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Development of a Nanoemulsion-Based Sheet Mask Containing Soybean Oil and Turmeric Oil to Reduce Stretch Marks in Postpartum Women

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ABSTRACT

Background: Stretch marks are a common problem in 90% of postpartum women, which can lower their self-confidence. Soybean oil and turmeric oil have the potential to regenerate the skin due to their isoflavon and curcumin content. Nanoemulsion is expected to increase the effectiveness of active ingredient absorption into the skin. The purpose of this research analyze the formulation, physicochemical characteristics, stability, and effectiveness of a nanoemulsion sheet mask containing soybean and turmeric oil for concealing stretch marks in postpartum women. **Methods:** This type of research is R&D, and Quasi Eksperimental Pre-Posttest With Control Group Design. A total of 32 postpartum women were divided into two groups, intervention group (n=16, soybean oil 5% and turmeric oil 5% nanoemulsion sheet mask) and control group (n=16, VCO sheet mask). The treatment was administered twice a week for 4 weeks. Stretch marks were measured using the Davey Score and analyzed using the Independent T-Test. **Results:** The nanoemulsion was made using an ultraturrax and produced a stable and safe product with a particle size of 94.75-163.7 nm, pH 6.5-7.1, and did not cause irritation. The average stretch Marks score decreased in both groups (Intervention group from 6.38 to 5.13; control group from 5.38 to 4.56). Statistikal analysis showed no significant difference in efficacy between the two treatments ($p > 0.05$). The difference in score reduction in the nanoemulsion group was 1.25 higher than in the VCO group. **Conclusions:** The nanoemulsion sheet mask was successfully formulated, stable, and safe for the skin. The use of this sheet mask can reduce stretch marks scores, and its effectiveness is not significantly different from that of the VCO group.

Keyword: Sheet mask; Postpartum Women; Soybean Oil; Turmeric Oil; Nanoemulsion; Stretch Marks

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INTRODUCTION:

Pregnancy is a natural process that makes a woman's body change physically and hormonally. During pregnancy, hormones play a big role by causing skin issues, especially when skin stretches and the adrenal cortex gets more active. This can damage collagen fibers and cause striae gravidarum, commonly known as stretch marks.(Hasnita et al., 2022; Miharti & Fitrishia, 2020) Skin changes begin in the first trimester under the influence of progesterone(Salahuddin et al., 2019) and

become more visible in the second and third trimesters with increased levels of melanocyte-stimulating hormone (MSH), which causes changes in skin color and texture, especially on the abdomen, breasts, and thighs. (F. Handayani, 2017; Latifah & Tsaqilla, 2024) The postpartum period is the time after the placenta is delivered until the reproductive organs return to their pre-pregnancy condition, which usually lasts about six weeks or 40 days

Striae gravidarum is a prevalent dermatological condition, encountered by approximately 90% of individuals undergoing pregnancy and recent motherhood.(Hidayatunnikmah et al., 2022) Although there exists a possibility for some women to witness a reduction in visibility, stretch marks frequently persist and can significantly impact a mother's self-esteem and psychological health, particularly during the postpartum phase, which is marked by emotional fluctuations attributable to hormonal changes.(Syarifah Masthura et al., 2024; Wang et al., 2023). According to the World Health Organization (2018), approximately 66% of pregnant women develop stretch marks, and the prevalence continues to increase.(S. T. Handayani et al., 2024) Stretch marks predominantly manifest on the abdomen, breasts, hips, and thighs, and their visibility tends to increase following childbirth as weight is reduced.(Latifah & Tsaqilla, 2024; Syarifah Masthura et al., 2024; Yuspa & Febrianti, 2021)

The management of stretch marks may be approached through topical treatments, which are considered a more secure and feasible option. These topical formulations are anticipated to enhance hydration, augment skin elasticity, and mitigate inflammation and pruritus.(Safitri, 2021) Naturally occurring compounds such as soybeans and turmeric have been recognized for their potential efficacy in dermatological care. Isoflavones and unsaturated fatty acids found in soybeans play a significant role in dermal regeneration, improving skin elasticity, and providing protection against collagen degradation.(Dewi et al., 2024; Nastiti & Umairo, 2024; Rizzo et al., 2023) Therefore, consistent and appropriate topical care is essential to maintain skin hydration, elasticity, and overall structural integrity.(Mayangsari et al., 2023) In contrast, turmeric is distinguished by its content of curcuminoids and essential oils that demonstrate antioxidant and anti-inflammatory effects while promoting the collagen synthesis process.(Nengsih & Rahayu Khairiah, 2023; Suprihatin et al., 2020)

However, although topical therapies are widely used, most formulations still rely on conventional systems such as creams, oils, and gels, which have limited capacity to penetrate deeper skin layers. Nanoemulsion systems have been shown to improve the penetration and bioavailability of active compounds due to their small particle size; nevertheless, their application as topical delivery systems for stretch marks remains limited. In addition, the use of nanoemulsion in sheet mask form and its application in postpartum women have not been extensively investigated. Therefore, this study aims to evaluate the formulation, physicochemical characteristics, stability, and therapeutic efficacy of a nanoemulsion-based sheet mask containing soybean oil and turmeric in reducing stretch marks among postpartum women.

METHODS:

This study used a quasi-experimental design with a pretest–posttest control group. A total of 32 postpartum mothers were divided into two groups: the intervention group (n = 16), which received a sheet mask based on 5% soybean oil nanoemulsion and 5% turmeric oil, and the control group (n = 16), which used a VCO sheet mask. The treatment was administered twice a week for four weeks.

The sample size was calculated using the Lemeshow formula

RESULTS:

The formulation was developed at the Cendekia Nanotech Hutama Laboratory in Semarang, following laboratory SOPs. The nanoemulsion serum was produced using a high-speed homogenisation method (Ultra-Turrax) to produce nano-sized oil particles, improving stability and skin absorption. The process began with mixing distilled water, soybean oil, turmeric oil, and Tween 80, then homogenizing until evenly mixed, continued with the addition of PEG and benzyl alcohol based on the formulation shown in Table 1.

Tabel 1. Formulation of Nanoemulsion Based on Soybean Oil and Turmeric Oil

Ingredient	Volume
Soybean Oil	5 ml
Turmeric Oil	5 ml
Tween 80	2 ml
PEG	5 ml
Benzil alcohol	1 ml
Aquadest	82 ml

Early evaluation based on organoleptic testing showed that the nanoemulsion had a slightly yellowish colour, a light aroma similar to soybeans with a hint of mint, and a watery texture. To ensure the quality and safety of the soybean oil and turmeric oil nanoemulsion serum, it is important to test it before applying it to the skin of postpartum women. A stable preparation not only maintains the active ingredient but also ensures the consistency of the ingredients. A range of tests were conducted to evaluate the product in Table 2.

Tabel 2. Stability, Quality, and Safety Test Results of the Nanoemulsion

No	Test Parameter	Type/Replication	Test Result
1	pH	Sample 1	7,14
		Sample 2	6,84
		Sample 3	6,50
2	Irritation Test	Panelist 1	Safe
		Panelist 2	Safe
		Panelist 3	Safe
3	Filtration Test (0.45 µm)	Sample	100 %
4	*Particle Size Analyzer* (PSA)	Sample 1	163,7 (52,5%)
		Sample 2	94,75 (100%)

The test results show that the soybean oil and turmeric oil nanoemulsion serum has a pH that is safe for the skin and does not cause irritation to the panelists. All samples also passed the 0.45 µm filtration test, indicating small and evenly distributed droplet sizes. Particle sizes below 200 nm indicate that the preparation is a stable nanoemulsion and supports the absorption of active ingredients into the skin, thus potentially helping to conceal stretch marks. After meeting all criteria and being declared stable, the preparation was packaged in a non-woven sheet mask with a volume of 10 ml.

Tabel 3. Baseline Characteristics of Respondents

Characteristic Respondents	Group				*p-value*
	Nanoemulsion		VCO		
	N	%	N	%	
Age					
20-35 Age	14	87,5	15	93,8	0,559*
>35 Age	2	12,5	1	6,3	
Parity					
1	9	56,3	7	43,8	0,849*
2	2	12,5	6	37,5	
3	4	25	3	18,8	
4	1	6,3	0	0	
Education Level					
SD	0	0	1	6,3	0,663*
SMP	2	12,5	0	0	
SMA	6	37,5	8	50	
S1	7	43,8	7	43,8	
S2	1	6,3	0	0	

Based on Table 3, the characteristics of respondents in the nanoemulsion group and the VCO group show a balanced distribution. The results of the homogeneity test using the Levene test showed a p-value > 0.05, indicating that both groups were homogeneous. In terms of age, the majority of respondents were in the 20–35 age range, namely 87.5% in the nanoemulsion group and 93.8% in the

VCO group, while respondents over 35 years of age were only a small proportion in both groups. In terms of parity, the nanoemulsion group was dominated by mothers with one birth (56.3%), and in the VCO group, parity one was also the most common (43.8%), followed by parity two and three with relatively comparable percentages. The educational level of respondents in both groups also showed a similar pattern, with the majority having a high school and bachelor's degree; in the nanoemulsion group, these were 37.5% and 43.8%, respectively, and in the VCO group, 50% and 43.8%.

The results of the analysis showed a change in stretch mark scores in both groups before and after the intervention. Based on Table 4, the results of the paired sample t-test showed that both the nanoemulsion group and the VCO group experienced a statistically significant decrease in stretch mark scores at all measurement stages ($p < 0.05$).

Table 4. Analysis of stretch mark concealment before and after treatment in the intervention group and control group

Measurement	Nanoemulsion Group				VCO Group			
	Before	After	Δ Mean	P value	Before	After	Δ Mean	P value
Pretest >< *Posttest* 1	6.38	5.94	0.44	0.004*	5.38	4.94	0.44	0.014*
Pretest >< *Posttest* 2	6.38	5.13	1.25	0.000*	5.38	4.56	0.81	0.000*
Posttest 1 >< *Posttest* 2	5.94	5.13	0.81	0.001*	4.94	4.56	0.38	0.009*

**Paired sample T-test Level of significance'sig<0.05*

Comparisons between groups analysed using independent t-tests can be seen in Table 5.

Tabel 5. Comparison of Pretest and Posttest Scores in the Nanoemulsion and VCO Groups

Variable	Group		P value**
	Nanoemulsi (Mean ± SD)	VCO (Mean ± SD)	
Pretest	6.38 ± 2.75	5.38 ± 2.73	0.120
***Posttest* 1**	5.94 ± 2.93	4.94 ± 2.46	0.304
***Posttest* 2**	5.13 ± 2.47	4.56 ± 2.45	0.523

The results of the independent sample t-test showed that there was no statistically significant difference between the nanoemulsion group and the VCO group at all measurement stages ($p > 0.05$).

However, clinically, the nanoemulsion group experienced a greater reduction in stretch mark scores compared to the VCO group, namely 19.6% in the nanoemulsion group and 15.2% in the VCO group. The effect size analysis (Cohen's d) showed a value of 0.36 in the pretest, 0.37 in posttest 1, and 0.23 in posttest 2, which is classified as a small effect. Nevertheless, the effect value in the nanoemulsion group was slightly higher, indicating a tendency for nanoemulsion to be more effective in helping to conceal stretch marks in postpartum.

DISCUSSION:

Development of the Nanoemulsion Formulation

The nanoemulsion serum formulation based on soybean oil and turmeric was successfully produced using the high-speed homogenisation method with an Ultra Turrax device. This method was chosen because it is capable of producing very small droplets and uniform distribution, thereby increasing the stability of the preparation and the effectiveness of active ingredient penetration into the skin. (Ermawati et al., 2023; Gadhave, 2014) The high shear homogenisation process allowed the oil phase to disperse evenly in the aqueous phase containing Tween 80 surfactant and PEG 400 cosurfactant, which served to reduce interfacial tension and prevent coalescence.(Deveci, 2025; Tadros, 2013) The formulation results showed a homogeneous and stable white appearance, indicating the formation of a good nanoemulsion system.

The selection of soybean oil is based on its physicochemical characteristics. Ayu Shabrina (2020) reported that soybean oil is non-volatile and has the potential to cause deposits or white spots on preparations when used in high concentrations.(Akbar et al., 2021) This was reinforced by Fei Teng (2020), who stated that the high protein content of soybeans can trigger aggregation and clumping.(Teng et al., 2020) Therefore, the oil concentration was set at 5%, referring to Febia's (2023) study which showed that nanoemulsions with a vegetable oil concentration of 5% produced smaller and more stable particle sizes.(Febia Sari & Sumaiyah, 2023) Through the nanoemulsion system, curcumin and isoflavones can be evenly dispersed and more easily absorbed by the skin due to the increased contact surface area, thereby increasing the bioavailability of the active ingredients.(Hendrika et al., 2023)

Characteristics of Nanoemulsion Preparations

Particle Size Analyser test results show that the particle size ranges from 94.75 to 163.7 nm, placing the preparation in the true nanoemulsion category (<200 nm). Small droplet size increases surface area and facilitates penetration into the stratum corneum in accordance with skin diffusion theory. Bioactive compounds such as curcumin and isoflavones can reach the epidermis and dermis layers, playing a role in fibroblast stimulation, collagen and elastin formation, and suppressing the inflammatory process.(Hendrika et al., 2023; Leite et al., 2023)

The pH value of the formulation is in the range of 6.5–7.1, consistent with the physiological pH of the skin, making it safe and non-disruptive to the skin's protective acid mantle. Irritation tests showed no adverse reactions, while 0.45 µm membrane filtration tests showed 100% pass rate, indicating the absence of large particles that could reduce the quality of the formulation. The stability of the formulation is also demonstrated by the absence of phase separation or organoleptic changes, consistent with the theory that the combination of non-ionic surfactants and high-speed homogenisation produces nanoemulsions with good kinetic stability.(Bolgen et al., 2025; Gupta et al., 2016; Kumar et al., 2025; Tungadi et al., 2024)

Respondent Characteristics

Respondent characteristics show that the age of postpartum mothers with stretch marks is relatively balanced between the nanoemulsion group and the VCO group, with the majority being in the 25–38 age range. This age is related to skin elasticity, where younger women experience a decline in fibrillin quality due to uterine stretching, causing microfibrils to become brittle and easily broken.(OKTAVIA, 2023a) Meanwhile, after the age of 45, skin elasticity decreases due to collagen decline and dermis thinning.(Murdalin, 2024)

Parity also plays an important role in the formation of stretch marks.(Teng et al., 2020) Repeated pregnancies cause repeated skin stretching, making collagen and elastin fibres more susceptible to damage and reducing collagen density. Mothers with two or more pregnancies have a higher risk of severe stretch marks, which can affect their response to treatment.(Jayanti et al., 2025; Patel, 2025) Increased oestrogen and relaxin hormones during pregnancy also weaken collagen fibre bonds and trigger the formation of striae gravidarum.(Jayanti et al., 2025)

Analysis of the Effectiveness of Nanoemulsion Sheet Masks

The results of a four-week clinical evaluation showed that both groups, those using nanoemulsion sheet masks and those using VCO, experienced a decrease in stretch mark scores. An independent t-test showed no statistically significant differences between the groups at all measurement times ($p>0.05$). However, descriptively, the decrease in scores in the nanoemulsion group was greater, from 6.38 to 5.13 (a decrease of 1.25 points or 19.6%),

compared to the VCO group, which decreased from 5.38 to 4.56 (a decrease of 0.82 points or 15.2%).

Although no statistically significant differences were found between groups, the greater reduction in the nanoemulsion group suggests potential clinical significance. A reduction of 19.6% indicates an improvement in skin appearance, which may enhance satisfaction and body image in postpartum mothers. Therefore, nanoemulsion-based sheet masks may still be considered a potential therapeutic alternative.

Analysis of changes in each group using a paired t-test showed that both interventions had a significant effect from pretest to posttest, with a greater decrease in the nanoemulsion group. These findings are in line with previous studies that mention curcumin and isoflavones play a role in improving skin structure, although their effects are influenced by age, parity, and skin elasticity.(Bingan, 2016; Jayanti et al., 2025; Oktavia, 2023b)

These findings also align with international studies showing that nanoemulsions enhance the penetration of active compounds due to their small particle size and large surface area. Such formulations have been reported to improve skin hydration, elasticity, and dermal repair, although short-term interventions do not always produce statistically significant results (Gupta et al., 2016; Kumar et al., 2025; Leite et al., 2023). Compared to conventional formulations, nanoemulsions offer better dispersion and stability; however, their effectiveness is influenced by treatment duration, individual skin characteristics, and hormonal factors. Longer intervention duration may lead to more pronounced outcomes.

The limitations of this study include the intervention duration of only four weeks, the lack of use of a skin analysis tool (Skin Analyzer) for objective measurements, the relatively small sample size, the uncontrolled variation in participants' lifestyles, and the absence of further toxicity testing, meaning that the safety of the formulation was only assessed through clinical observation of allergic reactions or irritation.

CONCLUSIONS:

A nanoemulsion-based sheet mask formulation of soybean oil and turmeric oil was successfully produced using high-speed homogenisation with Ultra Turrax, resulting in fine particles (94.75–163.7 nm), stable, safe (pH 6.5–7.1), non-irritating, and passing the 0.45 µm filtration test. The use of the sheet mask for four weeks reduced stretch mark scores by 19.6%, slightly higher than the VCO sheet mask (15.2%), although the difference was not statistically significant ($p>0.05$). Both sheet masks were proven to be safe and provided positive skin improvement in postpartum women.

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