) *Handbook of Pharmaceutical Excipients*. 6th edn. London: The Pharmaceutical Press.

Salima, T. and Nurwaini, S. (2023) 'Optimasi komposisi emulgator Tween 80 dan Span 80 terhadap stabilitas fisik dan uji aktivitas antibakteri emulgel minyak atsiri rosemari (Rosmarinus officinalis) terhadap Staphylococcus aureus', *Usadha: Journal of Pharmacy*, 2(2).

Tanjung, Y.P., Akmal, T. and Kawu, I.T. (2025) 'The formulation and antioxidant activity of facial serum from Sacha Inchi (Plukenetia volubilis L.) seed oil', *Indonesian Journal of Pharmaceutical Science and Technology*, 12, pp. 104–111. doi: 10.24198/ijpst.v12s2.58822.

Ting, K. L. and Kumar, J. R. (2017) 'Optimization and in-vitro characterization of erythromycin nanogels by using simplex-lattice mixture design', *Rapports De Pharmacie*, 3(2), pp. 371–383.

Wahyudi, L., I. Hajrin, W. and Andanalusia, M. (2023) *Optimasi formula sediaan gel ekstrak metanol herba Ashitaba (Angelica keiskei) dengan metode simplex lattice design*. Thesis. Mataram: Fakultas Kedokteran, Universitas Mataram.

Wikantyasning, E. R. and Indianie, N. (2021) 'Optimisasi Tween 80 dan Span 80 sebagai emulgator dalam formula krim tabir surya kombinasi ekstrak etanol daun alpukat (Persea americana M.) dan nanopartikel seng

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oksida dengan metode simplex lattice design', *Jurnal Ilmu Farmasi*.

Wulandari, F., Syaputri, F.N. and Jannah, N.R. (2022) 'The effect of various concentrations of the addition of emulsifier Tween 80 and Span 80 on the stability of cream formulation ethanolic extract of basil leaves (Ocimum americanum L.)', *Jurnal Ilmu Kefarmasian*, 3(2).

Zai, K., Ardriyanto, M.I. and Hanifah, A.N. (2026) 'Optimization of Myristica fragrans nanoemulgel formulation based on a low-energy method of preparation and simplex lattice design', *Natural and Life Sciences Communications*, 25(3). doi: 10.12982/NLSC.2026.058.

Zhang, X. et al. (2022) 'Fabrication of vitamin D3 nanoemulsions stabilized by Tween 80 and Span 80 as a composite surface-active surfactant: Characterization and stability', *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 645, p. 128873. doi: 10.1016/j.colsurfa.2022.128873