

Effects of Malaysian thermal spring water as adjunct therapy for mild to moderate acne vulgaris – a prospective, randomised, controlled, split face study

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ABSTRACT

Introduction: Acne is a common skin disease with a high psychosocial burden, affecting mostly adolescents and youth worldwide. Management of acne is often challenged by cutaneous side effects that leads to therapeutic intolerance, poor compliance and impaired efficacy.

Materials and Methods: This was a single-centre, evaluator-blinded, split-face, randomised study investigating the effects of thermal spring water (TSW) in improving efficacy and tolerability of standard acne therapy. Total of 31 participants with mild-to-moderate acne were recruited and subjected to TSW spray to one side of the face 4 times daily for 6 weeks in addition to standard therapy. The other side received standard therapy only.

Results: Six (19.4%) males and 25 (80.6%) female with mean age 25.1 ± 6.13 participated, 15 (48.4%) had mild acne while 16 (51.6%) had moderate acne. Seven (22.6%) were on oral antibiotics, 25 (80.6%) used adapalene, 6 (19.4%) tretinoin and 21 (67.7%) benzoyl peroxide. Skin hydration improved and better on spring water treated side with mean difference 12.41 ± 30.31 , $p = 0.04$ at the forehead, 39.52 ± 65.14 , $p < 0.01$ at the cheek and 42.172 ± 71.71 , $p < 0.01$ at the jaw at week 6. Participants also report significant reduction in dryness at the treated side at week 6, mean difference 0.93 ± 0.10 , $p < 0.001$. TEWL, sebum and pH were comparable on both sides with no significant differences. Tolerability towards standard therapy improved as early week 2 with reduction of stinging following application of topical therapy (mean difference 0.62 ± 1.43 , $p = 0.03$), increase in skin feeling good (-1.79 ± 1.70 , $p < 0.001$) and skin suppleness (0.62 ± 1.43 , $p < 0.001$). These improvements were significantly maintained till week 6. Cardiff acne disability index significantly improved at week 6 ($p < 0.001$) despite no significant changes in Comprehensive Acne Severity Scale score before and after treatment.

Conclusion: TSW may have a role as an adjunct to standard acne therapy by improving hydration, acne disability index and tolerability towards standard topical treatment.

KEYWORDS:

Acne, thermal spring water, trans-epidermal water loss, hydration

INTRODUCTION

Acne vulgaris is a common dermatologic disorder and was ranked as the 8th most prevalent disease worldwide by The Global Burden of Disease Project with a prevalence rate of 9-4%.¹ Approximately 85% of all individuals experience acne to some degree in their adolescence. Acne is a multifactorial chronic inflammatory disease of the pilo-sebaceous unit with four main pathogenetic mechanisms. Abnormal keratinocyte proliferation leads to ductal obstruction. An increase in sebum production creates a condition conducive for *Cutibacterium acnes* colonisation which cause production of inflammatory and chemotactic mediators that drive the inflammatory process leading to formation of comedones, papules pustules and sometimes nodules.² Acne has profound psychosocial effects that may undermine self-confidence and self-esteem at a vulnerable time in life.³

Patients with acne vulgaris exhibited markedly higher sebum secretion, greater transepidermal water loss (TEWL) and reduced stratum corneum (SC) hydration compared to age and gender matched controls.⁴ The degree of SC barrier permeability impairment correlates directly with acne severity.⁵ Current treatment for acne is effective and well established, however irritant dermatitis and side effects associated with local inflammation like dryness, irritability and redness are common and may lead to poor compliance. Restoring SC hydration and barrier function is an important factor in acne management to improve tolerability, compliance and ultimately efficacy.

Thermal spring water has been used for years in both spa and aerosol forms in patients suffering from multitude of skin diseases especially those associated with inflammation such as psoriasis and eczema. Their beneficial effect has been recognised for centuries especially in alleviating symptoms of inflammation.⁶⁻¹⁰ Thermal spring water (TSW) use for burn scars, pruritus, rosacea-like dermatosis and ichthyosis have also been widely described.^{9,11,12}

Our study objectives were to investigate the effect of a local thermal spring water on skin biophysical parameters including SC hydration, TEWL, sebum and pH in patients on treatment for acne vulgaris. Effect of the thermal spring water on local inflammatory symptoms associated with acne and tolerability to the standard acne topical therapy were determined.

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MATERIALS AND METHODS

Study Design

This was an investigator-blinded, randomised split-face standard therapy-controlled trial conducted at the Department of Dermatology, Hospital Canselor Tuanku Muhriz in Kuala Lumpur, Malaysia. The sample size was determined using G*Power software (version 3.1.9.4). By comparing experiment and control groups with an effect size of 0.8, power of 80% and a 5% type 1 error and accounting for a 20% of drop-out rate, the final required sample size is approximately 31 patients for each treatment and control group.

Patients aged 14 to 45 years old with diagnosis of mild to moderate acne vulgaris on topical therapy (topical retinoids: adapalene 0.1% gel or tretinoin 0.05% cream) with or without oral antibiotics (doxycycline) were included. Diagnosis and severity of acne was confirmed by a dermatologist. Exclusion criteria was known hypersensitivity to thermal spring water or mineral bath, any generalised dermatitis, current or recent (within 1 month from initiation of study) local inflammation or infection on the face, and patients on isotretinoin or \leq 8 weeks of discontinuation of isotretinoin therapy.

Participant's face was split with an imaginary midline and block randomisation was used to determine the side for thermal water therapy. One side received thermal spring water with standard therapy while the other side received standard therapy alone. Split face study design is used to reduce risk of other confounding factors such as the skin type, spray technique, compliance and other environmental factors. Throughout the whole study period, the investigator assessing the clinical outcome was blinded to the side of treatment.

Clinical outcome assessment includes TEWL, SC hydration, sebum and surface pH were measured using Tewameter TM300, DermaLab Combo and Hanna Instrument pH meter respectively. Measurement was performed at the forehead, maxillary and mandibular areas on both sides of the face. Inflammatory (papules and pustules) and non-inflammatory lesion (comedones) of each side were counted by the same investigator and the severity of acne was assessed using Comprehensive Acne Severity Scale (CASS). All parameters were assessed at baseline, week 2 and week 6. All participants were acclimatised in dermatology laboratory for 20 to 30 minutes at temperature of 18°C prior to measurement so that the skin parameters were measured under the same conditions throughout the study.

Participants self-assessment include tolerability to topical therapy, local inflammatory symptoms stinging, itching, erythema and dryness was assessed using a visual analogue score (VAS) at three time points: before treatment (baseline), during treatment (week 4 and week 6). The impact of acne on quality of life and the participants' perception of their acne was scored using Cardiff Acne Disability Index (CADI) at baseline and week 6. CADI is a validated short five-item participants self-administered questionnaire derived from the longer version of acne disability index.¹³

Thermal Spring Water Collection and Storage.

The source of the thermal mineral spring water is from Sg Lalang located in Hulu Langat, Selangor, Malaysia. Spring water from this area is known to have low mineral composition with almost absence of sulphur component due to its non-volcanic nature. Sungai Lalang Hot Spring Water is a neutral spring water with pH 7.3 and low mineral content with Na 30.137 mg/L, K 1.64 mg/L, Silicates 27.96 mg/L, Fe 0.057 mg/L, Zn 0.009 mg/L, Mg 0.0425 mg/L, Ca 1.373 mg/L and Cu 0.0004 mg/L. The water also contains bicarbonates.¹⁴ Thermal mineral spring water was obtained from the main well in Sg Lalang using a high-density polyethylene (HDPE) aspirator bottle. The water is left to cool to room temperature before filtered with filter paper No.54 via a glass funnel into the smaller 100 ml aluminium cylinder bottle and immediately sealed with mist spray nozzle. HDPE bottle is heat resistant with a low risk of leaching which may change the mineral composition of the studied water. Aluminium cylinder bottle was chosen due to its non-toxic and excellent corrosion resistance and act as a highly reflective coating for both light and heat and this is important to avoid thermal spring water composition alterations. Filtered water sample was cultured to ensure there was no bacteria contamination. All cultures showed no growth, similar to the autoclaved water sample which was used as control.

Patient Enrollment and Study Procedure

Thermal mineral spring water was supplied to the participants during their first visit (baseline) and second visit (week 2). Participants were instructed to spray one side of the face at a rate of five sprays in 1 minute, four times per day (7.00 to 8.00 am, 12.00 to 1.00 noon, 4.00 to 5.00 pm, 8.00 to 9.00 pm) for 6 weeks. A rigid plastic sheet was placed at the centre of the face to ensure the water mist did not reach the other side. The water was then left to air dried. The spray bottle was weighed weekly to monitor compliance.

Participants were required to continue their prescribed acne treatment on both sides of face. If the time of topical treatment coincided with the time for thermal water spray, thermal water was used first and let it air dried before application of topical medication. Participants were not allowed to change their usual skin care regime or use any acne treatment during the study period. Moisturisers or serum use were not allowed. Cosmetics use were allowed but adding new products was prohibited.

Written informed consent was obtained from all participants before participation in the study. The study was approved by University Kebangsaan Malaysia Research Ethic Committee, research code FF-2022-038.

Statistical Analysis

Data analysis was performed using SPSS version 24. Descriptive analyses determined sociodemographic characteristics of the study population. Categorical variables were presented as frequency with percentages. Continuous variables are presented as mean with standard deviation, median and inter-quartile range represent skewed data.

Bivariate analyses determined the effect of thermal spring water on TEWL, hydration, sebum, pH, tolerability to acne

Table I: Participants baseline sociodemographic characteristics (n = 31)

Characteristics	Mean(SD)	n	%
Age	25.1(6.13)		
Age of onset	17.2(4.95)		
Duration (months)			
Gender	24.1(14.2)		
Male		6	19.4
Female		25	80.6
Recurrence of Acne			
Yes		24	77.4
No		7	22.6
CASS			
Almost clear		5	16.1
Mild		10	32.3
Moderate		16	51.6
Current Treatment			
Tretinon		6	19.4
BPO		21	67.7
Adapalene		25	80.6
Antibiotic		7	22.6

Abbreviations: CASS, Comprehensive Acne Severity Score

Table II: Effects of TSW in skin barrier function, hydration, sebum and pH (n = 29) in both arms

Parameters	Mean Difference	Standard Deviation	p-value
TEWL			
Week 2			
Forehead	-0.27	3.88	0.711
Maxillary	0.07	4.44	0.932
Mandibular	0.13	2.79	0.8
Week 6			
Forehead	-0.53	3.98	0.48
Maxillary	-1.68	4.6	0.06
Mandibular	-0.77	3.57	0.26
Hydration			
Week 2			
Forehead	3.53	35.89	0.59
Maxillary	-8.1	47.12	0.35
Mandibular	5.7	78.37	0.69
Week 6			
Forehead	12.41	30.31	0.04
Maxillary	39.52	65.14	0.003
Mandibular	42.17	71.71	0.004
Sebum			
Week 2			
Forehead	0.83	11.74	0.7
Maxillary	-0.37	7.45	0.79
Mandibular	-2.03	6.79	0.11
Week 6			
Forehead	-0.31	9.67	0.86
Maxillary	-1.55	7.73	0.29
Mandibular	-2.14	10.12	0.27
PH			
Week 2			
Forehead	0.05	0.19	0.14
Maxillary	0.06	0.27	0.24
Mandibular	0.03	0.33	0.66
Week 6			
Forehead	0.01	0.19	0.74
Maxillary	0.10	0.29	0.06
Mandibular	0.02	0.19	0.56

Note: Results presented as a mean difference of skin biophysical parameters between side treated with standard topical acne therapy combined with TSW and standard topical acne therapy alone at week 2 and week 6.

Abbreviations: TSW, Thermal Spring Water; TEWL, Trans-epidermal Water Loss.

Table III: Comparison of effects of TSW on TEWL, hydration, sebum and pH between week 0 and week 6 (n = 29)

Parameters	Mean		Mean Difference	SD	p-value
	Week 0	Week 6			
TEWL					
Forehead	14.819	10.949	3.869	3.768	<0.001
Maxillary	12.645	11.406	1.24	4.96	0.19
Mandibular	11.118	9.493	1.62	4.63	0.07
Hydration					
Forehead	154.48	167.93	-13.45	59.85	0.24
Maxillary	224.79	266.28	-41.48	83.39	0.01
Mandibular	202.83	271.76	-68.93	82.71	<0.001
Sebum					
Forehead	13.38	12.38	1	15.81	0.74
Maxillary	10.3	9.07	0.97	11.33	0.65
Mandibular	7.41	9.93	-2.52	8.79	0.13
PH					
Forehead	5.49	5.38	0.11	0.45	0.22
Maxillary	5.71	5.69	0.02	0.43	0.79
Mandibular	5.72	5.65	0.07	0.42	0.39

Note: Results presented as a mean difference of skin biophysical parameters between baseline and 6 weeks (end of study period) over the side treated with TSW
 Abbreviations: TSW, Thermal Spring Water; TEWL, Trans-epidermal Water Loss.

Table IV: Assessment on the effect of TSW on local inflammatory symptoms associated with acne and topical acne treatment (n = 29)

Symptoms	Mean Difference	Standard Deviation	p-value
Pruritus			
Week 2	0.03	1.49	0.90
Week 6	0.10	1.15	0.63
Dryness			
Week 2	0.3	1.37	0.24
Week 6	0.93	0.99	<0.001
Redness (Erythema)			
Week 2	0.33	1.27	0.16
Week 6	-0.17	1.23	0.46
Stinging			
Week 2	0.1	1.45	0.70
Week 6	0	1.07	1

Note: The mean difference of inflammatory symptoms associated with acne and the topical therapy between the treated side with TSW versus the untreated side.
 Abbreviations: TSW, Thermal Spring Water.

Table V: Assessment of clinical effect of the TSW on immediate skin sensation post acne topical treatment

Sensation	Mean difference	Standard deviation	p-value
Skin Suppleness			
Week 2	-1.29	1.61	<0.001
Week 6	-1.82	1.36	<0.001
Skin tightness			
Week 2	0	2.39	1
Week 6	0	2.61	1
Skin feeling good			
Week 2	-1.79	1.7	<0.001
Week 6	-2.14	1.43	<0.001
Stinging			
Week 2	0.62	1.43	0.026
Week 6	0.79	1.95	0.037

Note: The mean difference of skin sensation between the treated side with TSW versus the untreated side.
 Abbreviations: TSW, Thermal Spring Water.

Table VI: Effects of TSW on acne severity and acne associated disability

	Mean	Mean difference	Standard deviation	p-value
CADI				
Week 0	7			
Week 6	4.23	2.774	3.074	<0.001
CASS				
Week 0		0	0.72	1
Week 6		0	0.76	1

Abbreviations: TSW, Thermal Spring Water; CASS, Comprehensive Acne Severity Score; CADI, Cardiff Acne Disability Index.

treatment, quality of life and local inflammatory symptoms. Level of significance was pre-set at 0.05.

RESULTS

A total of 31 participants were enrolled, 29 completed the study and were included in the statistical analysis. One patient withdrew secondary to treatment related adverse event and another one was lost to follow up. Baseline sociodemographic characteristics were summarised in Table I.

Clinical Outcome Assessment

Evaluation of effect of TSW in Skin Biophysical parameters
TSW treated side demonstrated better hydration compared to the untreated side with $p < 0.05$ at week 6. Mean difference in hydration between the treated side and the control side was 12.41 ($p = 0.036$) at forehead, 39.52 ($p = 0.003$) over maxillary area and 42.17 ($p = 0.004$) over the mandibular area. Sebum, TEWL and pH showed no significant difference between the treated side and the control side at each visit as shown in Table II. On the side treated with TSW, there was improvement in TEWL and hydration at week 6 in comparison to baseline. All areas namely forehead, maxillary and mandibular showed reduced TEWL and increased hydration numerically but the results were statistically significant over forehead area for TEWL and maxillary and mandibular area for hydration as shown in Table III.

Evaluation of effect of TSW in acne severity

There were no significant CASS score changes between the treatment arm and the control arm at baseline and at the end of the study. Some patients had improvement in acne severity which were not statistically significant.

Patient's Subjective Assessment

The effect of improved stratum corneum hydration of the skin was reflected by patients' self-assessment of symptoms. A significant number of patients reported improvement in skin dryness at treated side compared to the untreated side at week 6 with a mean difference of 0.931 ($p < 0.001$). Other inflammatory symptoms such as pruritus, erythema and stinging sensation showed no significant difference as shown in Table IV.

The side treated with thermal spring water significantly improved tolerability towards standard topical therapy as a significant number of participants reported reduced stinging sensation over the treated side of the face immediately after application of the topical treatment compared to the control side of the face and the difference can be felt as early as week

2 ($p = 0.026$). There was also improvement of the skin feeling good sensation and skin suppleness over the treated side compared to the non-treated side with ($p < 0.001$). However, there were no significant changes in the skin tightness sensation as per shown in Table V. These show that the TSW has a calming effect on the skin irritation induced by the topical acne treatment, and this would likely to improve participants adherence to therapy.

Majority of patients had reduction in CADI score at week 6 with mean difference of 2.774 ($p < 0.001$) as depicted in Table VI. At baseline, most participants had a mean score of 7, indicating moderate quality of life impairment. However, by the end of the 6-week study period, the mean CADI score had decreased to 4.23, indicating mild quality of life impairment. Participants' self-perceived improvement in quality of life impacted by acne measured by CADI score did not translate to improvement in their acne severity measured by CASS. There was no significant difference between the CASS score of the treated side of the face and the non-treated side of the face.

Safety

One participant developed adverse reaction to the studied water. She had facial erythema and itchiness on the treated side of the face after using the thermal spring water for 1 day (total of four spray). She was withdrawn from the study, symptoms resolved after stopping TSW. A few participants experienced mild tingling sensation over the treated side of the face, immediately after spraying which is transient self-limiting and did not warrant any intervention.

DISCUSSION

Emerging scientific data supports the beneficial effects of thermal spring water balneotherapy as an alternative or adjunctive treatment of skin diseases.^{9,10,15-29} Hulu Langat thermal spring water has low mineral concentration compared to other hot springs worldwide.¹⁴ Renowned thermal spring water with low mineral concentration include Avène (ASW) and La Roche-Posay (LRP) in France.^{9,21,27} The beneficial effects of these waters were attributed to its low mineral content with some specific characteristic like presence of unique microflora which is *Aquaphilus dolomiae* found in Avène and *Vitreoscilla filiformis* found in La Roche Posay, an ideal calcium magnesium ratio, high silicates content for ASW and high selenium content for LRP. Low mineral water has been shown to produce better hydration and skin comfort compared to high mineral content. Water with low salt concentration stay in contact with the skin longer as high surface tension caused the water to spread less over the skin surface and evaporated slower leading to a

better hydration.²⁸ Scanning electron microscopy showed application of low mineral concentration spring water on human skin explants resulted in homogeneous deposits of small crystals composed of only sodium and chlorine, whereas application of mineral rich spring water resulted in the formation of needle-like crystals composed of calcium and small sulphur grains which were heterogeneously spread across the skin surface.³⁰

The mineral content of thermal spring water affects the physical sensations experienced upon application to the skin and regular use. Freshness, suppleness, softness and comfort were perceived greater with lower mineral concentration thermal spring waters.²⁸ Thermal spring water also possess anti-inflammatory properties and exhibit antioxidant qualities which has been clearly documented in multiple *in vitro* studies. Lymphocytes cultured in Avène water had increased lymphoproliferative response to some mitogens, increased IL-2 and IFN- γ productions and decreased production of IL-4.³¹ La Roche Posay and Avène waters showed clear inhibitory effect on IL-6 and attenuated the formation of reactive oxygen species in human keratinocytes after UVB stimulation.¹⁵ The reduction of IL-6 levels was similar to betamethasone-17-valerate treatment.¹⁵ Avène water was able to inhibit histamine release and it was postulated that calcium and bicarbonate ions play a major role in its anti-allergic properties.³² It also reduced the inflammatory effect in a model of human skin explants stimulated by a neurotransmitter (vasoactive intestinal peptide).³³ High silicates content in Hulu Langat thermal spring water is advantageous as silica rich water like Monfortinho thermal spring water in Portugal has been shown to reduce cell metabolism and proliferation of keratinocytes and macrophages³⁴ and improve skin hydration in clinical study.³⁵ These findings suggest that silicate-rich spring water may hold promise in managing abnormal follicular keratinisation and inflammation in acne as well as alleviating irritation and barrier dysfunction associated with acne therapy.

Hulu Langat thermal spring water was an effective adjunct therapy for mild to moderate acne vulgaris in our study. Local symptom of dryness significantly improved, accompanied by objective increase in stratum corneum hydration and reduction in TEWL. Improvement of the skin barrier function might be one of the reasons thermal spring water reduce the irritant effect of topical retinoids and giving a better skin comfort sensation post topical retinoids application. Multiple studies have shown the beneficial effect of thermal spring water on skin hydration and barrier. Study using Sao Pedro of Sul thermal water in Portugal was able to improved skin barrier disruption in 82.4% of volunteers with skin irritation induced by sodium lauryl sulphate compared to sites treated with purified water.³⁶ Daily 20-minute baths in saline groundwater in South Korea for 2 weeks resulted with significant improvement in SCORAD index, skin hydration, TEWL, and pruritus in patients with atopic dermatitis.²⁶ A gel formulation containing Cró thermal water from Portugal which is rich in sodium, silica, potassium, and calcium resulted in improvement of skin textural parameters with significant improvements in hydration, TEWL, and skin relief.³⁷ The benefit on the skin barrier repair is likely due to

the combination of magnesium and calcium salts.³⁸ This beneficial effect of TSW in barrier function of the skin has also been demonstrated in other studies involving an atopic dermatitis patient where skin barrier defect is one of the underlying pathology with positive results.^{17-20,26,27}

Acne therapy especially topical retinoids contribute to inflammatory symptoms perceived by patients. This hinders adherence to therapy which leads to poor control of acne. Regular use of thermal spring water is beneficial in combating local inflammatory symptoms induced by acne and standard topical acne therapy. Significant reduction in desquamation was observed with retinoic acid combined with thermal spring water sprays compared to retinoic acid alone after 4 weeks in a randomised study.²² A significant number of our study participants reported enhanced suppleness and skin feeling good with thermal spring water post topical retinoid application as early as 2 weeks of therapy. Similar study using Leopoldine spa water showed a reduction in erythema measured by chromometer post sodium lauryl sulphate application which support an inhibitory effect of irritation.³⁹ Ave'ne thermal spring water use after fractional photo thermolysis has demonstrated a calming effect by minimising short-term adverse effects namely pain, dryness and redness in patients with dermal melasma treated with fractional resurfacing.²³ The use of low mineral thermal spring water following various dermatology procedures has been shown to effectively relieved pain and pruritus hence restoring patient comfort.^{21,24,25,29}

We did not observe significant changes in acne severity measured by CASS score likely due to the short study duration. A longer treatment duration would probably improve the efficacy as better hydration promotes better absorption of the medications. Improvement in acne treatment tolerability equal to a better adherence to therapy and the combined effect of these two would lead to a clinical improvement in acne. This study found that addition of thermal spring water to standard acne therapy resulted in a mean improvement on 2.7 points in CADI score reflecting the enhancement of stratum corneum hydration, reduction of local inflammatory symptoms and positive sensation did translate into better patient's quality of life (QoL). Acne is a dermatological condition with substantial psychosocial impact. The CADI is a questionnaire commonly used in clinical practice and therapeutic research to evaluates the impact of acne on patient quality of life. It has been identified as the simplest QoL scale to employ in dermatology practice.³⁹ A recent review revealed the widespread use of CADI questionnaire in therapeutic research globally.³⁶ Acne is a dermatological condition with substantial psychosocial impact. Although we did not demonstrate an improvement in CASS score, it established the relevance of CADI as a valuable addition to standard topical acne therapy in enhancing quality of life.

Numerous studies conducted on TSW from various regions around the world have demonstrated their positive impact on skin health both in vivo and in vitro studies and this also translated into their observed beneficial role in clinical studies. Although TSW from different sources may have distinct mineral compositions, each appears to offer skin

health benefits. The findings of this study offer further scientific support for the therapeutic application of spa waters in the management of chronic inflammatory skin diseases.

Treatment with thermal spring water is generally safe and the occurrence of adverse effect is almost negligible. Previous study in Thailand to evaluate acute cutaneous tolerance with thermal spring water with patch test found to be non-irritating under occlusion.¹⁸ However, one of our patients developed a reaction which necessitate withdrawal from the study. Although rare, hypersensitivity or irritation reaction to thermal spring water is possible and need to be further explored.

CONCLUSION

Hulu Langat thermal spring water was safe, well tolerated and beneficial as an adjunct treatment in mild to moderate acne vulgaris. Stratum corneum hydration improved associated improvement in symptoms of dryness. Adjuvant treatment with thermal spring water improve tolerability towards standard topical acne therapy such as benzoyl peroxide and retinoids by mitigating the irritation caused by these therapies. This led to lower patient-based rating of their acne impact on life.

LIMITATION

This study is limited by the small sample size and the lack of placebo control to determine if improved hydration and tolerability towards standard acne treatment is purely due the effect of thermal spring water or just water itself.

The optimal duration and frequency of thermal spring water treatment has yet to be determined. A longer follow up would also give more information on its effect on the acne severity.

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CONFLICT OF INTEREST

This is an investigator initiated study, none of the authors have relevant conflicts of interest.

DISCLOSURE

This research is partially funded by Ministry of Higher Education Malaysia as part of UKM SULAM programme initiatives. The author report no other conflicts of interest.

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