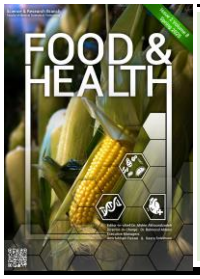

Food & Health Journal

Journal homepage: sanad.iau.ir/journal/fh

Effect of Borage Oil Supplementation on Skin Health: A Systematic Review of Randomized Control Trials

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ARTICLE INFO

Original Article

Article history:

Received 13 December 2024
Revised 18 January 2025
Accepted 3 February 2025
Available online 6 June 2025

Keywords:

Borage Oil
Dermatitis
Atopic
Acne Vulgaris
gamma-Linolenic Acid
Skin Care

ABSTRACT

Background: Borage oil, rich in gamma-linolenic acid (GLA), has been widely used for its potential anti-inflammatory and skin-repairing properties. This systematic review aims to evaluate the current evidence on the efficacy of borage oil in improving skin health.

Method: A comprehensive literature review was conducted across prominent databases, including Web of Science, PubMed, Google Scholar, Scopus, and the Scientific Information Database, extending up to February 2025. Searches in the Elsevier and SpringerLink databases complemented this review. The search strategy was formulated using the terms "Borage" OR "Borage oil", "Borage seed" in combination with "Skin" OR "Dermatitis" OR "Eczema" OR "skin health", along with all relevant components to explore the articles and databases. Following the screening process, a total of 14 articles were identified.

Result: After screening 628 abstracts, 14 RCTs were identified and met the inclusion criteria. In general, the findings suggested that borage may alleviate itching and improve erythema. It positively affected vesiculation and reduced skin blood flow. Borage may enhance skin hydration, benefiting skin barrier function, reducing crusting, and improving acne severity and oozing. Improvements were noted in skin roughness, smoothness, and dryness, along with increased hydration and humidity. GLA levels in plasma phospholipids increased, which was also accompanied by reduced levels of interleukin-8 and TGF-beta markers.

Conclusion: Borage oil may effectively alleviate skin issues and is recommended as an adjunct therapy for skin disorders.

Introduction

The skin, being the body's largest organ, serves multiple functions, including protection against germs, temperature regulation, and the perception of touch sensations. Skin diseases can be infectious, congenital, degenerative, inflammatory, or cancerous, affecting people of all ages (1). These conditions are more common in children aged 0-4 years and slightly more prevalent in men. Common subcategories of skin conditions include atopic dermatitis (also known as

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eczema), psoriasis, and acne. Recent studies have shown that skin and subcutaneous diseases accounted for 42.8 million Disability Adjusted Life Years (DALYs), with 5.26% attributed to years of life lost.

Additionally, skin diseases rank as the fourth leading cause of disability globally, excluding mortality (2). While not usually life-threatening, these conditions can significantly impact individuals' daily functioning, mental well-being, and relationships with others (3). As a result, skin conditions are a common reason for seeking medical assistance across all societies.

Common treatments for skin disorders, such as antibiotics and retinoids to treat acne or corticosteroids to treat eczema and psoriasis, despite their strong effectiveness, can be toxic or have acute side effects, or may have high costs (4).

Borage oil contains high amounts of Gamma-linolenic Acid (GLA), known as an anti-inflammatory substance that supports skin health. GLA is converted into Dihomo-gamma Linoleic Acid by the action of the Elongase enzyme. Subsequently, Arachidonic Acid is produced by the Delta-5 Desaturase enzyme, which is the primary source of anti-inflammatory substances called prostaglandins. Due to the lack of the Delta-6 Desaturase enzyme in the human body, GLA cannot be synthesized from Linoleic Acid. Therefore, GLA must be consumed orally (5).

Focusing on the potential benefits of plant oils on skin health, we chose borage oil, which has been previously investigated in human skin, animal skin, or in vitro studies. While numerous reviews have been conducted on the use of plant oils in skin health, there have been very few comprehensive reviews that focus solely on borage oil. The aim of this article was to review and summarize previous studies on the effects of borage oil on its use in skin health.

Method

Search strategy

During this systematic review, we adhered to the PRISMA guidelines. Studies on the impact of taking borage oil as a supplement on skin health were identified through a search of PubMed, Web of Science, and Google Scholar. Our search was conducted using the publisher databases of Elsevier, Wiley Online, and Springer. We viewed the keyword search strategy as a combination of MeSH terms and non-MeSH terms to cover exposure, borage oil and outcome skin health (Borage, "Borage oil", "Borage seed" in combination with "Skin", "Dermatitis", "Eczema", "Psoriasis", "skin care", "skin health", acne). Additionally, we reviewed the references of the included articles and related reviews to ensure that no articles were missed. There were no restrictions on time or language.

Inclusion criteria

Studies which met the following inclusion criteria were included: 1) randomized control trial (RCT) studies (either parallel or cross-over); 2) Studies conducted on people of all ages who had any type of skin diseases; 3) the exposure was borage oil as supplementation; 4) the outcomes were skin health, any diseases which are related to skin with no limitation. This study followed the PICOS (population, intervention, comparison, outcome, and study design) guideline.

Exclusion criteria

Excluded studies were as follows: 1) non-RCTs; 2) animal studies; 3) reviews, editorial articles, conference papers, and letters; 4) studies did not report borage oil as intervention; 5) relevant outcome was not available; 6) full text was not available.

Data extraction

Two separate reviewers collected and documented the following details in a form: first author, publication year, study design (including cross-over and parallel studies), study area, duration of follow-up, mean age, and sample size (F: n), as well as the dose of intervention (Table 1).

Table 1. Summary of each study included.

Author/year	Country	Study design	Dose	Disease	Sample size (F: N)	Duration (week)	Age	Result
M Andreassi et.al / 1997	Italy	Parallel (Intervention group: 30)	548 mg	Atopic dermatitis	60 (F:30)	12	15-30	Improvement of atopic dermatitis. Pruritus improved Reduction in erythema, vesicle formation and oozing Scaling appeared to be less affected by this treatment.

Table 1 (continued): Summary of each study included.

Author/year	Country	Study design	Dose	Disease	Sample size (F: N)	Duration (week)	Age	Result
2) Susanne Borrek et.al / 1997	Germany	Cross-over (Intervention group: 11)	360 mg daily	Atopic dermatitis	22 (F:14)	14	3-17	There was no improvement of the eczema
3) Henz et.al / 1999	Germany	Parallel (intervention group: 80)	500 mg daily	atopic eczema	160 (F:96)	24	14–65	Improvement was observed for erythema, vesiculation, crusting, excoriation, lichenification Serum IgE levels decreased but not statistically significant.
4) Thorolf Brosche et al / 2000	Germany	Parallel (intervention group: 14)	360 or 720 mg	Itch, skin humidity, trans-epidermal water loss	29 (F:16)	8	54.4–84.5	significant improvement of cutaneous barrier function Decrease in the transepidermal water loss. Improvement in itch Dry skin reduced No significant alteration of skin hydration was measured.
5) Christel J A W van Gool et.al / 2003	Netherlands	Parallel (intervention group: 60)	100 mg	atopic dermatitis	118	24	Infants (2 week of age)	Increase in GLA concentrations in plasma phospholipids
6) A Takwale et.al / 2003	England	Parallel (intervention group: 85)	920 mg	Atopic dermatitis	140 (69 children)	12	2 group: - 2-12 - over 12	No significant differences occurred between treatment and it is not beneficial in atopic dermatitis.
7) Unknown/ 2003	-	-	-	atopic dermatit	20 children	12	-	Use of borage oil did not bring any clinical or laboratory changes compared to the placebo
8)Silke De Spirt Et.al / 2008	Germany	Parallel (Intervention Group:45)	2200 mg	Skin condition in women.	45	12	18-65	Skin hydration was significantly increased Trans-epidermal water loss was decreased Roughness and scaling of the skin were significantly decreased

Table 1 (continued): Summary of each study included.

Author/year	Country	Study design	Dose	Disease	Sample size (F: N)	Duration (week)	Age	Result
9)Florence Puch Et.al / 2008	France	Parallel (Intervention Group:36)	150 mg GLA from BO	on epidermal function,	72	24	20–45	Improved stratum corneum barrier function Reduction in trans-epidermal water loss
10) Jae Yoon Jung Et.al / 2014	Korea	Parallel	2000 mg	acne vulgaris	45 (F:9)	10	18–33	Inflammatory and non-inflammatory acne lesions decreased
11) Nancy L. Morse et.al / 2018	Canada	open label clinical trial	120 mg of GLA	MED	28	4-8	19-65	Improved tolerance to UV exposure Increased MED
12) Genovese etal, / 2017	London	Parallel	50 ml	Healthy subjects	120 (In=60 / pl=60)	12	In:47.72 (6.5)	Significant increase in skin elasticity An improvement in skin texture Improve skin health.
13) M. Buslau etal, / 1996	Germany	Parallel	2000 mg	atopic dermatitis	32 (In:18 / Pl:14)	12	-	Improvement of the atopic The di-homo-gamma linolenic acid in serum increased significantly Increase for arachidonic acid No significant change in the total amount of serum IgE.
14) C Thijs et al, / 2000	Netherland	Parallel	230 or 460 mg GLA from BO	atopic mothers, lactating	40 (In: 20 /Pl:20)	1	22-38	Increased gamma-linolenic acid and dihomo-gamma-linolenic acid Arachidonic acid was not increased.

Result

The search yielded 619 articles from the PubMed, Google Scholar, and Web of Knowledge databases, along with nine additional records from other sources. After removing duplicates and non-qualified articles, 14 clinical trial studies were included in this review. The study selection process is detailed in the PRISMA flow diagram (Figure 1).

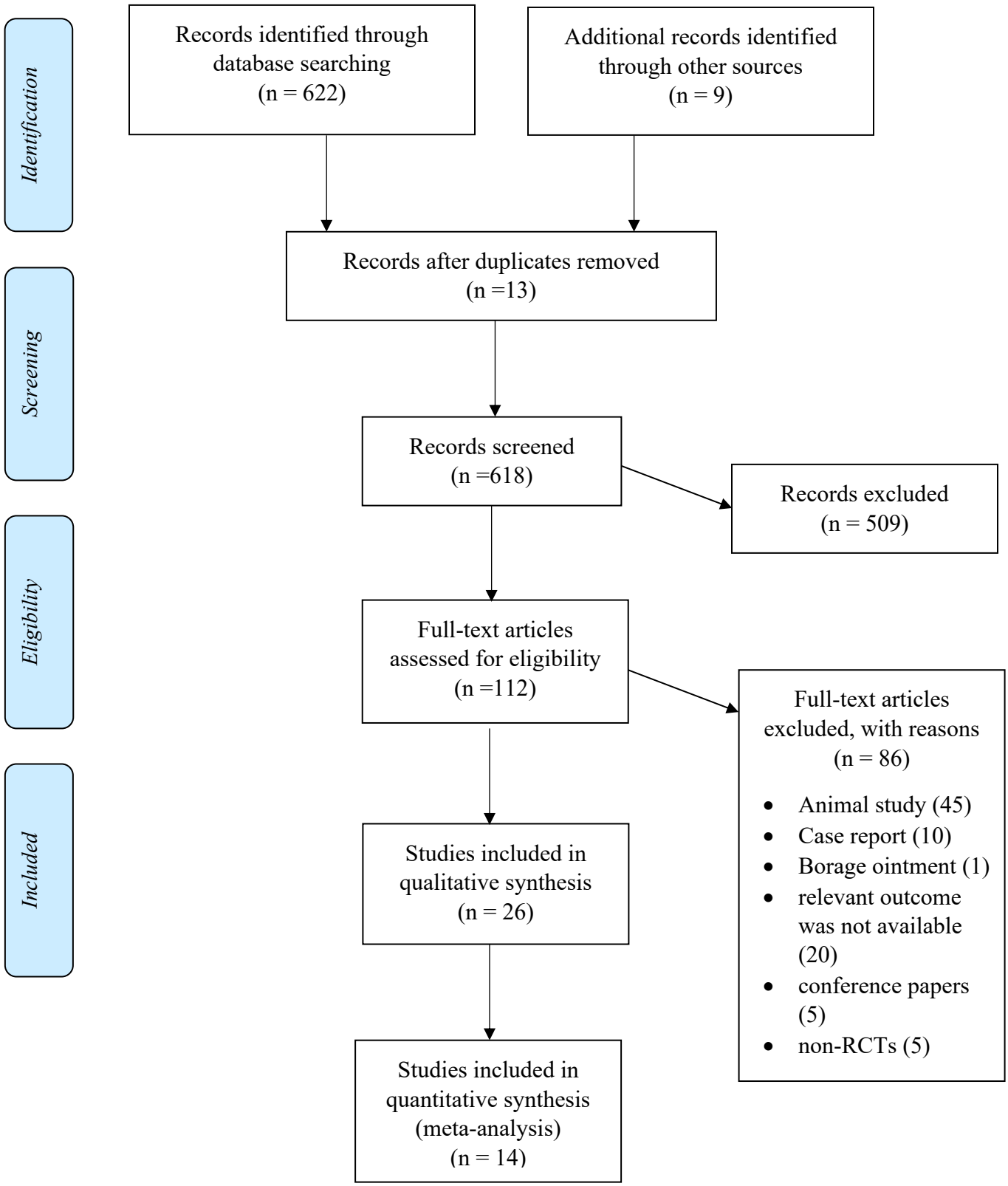

Fig. 1. Flow chart for study examined and included into the systematic review

These studies were conducted in 8 countries: Italy (6), Germany (7-11), the Netherlands (5, 12), England (13, 14), France (15), Korea (16), and Canada (17), spanning the years 1996 (7) to 2018 (17). A total of 929 individuals participated, comprising 509 patients in the intervention groups and 420 in the control groups. The minimum number of intervention participants was 11 (8), and the maximum number was 85 individuals (13). The longest study duration was 24 weeks (5, 9, 15), and the shortest was 1 week (12). In these 14 articles, the lowest dose of borage oil was 50 ml (14), and the highest was 2200 mg (11). Three studies did not specify the gender of participants (5, 13, 17), while three were conducted exclusively on women (11, 12, 15). Additionally, one study indirectly examined the milk of breastfeeding women (12). The age of participants ranged from 2-week-old infants (5) to individuals aged 84.5 years (10).

In the studies reviewed in this paper, some side effects were also observed. In one of the studies, two patients complained of diarrhea, which resolved spontaneously within a few days without treatment (16). In another study, several cases of influenza-like symptoms, nausea, headache, diarrhea, and vomiting were reported in both the borage oil-treated group and the placebo group (10).

In one of the studies, one subject developed a cough and took a cough medicine on one day (17). In addition to the aforementioned side effects, another study reported several cases of upper respiratory tract infection, diarrhea, nausea, vomiting, abdominal pain, episodes of urticaria, musculoskeletal pains, skin sepsis, glandular fever, and headache in both the borage oil-treated group and the placebo group (13).

Among the 13 articles reviewed, 11 focused on the Clinical factors. Five studies investigated the impact of itching, with two (8, 9) reporting no effect and three (6, 10, 13) indicating a positive outcome. However, the findings suggest that itching may improve due to borage. Erythema or redness was reported in three studies, with two (9, 11) of them reporting a positive effect and one (6) reporting no effect. Borage had a positive effect on vesiculation in two studies (6, 9) compared to the placebo group. The minimal dose of erythema (MDE) has been reported in one study (17), and the intervention group had a positive effect compared to the placebo group. A positive effect on reducing skin blood flow and no effect on wrinkling was observed in an article (11) compared to the placebo group. Trans epidermal water loss (TEWL) was examined in three articles (10, 11, 15), all of which reported a positive and significant effect, leading to the conclusion that Borage may enhance skin hydration. Two articles (10, 15) documented improvements in skin barrier function, with both studies affirming the efficacy of Borage. Crusting (scaling) has been reported in three articles. In one of them (6), there was no effect, while the other two (9, 11) achieved improvement compared to the placebo group. Lichenification and excoriation were addressed in a study (9), which was reported positive effects, indicating that Borage contributed to improvements in these conditions. One article highlighted Borage's positive influence on skin elasticity (14). Inflammatory acne lesion, non-inflammatory acne lesion, acne severity (16) and oozing (6) were measured in different articles, and a positive effect and improvement was seen in the intervention group. Furthermore, roughness, smoothness and dryness of the skin were reported in three studies (7, 10, 11), all showing positive outcomes and improvements, reinforcing the effectiveness of Borage. Additionally, an increase in skin hydration and humidity was positively noted in two studies (10, 11) in comparison with placebo group, further supporting the effectiveness of Borage in this regard.

Blood factors were assessed in 12 articles out of 14. Immunoglobulin E (IgE) levels were evaluated in four studies. In three of these studies, no significant differences were observed between the intervention and placebo groups, while the remaining study reported an increase in IgE levels within the intervention group. Three out of the 14 studies measured GLA in plasma phospholipids and showed an increase in the intervention groups. Furthermore, one study analyzing DGLA in plasma lipids showed a significant increase in the intervention group.

Additionally, one study examined plasma lipids, revealing a significant increase in ARA and a decrease in Palmitoleic acid in the intervention group compared to the placebo. Another investigation (16) into interleukin-8 and TGF-beta found a reduction in these markers within the intervention group. A separate study reported a significant rise in prostaglandin levels in the intervention group (6). Research on red blood cell membrane phospholipids in an article (10) demonstrated an increase in omega-6 levels in the intervention group, alongside decreases in saturated fats, omega-9 fatty acids, and monounsaturated fatty acids (MUFAs).

Discussion

In our present study, we comprehensively and systematically reviewed the currently available literature that investigates the effects of borage oil supplementation on skin health parameters. This study updates previous research, and additionally, the remaining studies did not provide a separate analysis of the effects of borage oil. It appears that consuming borage oil may improve skin health.

Based on our findings in older adults and patients with atopic dermatitis, a positive correlation appears to exist between the consumption of borage oil and a reduction in itching among participants, consistent with other studies (6, 10). The biochemical factors responsible for this reduction in itching are also likely associated with the type and composition of fatty acids in the skin cell membrane (10). GLA and DHGLA, following borage supplementation, serve as

precursors to monoenic prostaglandins; their increased density in cell membranes is an essential factor in reducing the pro-inflammatory effect of AA, the precursor of dienoic prostaglandins (10).

After evaluating the effects of borage oil supplementation on erythema (skin redness), consistent with other research, we found a positive link in participants (6, 11, 13). It's possible that the polyunsaturated fatty acids (PUFAs) in borage oil help strengthen cell membranes, making them more resistant to external damage. Additionally, PUFAs like GLA and DHGLA are involved in the production of leukotrienes and prostaglandins (PGs). These products are known to have anti-inflammatory and anti-proliferative properties (11).

De Sprit et al. (2008) found a positive association between borage oil intake and a reduction in skin blood flow, as we did (11). Increased blood flow in the skin is often associated with inflammation, resulting in redness. It is possible that PUFAs, such as GLA and DHGLA, in borage oil are involved in the production of leukotrienes and prostaglandins (PGs) that help protect cell membranes and structures, which may reduce external damage to the skin and the response to inflammation (11).

In line with other studies, we observed a positive correlation between borage oil supplementation and reductions in skin roughness and dryness, as well as improvements in skin hydration and firmness in both elderly individuals and women (10, 11). Possible explanations for this effect include the change in the fatty acid composition of erythrocyte membrane phospholipids, with increased incorporation of GLA and DGLA, and a reduction in trans-epidermal water loss (TEWL) and an increase in skin hydration (10, 11). Long-chain omega-3 fatty acids in borage oil may help down-regulate the production of inflammatory cytokines and enhance the stability of cell membranes. These actions enhance the skin's water retention capabilities, resulting in improved hydration and alleviation of conditions such as dryness and flaking (2,6).

In skin conditions associated with vesicle formation and oozing, such as eczema, borage oil's ability to enhance the levels of anti-inflammatory mediators is noteworthy. In studies with guinea pigs, borage oil increased levels of dihomo-gamma-linolenic acid (DGLA) and anti-inflammatory eicosanoids derived from it, such as PGE1. This suggests that borage oil could help reduce skin irritation, inflammation, and the formation of vesicles, providing a calming effect on inflamed skin (1).

Borage oil may also help reduce crusting and lichenification in chronic skin conditions. The bioactive peptides associated with collagen production are known to support skin repair by stimulating fibroblast activity, leading to the generation of new collagen, elastin, and hyaluronic acid. This can help repair damaged skin (14).

Borage oil, rich in gamma-linolenic acid (GLA), offers significant benefits for skin health, particularly for aging individuals who often experience a decline in skin function due to a deficiency of essential fatty acids (EFAs). This deficiency is partially attributed to reduced hepatic 6-desaturase activity, which is critical for converting linoleic acid (LA) into gamma-linolenic acid (GLA) and subsequently into dihomo-gamma-linolenic acid (DGLA).

Our findings also showed that GLA in borage oil could improve acne vulgaris by modulating the inflammatory process through conversion into DGLA, a substrate for cyclooxygenase and 15-lipoxygenase. These enzymes produce prostaglandin E1 (PGE1) and 15-hydroxydihomo-γ-linolenic acid (15-OH-DGLA), both of which possess anti-inflammatory properties, and the GLA metabolite 15-OH-DGLA may improve hyperproliferative skin conditions by modulating nuclear protein kinase C (PKC) and mitogen-activated protein kinase (MAPK). The anti-proliferative effect of 15-OH-DGLA may also correct follicular hyperkeratinization, a primary feature of acne vulgaris, thereby improving non-inflammatory acne lesions (18).

As far as possible, all studies without language restrictions were included in this study. The period of studies on this subject is quite extensive. Although there are several limitations, the findings should be interpreted with caution. Most importantly, there were few eligible studies, and most of them included small sample sizes. Furthermore, the significant heterogeneity between studies indicates that the effects of borage oil on skin health are not uniform, as the eligible studies employed different methodologies and were conducted among different populations. The full text of some studies were not available. Due to the limited number of studies, we considered different age groups; therefore, the results may not be applicable to all ages.

Conclusion

Based on the studies reviewed in the results, the use of borage oil may be effective and beneficial in alleviating skin symptoms and problems. It is suggested to be used as a supplementary treatment for skin diseases to reduce the dose of drugs. However, studies involving different races with larger sample sizes are needed.

Acknowledgments

None.

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