

THE EFFICACY OF 5% PROBIOTICS (LACTOBACILLUS) GEL IN REDUCTION OF SEBUM PRODUCTION

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ABSTRACT

Skin is the most external neuroendocrine organ of the body and is a habitat for many microbiomes. Among these, *Propionibacterium acne* (P.acne) is the most common species that causes increase sebum production which will lead to acne formation. P.acne hydrolyses di and tri-glycerides into FFA with the help of lipase which results in lowering of skin PH, increase sebum production, irritation and promote inflammation. Probiotics reduce the sebum production and decrease inflammation by blocking the growth of P.acne. The amount of volunteer needed will be 14. The age gap is between 18-40 and can be of both male & female. Explanation to volunteer and getting the written informed consent will be done before starting any procedure. The gel has to be taken about 5mg twice/day (one at morning, one at night). Follow up will be on 0,4th and 8th week. The volunteer has to come back to hospital and the researcher will monitor the sebum production condition & skin condition by using the sebumeter & the VISIA. If there is side effects like skin redness and irritation. The researcher will note down and take action at once.

Keywords: Propionibacterium, Sebum, Acne

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INTRODUCTION

Acne is the most common and popular skin disease which is caused by multiple factors. These include hyper- seborrhea, alteration of follicular keratinization, inflammatory process caused by colonization of *Propionibacterium acne*(P.acne) and immune complex response which include both innate and acquired immunity (Tan et al., 2018). Acne effects on both sexes. Even though its prevalence got highest in between teenagers, it can also occur in adult population (Chilicka, Rogowska, Szygula, Dziendziura-Urbinska, & Taradaj, 2020).

Skin is the most external neuroendocrine organ of the body and is a habitat for many microbiomes (Grice & Segre, 2011) (Adamczyk, Garnarczyk, & Antonczak, 2018). Microbial compositions vary on human to human since they depend on environmental factors, pollution/humidity, exposure to UV radiation and daily use of cosmetics (Faergemann & Larko, 1987). Researchers and many scientific evidences have now approved that skin microbiomes have a close relationship with the pathogenesis of acne. Among many kinds of microbiome, P.acne is the most likely acne causing pathogen and it is commonly found in sebum rich area like face, scalp and back. Main action of P.acne is that it hydrolyses di and tri-glycerides into FFA with the help of lipase which results in lowering of skin PH, increase sebum production, irritation and promotes inflammation. C.acne also produce proinflammatory mediators such as protease, hyaluronidase and neuraminidases. Hormones such as androgen and testosterone play a role in controlling of sebum production. Excessive sebum production has an intimate relationship with the pathophysiology of acne (Ray, Trivedi, & Sharma, 2013). There have been numerous treatments for acne which are non-invasive topical agents such as Alpha hydroxy acid, benzoyl peroxides, retinoid and topical antibiotics and invasive agents like oral antibiotics, oral vitamin A derivatives (isotretinoin), laser therapy and chemical peeling. But there are still challenges in current acne treatment. Topical treatment causes skin dryness, irritation and can cause skin barrier disruption. Dark side of oral treatment is that isotretinoin has wide variety of side effects including skin dryness, alopecia, arthralgia, depression, liver function test/serum lipid abnormalities. It needs complex lab test to monitor liver function and lipid profile while on isotretinoin therapy and even before starting the oral therapy. Isotretinoin also has the serious risk on pregnant woman which causes spontaneous abortion and congenital malformation.

Nowadays, researchers are continuously searching for the new way of treating acne which brings more positive result with less side effect. Topical Probiotics treatment has now been increasing attention to use in acne disease. It has direct and indirect acne treating potential. Direct effects are exerted by blocking the growth of P.acne, resulting in reducing of sebum production which in turn decrease inflammation/irritation, enhancement of antibody production and cytokine synthesis is also balanced (Fuchs-Tarlovsky, Marquez-Barba, & Sriram, 2016). Indirect effects occurred through reducing the side effects of other existing treatments (Kober, 2015). Not only reduced sebum production, probiotics also increase production of ceramides such as phytosphingosine which provides antimicrobial and antiinflammation.

On October 2001, WHO reported that probiotics as ‘live microorganisms’ which when administered in adequate amount confer a health benefit on the host. In this thesis, we would like to find out more about efficacy, safety and adverse effect of topical probiotics lactobacillus strain in reducing sebum production

LITERATURE REVIEWS

Pathogenesis of acne

Acne is a chronic inflammatory disease and it can be classified into three types- acne vulgaris, acne rosacea and acne inversa. Before moving into each acne type, the main thing is that all of the types of acne are cause by the disorder of the structure called folliculopilosebaceous unit

(FPSU). FPSU unit has three parts and each part has its own function. Follicular part contains keratinocyte which produce keratin and the Pilar unit product is the hair. The last one, sebaceous gland produces sebum. During the delivery of the baby, sebaceous glands produce sebum which act as lubricant, preventing the sticking of the baby in the birth canal (FW, 2005). Abnormal keratin production by keratinocytes (stimulus can be hormone especially Dihydrotestosterone) causes accumulation of keratin within the follicle. Hyperkeratinization causes increase in pressure within the follicle which in turn lead to lack of oxygen and result in anorexia. The state anorexia favors the growth of P.acne which is a gram positive anaerobic bacteria. (Danby, 2015).

Overproduction of sebum related to androgenic hormones and genetics. Sebum provide nutrition to P.acne and supports its proliferation ((Danby, 2015). P.acne produces protease and lipase, which hydrolyses di and triglycerides that are part of sebum into free fatty acid, which act as irritant and proinflammation factor. P.acne causes activation of innate immunity via the expression of protease activated receptor (PARs), Tumor necrosis factor (TNF alpha), Toll like receptor (TLRs) and the production of gamma interferon (INF), interleukins (Il-8,Il-12,Il-1) and tumor necrosis factor. These cytokines induce matrix metalloproteinases (MMP) which plays a role in inflammation, dermal matrix destruction and hyperpigmentation of post-acne.

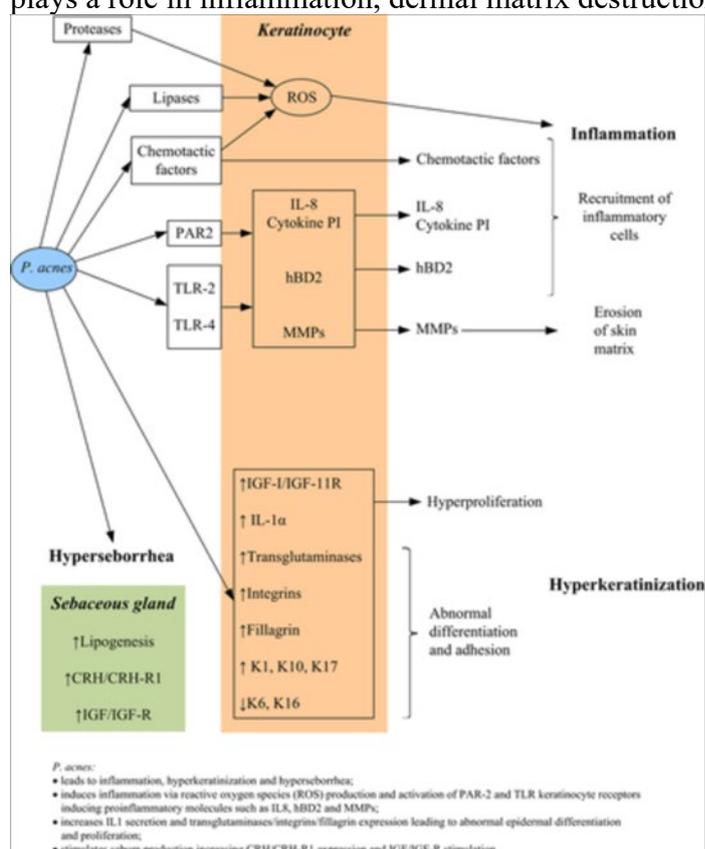


Figure 1 The figure shown above is built by (Beylot & Auffret) in the year of 2013, under the title of Propionibacterium acnes: an update on its role in the pathogenesis of acne.

Types of acne

Acne type can be differentiated into two groups-noninflammatory and inflammatory acne lesions.

Noninflammatory lesion

- Consist of plugged pores with open tops which is known as Blackhead.
- Plugged pores with closed tops known as Whitehead. (Materson, 2018)

Inflammatory Lesion

Inflammatory lesion consists of papules, pustules and nodules.

- Papules are small elevated bumps which are in red color and often tender.
- A collection of pus over papule is called papulopustule.
- Definition of pustule is that a collection of pus alone at the opening of a pore.
- If a pustule is occurred on the follicle, it is called a folliculopustule.
- Nodule are raised or deep, red or purple bumps and they are usually tender.
- Cysts are encapsulated cavities lined by a true epithelium and inside which contains fluid or semi-solid materials.

Grading of Acne

If the one with some noninflammatory lesion with few inflammatory lesion (only papules and pustules) without nodules can be classified as mild severity. For the moderate severity, one can have no more than one small nodular lesion together with some noninflammatory lesion. Severe stage when having many noninflammatory and inflammatory lesion with few nodular lesions.

Severity	Description
Clear	Clear skin with no inflammatory or noninflammatory lesions
Almost clear	Almost clear; rare noninflammatory lesions with no more than one small inflammatory lesion
Mild	Mild severity; greater than Grade 1; some noninflammatory lesions with no more than a few inflammatory lesions (papules/pustules only, no nodular lesions)
Moderate	Moderate severity; greater than Grade 2; up to many noninflammatory lesions and may have some inflammatory lesions, but no more than one small nodular lesion
Severe	Severe; greater than Grade 3; up to many noninflammatory and inflammatory lesions, but no more than a few nodular lesions

Adapted from Center for Drug Evaluation and Research, U.S. Department of Health and Human Services (2006). FDA = Food and Drug Administration.

Figure 2 A sample grading for acne severity which is approved by FDA (Katrina, 2018).

Acne treatment aims to reduce inflammation, prevent systemic side effects, minimize post-acne hyperpigmentation, and improve quality of life. Treatment options depend on severity and include topical and oral therapies, lifestyle changes, and patient education.

Acne Treatment Overview: Acne treatment aims to reduce inflammation, prevent side effects, minimize hyperpigmentation, and improve quality of life. Treatment depends on the severity of acne and patient factors like education, lifestyle, diet, and hygiene.

Topical Treatments:

1) Retinoids (Vitamin A derivatives):

Mechanism: Dissolve comedones (clogged pores) and regulate skin cell growth. Forms include retinol, retinal, and esters, with varying strengths. Potent forms can cause irritation.

Usage: Start 3 times a week, increasing frequency as tolerated.

2) Benzoyl Peroxide:

Mechanism: Releases oxygen, dissolves sebum, and kills *P. acnes* bacteria. Effective for antibiotic-resistant acne.

Concentration: 2%-20%, with potential side effects like contact dermatitis.

3) Salicylic Acid:

Mechanism: Prevents comedone formation by slowing cell shedding inside follicles and inhibiting *P. acnes* growth.

Side Effects: Mild stinging, especially on broken skin.

Oral Treatments:

1) Isotretinoin:

Mechanism: Inhibits sebum production and keratinization. Can cause significant side effects (joint pain, dry skin, liver issues, depression).

Contraindications: Avoid during pregnancy due to risk of birth defects.

2) Oral Antibiotics (Tetracyclines):

Examples: Doxycycline, Minocycline.

Mechanism: Inhibit bacterial protein synthesis, also reduce inflammation.

Side Effects: Nausea, diarrhea, and gut disruption with long-term use.

3) Oral Contraceptive Pills (OCP):

Mechanism: Antiandrogenic effect reduces sebum production in women with hormone-related acne.

Side Effects: Weight gain, nausea, and increased appetite.

Other Acne Therapies:

Laser and Light Therapies: Nd:YAG, Intense Pulsed Light, and radiofrequency used as monotherapy or in combination.

Topical Probiotics on sebum production:

Propionibacterium induces an increase in the production of free fatty acids, which subsequently leads to inflammation and the development of follicular keratosis. On the epidermal surface, the application of topical probiotics inhibits the proliferation and colonization of *Propionibacterium*, thereby reducing sebum production and enhancing skin complexion.

Topical Probiotics on inflammation:

Probiotics colonize the skin, promoting the production of antimicrobial peptides (AMPs) that inhibit pathogens and improve the skin's microbial balance. They prevent pathogen adhesion to skin cells and work with the host's immune response to provide a dual defense against infection. This approach holds promise for developing anti-inflammatory and anti-infective therapies. (Carolina Vieira De Almeida, 2023)

Topical Probiotics on photoaging:

Probiotics also show promise in preventing skin photoaging by reducing UV-induced oxidative stress, MMP synthesis and collagen degradation. (Carolina Vieira De Almeida, 2023)

General Benefits of Probiotics:

Skin: Prevents acne by reducing inflammation and improving skin barrier.

Digestive Health: Helps with diarrhea, constipation, IBS, and lactose intolerance.

Mental Health: Improves symptoms of anxiety, depression, and other disorders.

Cardiovascular system: Help lower blood pressure and reduce bad cholesterol (LDL).

Immune System: Enhances immune response and prevents infections

RESEARCH METHODOLOGY

The study is a clinical, whole-face experimental design conducted at Mae Fah Luang University Hospital in Bangkok, Thailand. It involves male and female participants aged 18-35 who have moderate to high sebum production and are experiencing acne. The study aims to assess the efficacy of 5% probiotics (*Lactobacillus*) gel on sebum production and skin complexion. The sample size is determined based on previous research, with a target of 14 volunteers accounting for a 40% dropout rate. Participants, aged 18-40, must meet specific inclusion criteria, such as having uncontrollable sebum production and being willing to follow study instructions.

Exclusion criteria include chronic diseases, pregnancy, or current acne treatments. Volunteers undergo a patch test before the study, and their sebum levels are measured using the Sebumeter® SM815 at baseline, week 4, and week 8. Skin texture is evaluated using the VISIA® Complexion Analysis System. Data collection includes oiliness levels, skin condition, and volunteer satisfaction, with adverse effects monitored. Volunteers are followed up at weeks 4, 6, and 8. Statistical analysis involves comparing the mean changes in sebum production and skin texture using appropriate statistical tests. Ethical guidelines are strictly followed, ensuring informed consent, confidentiality, and participant safety throughout the study.

RESEARCH RESULTS

General Characteristics of the Participants

Table 1 General Characteristics

General characteristics		n = 14
Gender, n(%)		
Male		6
Female		8
Age (years)		
Mean±SD		
Min-Max		

Sebumeter score at each week

Table 2 Sebumeter score at each week

		Probioitcs1	Probiotics2	Probiotics3	Probiotics4	Probiotics5	Probiotics6	Probiotics7
Baseline	Forehead	308	283	298	299	312	236	253
	Tip of nose	295	287	385	234	293	294	346
	Right cheek	250	374	276	316	386	354	260
	Left Cheek	268	358	264	229	309	319	278
4 th week	Forehead	300	285	280	240	320	208	250
	Tip of nose	253	280	253	257	273	290	344
	Right cheek	270	300	234	285	287	342	275
	Left Cheek	265	297	260	248	282	320	270
8 th week	Forehead	253	240	220	217	335	174	237
	Tip of nose	200	218	187	248	228	253	205
	Right cheek	211	186	205	188	215	275	220
	Left Cheek	195	191	198	230	212	263	224
		Probioitcs8	Probiotics9	Probiotics10	Probiotic11	Probiotics12	Probiotics13	Probiotics14
Baseline	Forehead	211	287	223	314	221	274	250
	Tip of nose	226	349	266	365	242	248	228
	Right cheek	370	276	240	320	268	232	239
	Left Cheek	342	292	257	347	243	251	257
4 th week	Forehead	253	294	220	310	235	260	230
	Tip of nose	213	321	274	355	231	237	212
	Right cheek	268	254	238	279	212	218	264
	Left Cheek	287	299	242	300	257	244	248
8 th week	Forehead	238	274	204	284	214	231	218
	Tip of nose	207	292	220	337	203	194	200
	Right cheek	243	231	195	236	209	215	177
	Left Cheek	254	253	260	240	235	220	189

Sebumeter score

Table 3 Statistical analysis of Sebumeter score at forehead, tip of nose, right cheek, and left cheek on baseline, follow-up 4th, and 8th week (n=14)

	Mean±SD	P-value
Forehead		
Baseline	269.21±36.34	0.002*
4 th week	263.21±35.21	
8 th week	238.50±39.31	
Tip of nose		
Baseline	289.86±53.38	<0.001*
4 th week	270.93±44.54	
8 th week	228.00±42.21	
Right cheek		
Baseline	297.21±55.09	<0.001*
4 th week	266.14±34.17	
8 th week	214.71±25.83	
Left cheek		
Baseline	286.71±41.66	<0.001*
4 th week	272.79±24.83	
8 th week	226.00±26.17	

Data were analyzed with Repeated measure ANOVA

* Statistically significant at the 0.05 level ($\alpha = 0.05$)

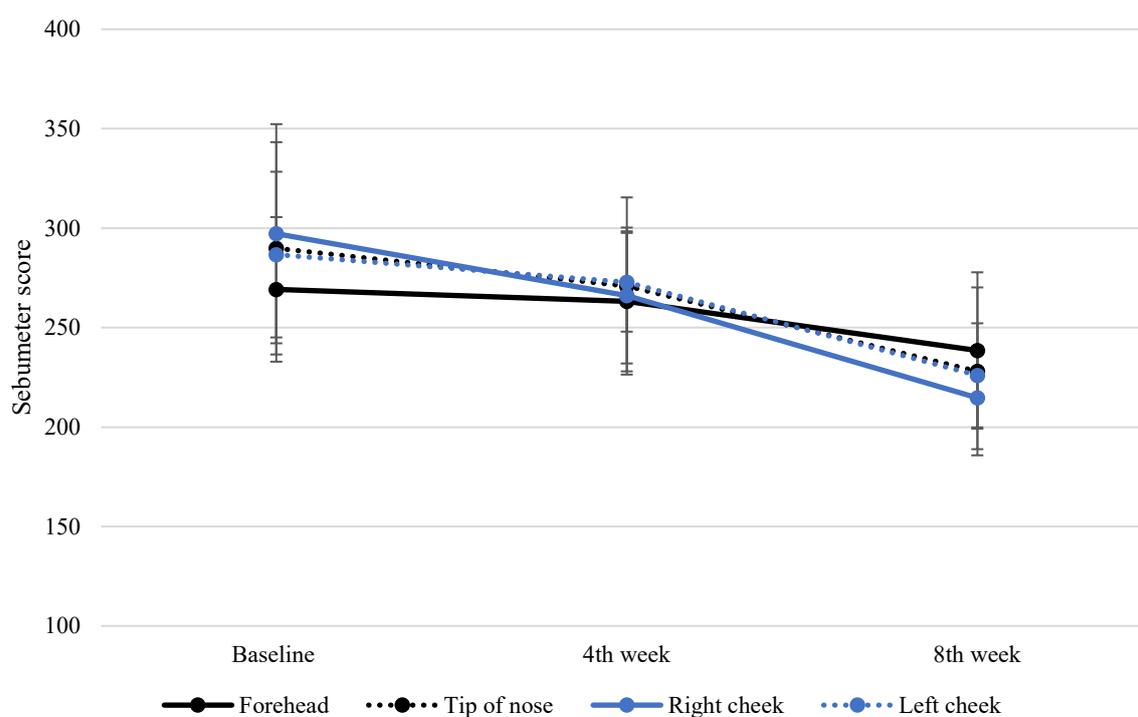


Figure 3 Line graph displaying sebumeter score at forehead, tip of nose, right cheek and left cheek on baseline, follow-up 4th, and 8th week

According to the statistical analysis result from Table 4.3 and Figure 4.1, mean of sebumeter score at forehead on baseline, follow-up 4th, and 8th week were 269.21±36.34, 263.21±35.21,

and 238.50±39.31, respectively. The mean of sebumeter score at forehead in each visit decreased statistically significant at the 0.05 level ($p=0.002$).

The mean of sebumeter score at tip of nose on baseline, follow-up 4th, and 8th week were 289.86±53.38, 270.93±44.54, and 228.00±42.21, respectively. The mean of sebumeter score at tip of nose in each visit decreased statistically significant at the 0.05 level ($p<0.001$).

The mean of sebumeter score at right cheek on baseline, follow-up 4th, and 8th week were 297.21±55.09, 266.14±34.17, and 214.71±25.83, respectively. The mean of sebumeter score at right cheek in each visit decreased statistically significant at the 0.05 level ($p<0.001$).

The mean of sebumeter score at left cheek on baseline, follow-up 4th, and 8th week were 286.71±41.66, 272.79±24.83, and 226.00±26.17, respectively. The mean of sebumeter score at left cheek in each visit decreased statistically significant at the 0.05 level ($p<0.001$).

Table 4 Multiple comparison analysis (Post-hoc test) of Sebumeter score (n=14)

	Mean difference	P-value
Forehead		
Baseline vs. 4 th week	-6.00	1.000
Baseline vs. 8 th week	-30.71	0.012*
4 th week vs. 8 th week	-24.71	0.001*
Tip of nose		
Baseline vs. 4 th week	-18.93	0.211
Baseline vs. 8 th week	-61.86	0.002*
4 th week vs. 8 th week	-42.93	0.001*
Right Cheek		
Baseline vs. 4 th week	-31.07	0.042*
Baseline vs. 8 th week	-82.50	<0.001*
4 th week vs. 8 th week	-51.43	<0.001*
Left Cheek		
Baseline vs. 4 th week	-13.93	0.168
Baseline vs. 8 th week	-60.71	0.001*
4 th week vs. 8 th week	-46.79	<0.001*

Multiple comparison by Bonferroni method

*The mean difference is significant at the 0.05 level ($\alpha = 0.05$)

According to the multiple comparison analysis result from Table 4.4, sebumeter score at forehead on 8th week was lower than baseline (MD = -30.71, $p = 0.012$) and 4th week (MD = -24.71, $p = 0.001$) all statistically significant at the 0.05 level. The sebumeter score at tip of nose on 8th week was lower than baseline (MD = -61.86, $p = 0.002$) and 4th week (MD = -42.93, $p=0.001$) statistically significant at the 0.05 level. The sebumeter score at right cheek on 4th week was lower than baseline (MD = -31.07, $p = 0.042$), on 8th week lower than baseline (MD = -82.50, $p < 0.001$) and 4th week (MD = -51.43, $p < 0.001$) all statistically significant at the 0.05 level. The sebumeter score at left cheek on 8th week was lower than baseline (MD = -60.71, $p = 0.001$) and 4th week (MD = -46.79, $p < 0.001$) also statistically significant at the 0.05 level.

Pore size by VISIA® Complexion Analysis System

Table 5 Statistical analysis of pore size on baseline, follow-up 4th, and 8th week (n=14)

	Mean±SD (%)	P-value
Baseline	71.14±20.74	
4 th week	77.36±16.87	<0.001*
8 th week	79.64±16.70	

Data were analyzed with Repeated measure ANOVA

* Statistically significant at the 0.05 level ($\alpha = 0.05$)

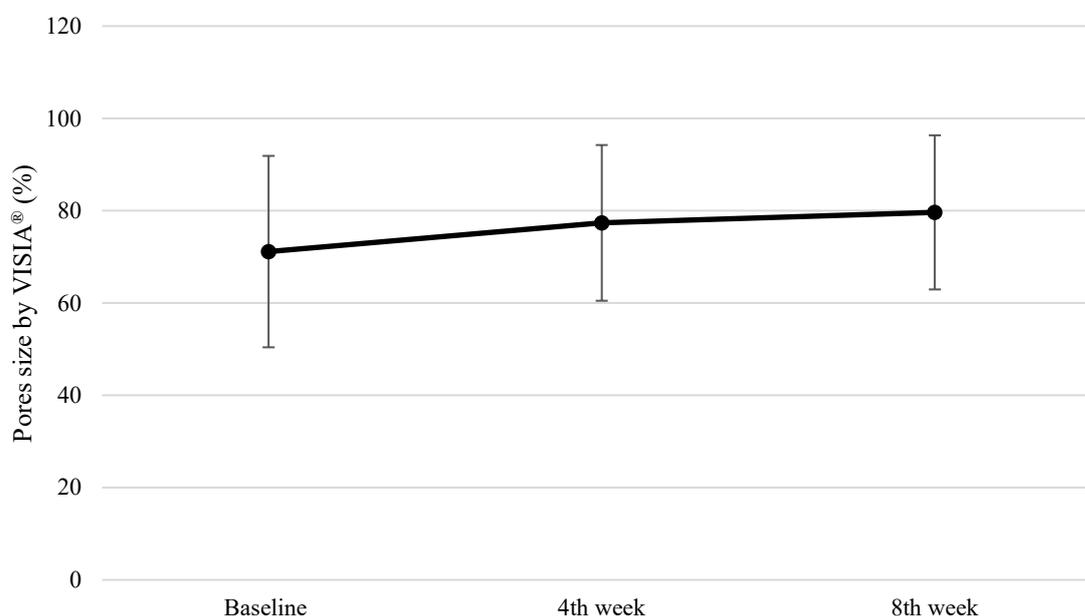


Figure 4 Line graph displaying pore size on baseline, follow-up 4th, and 8th week

According to the statistical analysis result from Table 4.5 and Figure 4.2, mean of pore size on baseline, follow-up 4th, and 8th week were 71.14±20.74%, 77.36±16.87%, and 79.64±16.70%, respectively. The mean of pore size in each visit increased statistically significant at the 0.05 level ($p = 0.002$).

Table 6 Multiple comparison analysis (Post-hoc test) of pore size (n=14)

	Mean difference (%)	P-value
Baseline vs. 4 th week	6.21	0.044*
Baseline vs. 8 th week	8.50	0.001*
4 th week vs. 8 th week	2.29	0.676

Multiple comparison by Bonferroni method

*The mean difference is significant at the 0.05 level ($\alpha = 0.05$)

According to the multiple comparison analysis result from Table 4.6, pore size on 4th week was higher than baseline (MD = 6.21%, $p = 0.044$), and on 8th week was higher than baseline (MD = 8.50%, $p = 0.001$) all statistically significant at the 0.05 level.

Participant's satisfaction score at 8th week

The satisfactory of participants at 8th week evaluated the results with the grading scale as follow:

0 = no satisfaction

1 = little satisfaction

2 = moderate satisfaction

3 = more satisfaction

4 = most satisfaction

Table 7 Frequencies of participant's satisfaction score at 8th week (n=14)

Satisfaction level	n = 14
No satisfaction	0
Little satisfaction	0
Moderate satisfaction	3
More satisfaction	8
Most satisfaction	3

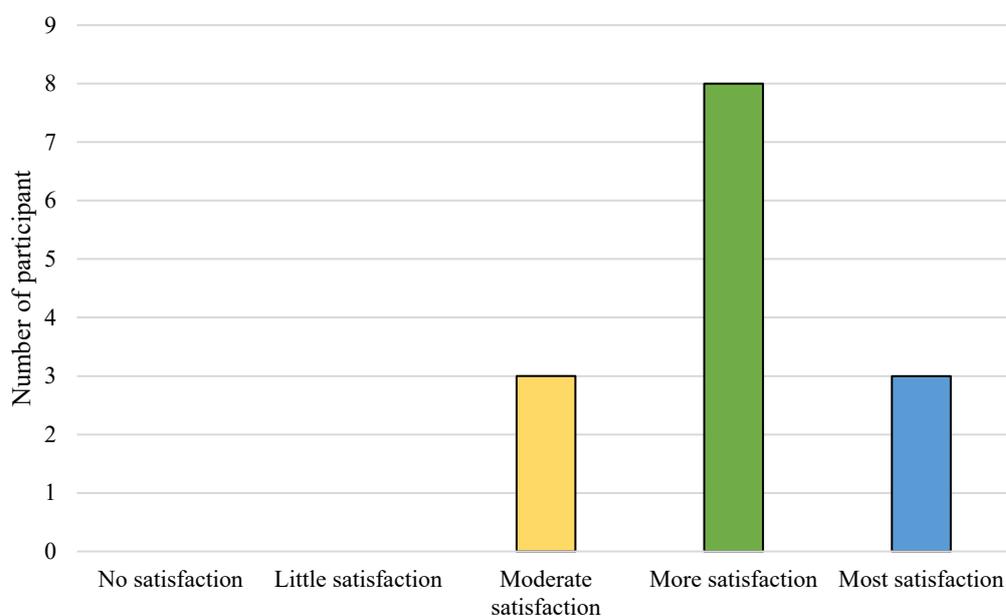


Figure 5 Frequencies of patients' satisfactory score

According to the result from Table 4.7 and Figure 4.3, eight subjects rated more satisfaction. Following that, three subjects reported moderate satisfaction and three subjects reported most satisfaction.

Side effect

Table 8 Frequencies of side effect on follow-up 4th, and 8th week (n=14)

Side effect	4 th week	8 th week
Itchiness	1	1
Rash	1	0
No side effect	12	13

According to the result from Table 4.8, the side effects on follow-up 4th week were itchiness after first application and a rash on the right cheek, with one subject each of these symptoms.

For the volunteer who got itchiness, the itchiness persists for only a few seconds and does not require any treatment. It may be attributed to a Type I hypersensitivity reaction. For the volunteer who got rash, the rash appears on the right cheek immediately following application, measuring approximately 2x2 mm, and consists solely of erythema without papules or pustules. The condition subsides after approximately 5 minutes of ice compression. This may also be indicative of a Type I hypersensitivity reaction. Another volunteer experienced mild itchiness during the 8th week follow-up, which occurred shortly after the first application and lasted only for a few seconds. This was not a severe side effect, and there was no need to wash off the gel. The symptom resolved spontaneously without further intervention. Since the reaction occurred shortly after application, it is likely attributable to a Type I hypersensitivity response.

DISCUSSION & CONCLUSION

Acne vulgaris is one of the most prevalent dermatological conditions, affecting individuals of all genders due to a complex interplay of factors, including hyperseborrhea, follicular keratinization abnormalities, and inflammation caused by *Propionibacterium acnes* (*P. acnes*) colonization. This study aimed to investigate the efficacy of a 5% probiotic (*Lactobacillus*) gel in reducing sebum production. Fourteen participants, aged 18 to 40 years, with no underlying medical conditions and no prior acne treatments in the four weeks preceding the study, were enrolled. Importantly, all participants adhered to the follow-up schedule, and no dropouts were reported. To assess the effectiveness of the probiotic gel, objective and subjective measures were utilized, including Sebumeter readings, VISIA scan analysis, and patient satisfaction scores. Evaluations were conducted at baseline (Week 0), Week 4, and Week 8 to determine changes in sebum production, pore size, and overall treatment efficacy. The results demonstrated a statistically significant reduction in sebum production across all measured facial regions (forehead, nose, right cheek, and left cheek) ($p < 0.05$). Specifically:

- Forehead: Sebum levels decreased significantly from 269.21 ± 36.34 at baseline to 238.50 ± 39.31 at Week 8 ($p = 0.002$).

- Nose: Sebum levels declined from 289.86 ± 53.38 at baseline to 228.00 ± 42.21 at Week 8 ($p < 0.001$)

- Right cheek: Sebum levels were reduced from 297.21 ± 55.09 at baseline to 214.71 ± 25.83 at Week 8 ($p < 0.001$).

- Left cheek: Sebum levels showed a significant decrease from 286.71 ± 41.66 at baseline to 226.00 ± 26.17 at Week 8 ($p < 0.001$).

Moreover, an increase in pore size was observed, with mean percentages rising from 71.14% at baseline to 79.64% at Week 8 ($p = 0.002$). Patient satisfaction scores indicated high levels of favorable responses, with most participants expressing positive outcomes regarding their facial skin condition. Minimal side effects were reported, mainly mild itchiness and rash, with no severe adverse effects. The observed reduction in sebum production aligns with previous research suggesting that probiotics exert antimicrobial effects on *P. acnes*, potentially disrupting bacterial colonization and reducing inflammation (Bowe, 2006). The findings further support literature indicating that probiotics can contribute to restoring acidic skin pH, relieving oxidative stress, and enhancing skin barrier function, which are beneficial for acne treatment and overall dermatological health (Sharma et al., 2016). Additionally, Karnati R.K. (2022) highlighted that topical probiotic applications are considered safe and well-tolerated compared to conventional acne therapies, such as chemical exfoliants, which may induce skin irritation.

Limitations of the Study

While the study provides promising evidence regarding the efficacy of 5% probiotic (*Lactobacillus*) gel in reducing sebum production, several limitations should be acknowledged.

1) Small Sample Size: The study included only 14 participants, which may limit the generalizability of the findings, although the number of participants used has been scientifically obtained via statistical calculation method. Future studies should incorporate larger sample sizes to validate these results.

2) Short Study Duration: The follow-up period was limited to eight weeks, which is adequate to monitor the efficacy, but not providing assessment of the long-term effects of probiotic gel on acne severity and recurrence. Extended clinical trials can be of additional evaluation of its sustained efficacy and potential cumulative benefits.

3) Scope of Evaluation: While sebum reduction and pore size were assessed, other parameters such as inflammatory lesion count, comedonal acne severity, and microbiome alterations were not examined. Expanding the scope of clinical and microbiological assessments would provide a more comprehensive understanding of probiotics' role in acne management.

Conclusion

The findings from this study indicate that 5% probiotic (*Lactobacillus*) gel effectively reduces sebum production, with statistically significant improvements observed across all facial regions. Additionally, an increase in pore size and high patient satisfaction further highlight its potential therapeutic benefits. Given its minimal adverse effects, probiotic gel could serve as a safe and viable alternative to standard acne treatments. However, further investigations—including larger, controlled, and long-term studies—are necessary to confirm its efficacy and optimize its formulation for broader and long-term dermatological applications.

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