Journal of Holistic Integrative Pharmacy 4 (2023) 299–309

Contents lists available at ScienceDirect

Journal of Holistic Integrative Pharmacy

journal homepage: www.keaipublishing.com/en/journals/journal-of-holistic-integrative-pharmacy

Vitamins strategies for psoriasis: An update on current scientific evidence

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ARTICLE INFO

Keywords:
Psoriasis
Vitamins therapy
Targeted mechanism
Clinical study
Chromatographic analysis

ABSTRACT

Psoriasis is an aggressive chronic skin disorder that requires various therapies such as topical, oral, and occasionally, subcutaneous, or intravenous. In contrast, vitamins have more significant evidence in alteration to first-line therapies in the treatment of psoriasis. Vitamins such as fat-soluble and water-soluble supplements act as a secondary treatment that is given to reduce possible adverse effects from systematic medication, increase patient compliance, and consider affordable treatment costs. Here, the comparative study was conducted based on the data search from Pub Med, Google Scholar, Willy Library, etc., for both fat and water-soluble vitamins in psoriasis treatment first time. The present review summarizes the role of fat-soluble vitamins (A, D, E) and water-soluble vitamins (B_2, B_6, B_{12}, and C) based therapies in psoriasis treatment and result highlights the efficiency of oral supplementation of vitamins in psoriasis and systematic inflammation. Further, clinical studies along with *in-vitro* and *in vivo* based investigations have been compiled in this review, which shows that vitamins effectively can manage psoriasis. Additionally, the present review consists of chemical identification of both fat and water-soluble vitamins by High Performance Liquid Chromatography. The role of vitamins therapies in psoriasis management is promising and can be further to give in new horizon for improving the treatment efficacy. This review could provide an insight into vitamins emerging therapy in the treatments of psoriasis.

1. Introduction

Psoriasis represents a long-lasting immune system genetic disease that affects skin, joints, or both. Psoriasis includes a composite genetic make-up with an estimated global pervasiveness of 2 %-3 % of the worldwide population, with recent approximate suggesting more than 125 million affected individuals throughout world.[1] Psoriasis is broadly categorised into various phenotypes such as plaque, guttate, pustular, inverse, palmoplantar and erythrodermic type. The most common symptomatic manifestations include itching, soreness and burning sensation.[2] Psoriasis badly affects on the scalp region, knees, umbilicus, elbows and lumber region through lesions, which can occur anywhere and cover the entire surface area of the skin.[3] Psoriasis is also categorised into pruritic and painful lesions, which can crucially suffer patient life, even when the disease is not substantial. Based on potential effects of food supplements, vitamins, and nutrients on psoriasis, dermatologists determine the nutritional status during diagnosis. The appropriate balanced diets are recommended fulfilling the nutritional and caloric requirements. This may include the regulated intake of fats and sugars along with necessary dietary fibers with restricted intake of red meat, alcohol, simple sugars. While the patients with low serum levels of vitamins are considered for the vitamin supplementation and these changes are considered to benefit the psoriasis therapy and associated comorbidities such as inflammatory bowel disease, cardiometabolic disorders.[4]

There are various first-line treatments available for the management of severe forms of psoriasis. The various drugs such as methotrexate, salicylic acid, coal tar, cyclosporine are used for the severe form of psoriasis treatment.[4] These drugs have several side effects when it is used for the moderate and mild form of psoriasis. So further, the vitamins play an essential role in treating mild and moderate psoriasis. Nowadays, the various vitamins and their analogues are used to manage mild to moderate forms of psoriasis. They are given to the patient individually or in combination with the other drug.[5] Vitamins usually carry out a crucial role in psoriasis treatment. There are mainly two therapeutic vitamins and their used derivatives, i.e., vitamin A and vitamin D, respectively,

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https://doi.org/10.1016/j.jhip.2024.01.005
Received 21 September 2023; Received in revised form 24 January 2024; Accepted 25 January 2024

and three antioxidant vitamins and their derivatives are employed in the effective therapy of psoriasis. The well known properties of vitamin D typically induced by potential exposure to direct sunlight in treatment of psoriasis are being investigated for many decades.[6] Vitamin D mainly prolongs the homeostasis of cutaneous barrier in psoriasis and various published studies investigated the correlation between vitamin D specific receptors and vulnerability towards psoriasis; in psoriatic skin, a reduced expression of specific vitamin D receptor and reduced tight junction protein is typically associated.[7] Vitamin A and its functional congeners are broadly used to treat psoriasis. Along with this patients have also responded positively both to local as well as oral application of the vitamin based therapy.[8] Vitamin A deficiencies frequently have been detected in psoriatic patients. Also, water-soluble vitamins, when given in combination with some of the potable drugs, then they also play an influential role in the treatment of psoriasis.[9]

The graphical abstract describes that both fat-soluble and water-soluble vitamins plays a vital role in psoriasis management. To date, there is no complete review, which consists of the role of both fat-soluble and water-soluble vitamins in psoriasis. A literature investigation was conducted via an electronic search using PubMed, Scopus, A.C.S., Web Science, Science Direct, Google Scholar, and library textbooks. Based on the literature search, we reviewed various researchers' various achievements on the role of various vitamins in psoriasis treatment and management. Here, from the study, we are also able to find out the best effective form of vitamin useful in the healing of psoriasis.

2. Pathophysiology of psoriasis

Psoriasis is a prevailing chronic inflammatory skin disorder which is phenotypically illustrated as white scaly plaques. Psoriasis is not based on one single cause but is attributed to a set of factors including environmental and genetical factors.[10] The typical manifestations of psoriatic skin comprises of epidermal thickening termed as acanthosis which is a result of rapid turnover of epidermal keratinocytes.[11] This can also be attributed to the parakeratosis which is caused due to nuclei remains in the cornified layer of keratinocytes formed due to premature differentiation of keratinocytes. The granular layer of epidermis is lost in the psoriatic lesions.[12]

The development of scaly skin and epidermal hyperproliferation are the most significant hallmarks of the psoriatic skin. Thus, the therapeutic relief in psoriasis is achieved by controlling the proliferation index. Ki-67 is an important marker to detect the proliferation which dramatically is elevated in psoriatic skin indicating the brisk turnover of epidermal keratinocytes. The gene responsible for encoding of Ki-67 is MKI67.[13] Latest interventions utilises quantitation of proliferative index via newly formed DNA incorporating a detectable probe.[14] Another marker found widely in suprabasal layers is Cytokeratin-16 (CK-16) which is associated with the abnormal hyperproliferation and differentiation and is not found in healthy skin.[15,16] The main distinguishing feature of psoriatic skin is the presence of anti microbial peptides which is unique for the psoriasis and differentiates the condition from other inflammatory skin disorders. SKALP/elafin/PI3 (antileukoprotease), hBD2/DEFB4 (human beta-defensin 2), psoriasin (S100A7) are the other resilient markers for this condition.[17]

Psoriatic lesions in addition are identified by numerous subsets of immune cells such as dendritic cells, T and B cells, macrophages, plasma cells, neutrophils. However, the major determinants are $CD4^+$ T helper (Th)-cells (Th1, 17,22). The prevailing cytokines involved in the inflammatory environment are IL-17,22,23, TNF-α, IFN-γ.[18]

Psoriatic condition is associated with the dysregulated responses of innate and adaptive immunity and sufficient data supports the auto-inflammatory as well as autoimmune mechanisms.[19] Innate cell type 3 also is responsible for the generation of IL-17 which initiates the immune cell activation and epidermal hyperplasia.[20] The dysfunctional cytokine axis of IL-23 and 17 which is linked with TNF-α mainly exacerbates psoriasis.[21] However, the cross talk between dermal and immune cells is still not well understood but is significant in elucidation of the mechanism behind psoriatic condition.

T cell lineages such as T_H1, T_H2, T_H9, T_H17, T_H22 cells and regulatory T cells (Treg's) generates its specific cytokine and that further induces signals via a set of transcription factors. However, in psoriasis keratinocytes proliferates beyond its limit with the classical histological phenotype of psoriasis specific to acanthosis and epidermal hyperplasia.[22] The chief physiological utility of keratinocytes is the establishment and defence of the skin barrier, and to generate inflammatory cytokines including receptors of IL-17 and TNF-α which contributes in both the beginning and the intensification of psoriasis.[23] Therefore, of all the other innate immune cells dendritic cells are necessary as producer of cytokines, antigen presenters and to develop the link between adaptive and innate systems. However, plasmacytoid dendritic cells characterize various elements of innate immune system that circulate in blood; also certain viral and antigens act in response by releasing type I IFNs during the initial segment of inflammation in psoriasis, whereas myeloid dendritic cells promote the expansion of specified T_H cell populations through the assembly of cytokines such as IL-23 and IL-12.[24]

APCs (Antigen-presenting cells) demonstrates antigens identified by T-lymphocytes. These APCs exposes MHC of class I and II for which receptors are present on T-cell surface. The signalling via T-cell and APC complex activates cytokine and T-cell which results in alteration of epidermal differentiation and hyperproliferation, neoangiogenesis and decreased vulnerability towards apoptosis.[25] The inflammatory response is a result of immunologic synapse complex of adhesion molecules possessing T-cell receptors such as Lymphocyte function-associated antigen (LFA) 1, cytotoxic T lymphocyte antigen 4, CD40, CD86, CD28, CD80.[26] Natural Killer (NK) T cells directly presents antigen and are located in close proximity to the epidermal keratinocytes in psoriasis.[27]

3. Vitamins and psoriasis

Vitamins are complex organic compounds that are either produced in the organism or acquired from nature in the form of dietary sources.[28] Therefore, vitamins are obtained through the food we consume, and our body needs vitamins to function correctly. Vitamins are categorised basically into two fat and water-soluble classes. Fat-soluble vitamin stored in the body for an extended period compared to water-soluble vitamins, so it holds a higher risk for harmfulness than water-soluble vitamins when taken in extra amount.[29] The different fat-soluble vitamins are vitamin A (Retinol), itamin D (Calciferol), vitamin E (Tocopherols, Tocotrienols), vitamin K (Phylloquinone). Water-soluble vitamins structurally and functionally not dependent compounds which shares the characteristics of being vital for basic cellular activities, growth, and development. Numerous water-soluble vitamins are vitamin B_1 (Thiamine), vitamin B_2 (Riboflavin), vitamin B_6 (Pyridoxal group), vitamin B_{12} (Cobalamins), vitamin C (L-ascorbic acid), and Pantothenic acid. Each of the vitamins has its unique function in the body, and they are irreversible.

Role of vitamins especially vitamin D in auto-immune disorders has been well established in various investigations. Recently, vitamin D receptor (VDR) a nuclear hormone has been reported to play a major role in proliferation and differentiation of keratinocytes and in maintaining skin barrier homeostasis in psoriatic skin. This is necessary to maintain the tight junctions of epithelial and endothelial cells as dysregulated by psoriasis and reduces the pathological inflammatory response. This provides strong evidence for the role of vitamins especially vitamin D in the effective management of the psoriasis.[30]

Moreover, topical steroids, vitamin D analogues, and topical retinoids are among the first-line treatments for psoriasis.[31] As a result, the treatments listed above provide significant relief, but long-term remission is unlikely. Topical steroids and topical vitamins A and D, when used together, are more effective than either therapy alone.[32] Although topical therapies are commonly withdrawn due to the expensiveness and inconvenience of regular application, especially in moderate to severe

psoriasis forms. The compilation of *in-vivo* and *in-vitro* study of the vitamins and their derivatives is also mentioned in Table 1 and Table 2 respectively.

Fat-soluble vitamins and analogues have been shown to be effective therapies for psoriasis. These drugs have a low risk of side effects, making them effective for psoriasis treatment. The role of fat soluble vitamins A, D, E, and K in the cutaneous environment helps to explain their efficacy.[33] Several studies have found that patients with psoriasis are often vitamin deficient. It is unclear if this insufficiency is a direct result of the disease process, a byproduct of numerous comorbidities in specific groups, or a mild connection. However, several studies have found that oral vitamin supplements or customized diets can help in the treatment of psoriasis. In this section, we will delve into the role of fat-soluble vitamins in pathogenesis and the treatment of psoriasis.[34]

There is emerging evidence that vitamin A and D deficiency exists in psoriasis sufferers.[35] Several investigations have shown that topical or oral medicines ameliorate illness at the cellular level. Vitamin E has also been shown to be effective at the cellular level, but there is no evidence that it is deficient in psoriasis.[36] Current vitamin K research points to a cellular, anti-inflammatory route that may have a role in psoriasis therapy. More research on vitamin K is needed to establish the potential effect of supplementation in psoriasis sufferers. Because of the favorable safety profile and low cost of fat-soluble vitamin supplementation, psoriasis sufferers may benefit significantly.[33]

3.1. Fat-soluble vitamins

In case of ingestion of fat-soluble vitamins like A, D, E, and K in excess, they can cause toxicity and the condition is termed as hypervitaminosis which can pose much greater risk than water soluble vitamins.[37] As a result, the efficacy of fat-soluble vitamins and their analogues in the treatment of psoriasis has been proven.[38] Psoriasis can be treated using a variety of fat-soluble vitamin medicines. The fat-soluble vitamins block keratinization and target the retinoid X receptors (R.X.R.) and Retinoic acid receptors (R.A.R.) receptors.[39] As a result, the full mechanism of fat-soluble vitamin activity is illustrated in Fig. 1.

Table 1
In vivo study of vitamins and their analogues in treatment of psoriasis.

S. No.	Category	Drug	Animal model	Result	Reference
1.	Vitamin A	Acitretin	Male Wistar Albino rats and Adult Swiss Albino mice	↓ epidermal thickness.	32
		Apremilast	12 Male Wistar albino rats	↑ bioavailability in treatment of psoriasis	37
		Tazarotene	Male albino NMRI mice tail model	↑ drug accumulation in various skin layers and effective in treatment of psoriasis.	38
2.	Vitamin D	Calcipotriol	Male BALB/c mice	↑ anti-psoriatic activity.	39
		Maxacalcitol	Female BALB/c mice	↑ anti-psoriatic effect compared with Betamethasone valerate	40
3.	Vitamin E	Tocopherol	Sprague Dawley rats and male BALB/c mice	↑ efficacy and effectiveness in psoriatic patients	41
4.	Vitamin B_1	Thymoquinone	Male BALB/c mice	↓ level of IL-17 and TNF-α in psoriatic skin	42
5.	Vitamin C	Ascorbic acid	C57BL/6 mice	↑ effect of drug in psoriatic patients	43

3.1.1. Vitamin A

Vitamin A is a fat-soluble vitamin that is essential for the appropriate functioning of a wide range of metabolic physiologic functions. The use of vitamin A derivatives to treat psoriasis has been widely reported.[40] Both topical and oral administration of these medications have elicited positive results from psoriatic patients. Although the mechanism responsible for vitamin A deficiency in psoriasis is still not known. Vitamin A detection in psoriatic skin lesions is restricted. Deficiency of vitamin A is a common occurrence in psoriatic patients.[41] Rollman and Vahlqist, studied and reported the vitamin A status for 107 psoriasis patients versus 137 healthy control volunteers. As a result, most studies hypothesised that altered pathway for retinol mechanism in psoriasis skin lesions takes place, based on increased retinoic acid synthesis. Wang et al. recently discovered and showed that the vitamin A need for psoriatic skin lesions was prominent in a psoriasis mouse model.[42]

The thickened epidermis and immune infiltrates in psoriasis includes pro-inflammatory cytokines such as TNF-α, IL-17A, IL-23. vitamin A has significant role in therapy of psoriasis. Human body processes vitamin A in the form of retinol.[43] Retinol is known to combine with Retinol binding protein 4 (RBP4) to form a complex (holo-RBP4) which is specific for a membrane protein better known as stimulated by retinoic acid 6 (STRA6). This complex targets retinol into target sites. This program signalling pathways for human skin cells to differentiate and proliferate.[44,45] Skin proliferation is down regulated by 2 metabolised products of retinol that is retinal and retinoic acid. Cellular retinoic acid binding protein 1 and 2 (CRABP 1 and 2), retinal dehydrogenase (RDH), CYP450 family, cellular retinol binding protein 1 and 2, lecithin retinol acyltransferase (LRAT) are various proteins involved in the metabolism of retinol. Although, the association of metabolic syndrome is still unclear in case of psoriasis but it is believed that adipocytokines play important role in immune responses and inflammation, both of which are associated with psoriasis.[46] Authors suggest some association of RBP4 and STRA6 levels in psoriatic condition. These proteins help to achieve more redistribution of retinol in the target tissue which are required for psoriatic changes.[47]

Inhibitors of TNF-α, interleukin IL 12/23 and more recently IL17 inhibitors are used to control the severe and moderate forms of psoriasis.[44] These drugs are used to raise the risk of emergent mycotic infections such as *Pneumocystis jirovecii* pneumonia, candidiasis and histoplasmosis in patients. According to Picciani et al., 26 % (37/120) of patients with psoriasis tested positive for oral candidiasis compared to 0 % (0/140) healthy volunteers.[48]

Acitretin is an oral retinoid that is effective in treating psoriasis. It is the most major metabolite of etretinate, having a half-life of 49 h, which is significantly less than that of etretinate. Acitretin works by averting psoriasis-related increased cell proliferation and keratinization.[49] Hence, skin thickening, plaque formation, and scaling as a result is reduced. The mechanism of action of acitretin is still not known. It is thought to function by targeting certain receptors in the skin (retinoid receptors such as R.X.R. and R.A.R.) to assist restore the growth cycle of skin cells.[50] When given with food and at doses in the range of 20 to 100 mg per day, acitretin has the best oral absorption. As a result, the range is around 72 percent. After a single 50 mg dose of acitretin was given to 12 healthy participants, 47 % to 109 % of the supplied dose was absorbed. Michael S. Heath et al. had reported that, in a trial design of randomized open-label 60 patients suffering from psoriasis, three treatment groups were monitored for 24 weeks, less than 30 % patients who were on the monotherapy of acitretin, in compression to entrapment monotherapy,

Table 2
In vitro study of vitamins and their analogues in treatment of psoriasis.

S. No.	Category	Drug	pH	Model	Result	Reference
1.	Vitamin A	Acitretin	5.5	Higuchi and Korsmeyer Peppas	↑ release from 60 % to 96 %.	44
		Apremilast	5.4	Franz diffusion cells	↑ permeation of apremilast across the nail plate.	45
		Tazarotene	7.4	Membrane diffusion technique	↓ release of tazarotene in vessels (0.1 %-2.39 %).	46
2.	Vitamin D	Calcipotriol	7.4	PermeGear diffusion cells	↑ skin penetration up to 32 %.	47
		Maxacalcitol	7.4	Franz Diffusion cells	↑ skin permeability compared with other vitamin D_3 analogues.	48
3.	Vitamin E	Tocopherol	7.4	Franz Diffusion cells	↑ penetration in the skin	42
4.	Vitamin B_1	Thymoquinone	7.4	Dialysis bag method	↑ release to 100 %.	43
5.	Vitamin B_2	Riboflavin	7.4	Dialysis bag method	↑ release of the drug.	49

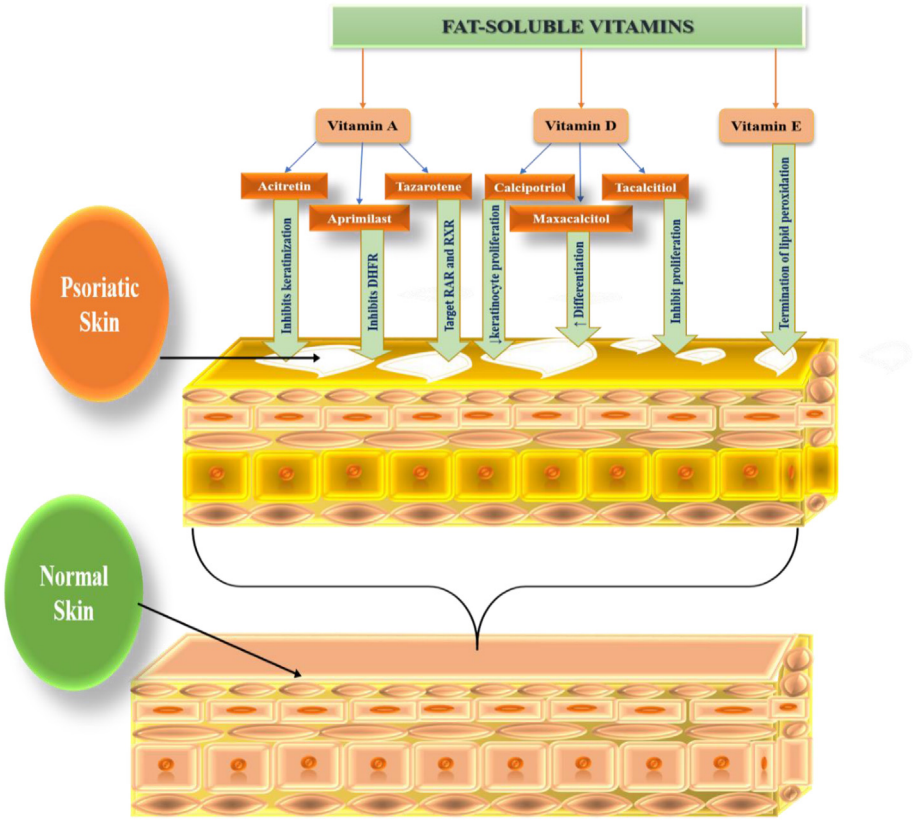

Fig. 1. Exploration the available evidence to support the use of fat-soluble vitamins in the management of psoriasis. In psoriasis condition, body produces excessive skin cells and major fat-soluble vitamins including vitamins A, D, and E can help improve psoriasis symptoms by reducing this overproduction.

achieved a 75 % progress in P.A.S.I. score (PASI75).[51] When compared to the acitretin group only, a border group of patients who got entrapment therapy plus attained improvement in PASI75 score. Although the main focus of clinical trials was chronic plague psoriasis, acitretin has been found to be as harmless and effective in two other types of psoriasis volunteers.[52]

Tazarotene belongs to the acetylenic family of retinoids. It is a pro-drug having significant utility in topical formulations to manage the conditions like sun based skin injuries (photodamage), psoriasis, acne.[53] Even though the literal mechanism of tazarotene activity is not well elucidated, some investigations have reported that the active form of drug (tazarotenic acid) binds to all three candidates belonging to the family of retinoic acid receptor (R.A.R.) family: RARa, b and g but elicits relative selectivity for RARb, and RARg which may alter the gene expression. It's also attracted to R.X.R. receptors.[54] The quick biotransformation of tazarotene to its active metabolite, tazarotenic acid, which metabolises after getting absorbed, results in minimal systemic absorption. In both normal and psoriatic patients, tazarotenic acid has shelf-life of 18-h. Samar Khalil et al. compared the effect of tazarotene cream in concentration of 0.05 % and 0.1 % formulations in a two multicentre, double-blind, randomised investigation. For 12 weeks, 1303 patients used one of the lotions daily for psoriatic lesions. Both treatment creams resulted in a greater reduction in plague progression when compared to placebo. The reaction was mentioned for a period of 12 weeks. The 0.1 % cream elicits better responses than the 0.05 % cream, but seldom cause irritation. Psoriasis can be effectively treated with 0.1 % tazarotene cream, according to the authors.[55]

3.1.2. Vitamin D

Epidermal keratinocytes are the only cells which can synthesize vitamin D from its precursor and provides all the necessary machinery including CYP2TA1 and CYP2B1 required to metabolize vitamin D. Vitamin D receptors are expressed on keratinocytes and exhibits autocrine and paracrine descriptors for the active form of vitamin D.[56] Vitamin D in association with calcium was effect on the skin differentiation and proliferation. As per the *in vitro* reports vitamin D at low concentrations enhances proliferation of keratinocytes and reverses this trend of proliferation and differentiation at high concentration.[57,58]

Presence of serum, cells density, calcium concentrations are the other factors having invitro effect on vitamin D.[59] C-myc and cyclin D expression attenuates via inhibition of proliferation by vitamin D and keratinocytes.[60] The differentiation part of vitamin D is mediated through increasing the levels of intracellular calcium, elevating the expression of phospholipase C and increased formation of ceramides.[61,62] Similarly, apoptosis of keratinocytes is facilitated at high doses of vitamin D and is negatively regulated at physiological doses stimulated by pro-apoptotic factors such as UV-radiations, TNF-α, ceramides.[63] Anti-apoptotic effect of vitamin D is due to sphingosine-1-phosphate. Stimulation of PI3K/Akt and MEK/ERK pathways is also responsible for the anti-apoptotic pathway.[64] Many studies have reported the deficiency of vitamin D in psoriasis patients.[65]

Clinically, Finamor et al. elaborated the daily intake of vitamin D_3 in psoriasis led to the improvement of severity index score PASI.[66] This can be attributed to various pathways which contributes in initiating the inflammatory cascades via vitamin D transforming enzymes and vitamin D specific receptors. Intake of vitamin D dysregulate the extent of dendritic cells to activate proliferation and secretion of T-cells and IFN-γ respectively.[67] Other investigations support the facts of suppression of inflammatory cytokines by vitamin D like IL-12/23 P40, TNF-α, IL-1 in psoriatic skin.[68] In another study, it was demonstrated that vitamin D congener upregulates the keratinocyte based LCE proteins and corrects the LCE based defects in psoriasis.[69] There is an association of polymorphism of vitamin D receptor and psoriasis.[70] The decreased expression of vitamin D receptor mRNA might be involved in changing the cutaneous barrier and progression of psoriasis.[71] The reduction in expression of vitamin D mRNA expression also reduces the tight junction proteins in psoriatic skin, which is fundamentally essential for regulation of permeability and adhesion of keratinocytes.[69,72] In case of topical vitamin D administration, inhibition of keratinocyte proliferation is mediated via genomic mechanism of vitamin D receptor.[73] Calcipotriol when given topically inhibits pro-inflammatory cytokines and β-defensin which can exacerbate psoriasis.[74]

Calcipotriol is a synthetic analogue of vitamin D. Skin exposure to UV radiation mediates the conversion of vitamin D_3 (cholecalciferol) from 7-dehydrocholesterol. The mechanism responsible for calcipotriol in the healing of psoriasis remains unknown. However, it has been demonstrated that calcitriol has a similar affinity for the vitamin D specific receptor as calcitriol, while having less than 1 % of the calcium metabolic activity.[75] Teo Soleymani et al. revealed that calcipotriol ointment, given at a dosage of 50 μg/g twice a day, was statistically more successful in lowering erythema, lesional thickness, and scaling in a large randomised, double-blinded, multicentre compression research. The authors came to the conclusion that calcipotriol is useful in the management of psoriasis.[76]

A vitamin D_3 analogue is **maxacalcitol**. Treatment of psoratic patients with maxacalcitol ointment at a dose of 25 μg/g once daily was demonstrated to be effective in lowering erythema and scaling in a large, double-blind, placebo-controlled active comparator study. Masaru Karakawa et al. did not find any statistically significant differences in the progress rates of P.A.S.I. scores between the combination and monotherapy group when they looked at the additive outcome of adalimumab and maxacalcitol. There was, however, a trend toward a better improvement rate in the combination group when compared to the monotherapy group.[77]

Plaque psoriasis is treated with **tacalcitol**, a synthetic vitamin D analogue. Everyday therapy with tacalcitol ointment at dose of 20 μg/g has also been shown to be effective and safe. In their investigation, Parul Aggarwal et al. found no significant improvement in the lesions at the end of the therapy period. When tacalcitol was added to NB-UVB, the target plagues were cleared faster and the response was maintained better than when NB-UVB was used alone. In her study, she found that tacalcitol ointment, in combination with NB-UVB phototherapy, appears to be a valuable and fairly-tolerable therapy, with a faster beginning of action and better response maintenance than other treatments, NB-UVB alone, in treating plaque psoriasis.[78]

3.1.2.1. Oral analogues of vitamin D therapy in psoriasis. 1α(OH)D is the first vitamin D analogue employed to treat psoriasis which leads in the alteration of keratin expression.[79] 1α(OH)D inhibits the proliferation and differentiation of keratinocytes which exhibits the anti-psoriatic effects. Vitamin D intake for 3 months potentially elevates the anti-inflammatory cytokines expression including IL-5 and IL-10 and attenuates the pro-inflammatory cytokines like IL-6, IL-8, IL-17, IL-1β, IFN-7, TNF-α along with the plasma level of homocysteine and PASI scores.[80] Chronic studies to evaluate the effect of vitamin D_3 intake furnished that high doses of vitamin D_3 led to improved skin conditions with no observable toxic effects which is conclusive of safe and efficient treatment of vitamin D in psoriasis.[81]

3.1.2.2. Topical analogues of vitamin D therapy in psoriasis. Topical administration is the first line treatment in mild to moderate conditions.[82] For this calcipotriol if the most efficient therapy which attenuates the production of IL-6 but is ineffective against the levels of TNF-α. The combinatorial treatment of NB-UVB along with calcipotriol is more beneficial than NB-UVB alone.[83] Calcipotriene along with betamethasone dipropionate in the form of ointment also elicited beneficial effects in psoriasis and has reached Phase 3, randomized, multicenter, investigator-blind study.[84,85]

3.1.3. Vitamin E

Herbert M Evans and Katherine Bishop identified vitamin E in 1922. It was biochemically defined and termed tocopherol in 1936.[86] Vitamin E is produced by plants and obtained from dietary sources. Nuts, spinach, whole grains, olive oil, and sunflower oil are all good sources. The word "vitamin E″ refers to eight distinct fat-soluble tocopherols and tocotrienols, the most physiologically active of which is α-tocopherol.[87] In the body, there are two active forms of vitamin E: α-tocopherol and γ-tocopherol. Both types are abundant within the stratum corneum after sebaceous glands secrete them. Vitamin E supplementation, whether taken orally or intravenously, has been found to reach the skin's outermost layers and does so within two weeks. The majority of vitamin E's benefits have no established mechanism of action. Vitamin E possess antioxidant properties that imparts protection to cell membranes from oxygen radical species.[88] Vitamin E, on the other hand, has been found to have anti-oxidant properties. Vitamin E's antioxidant impact is mediated in part by the prevention of lipid peroxidation. When vitamin E combines with unstable lipid radicals, stable lipids and a reasonably stable vitamin E radical are produced.[89] By reacting with ascorbate or glutathione, the vitamin E radical is converted back to stable vitamin E. α-tocopherol has a 36 % oral bioavailability, while γ-tocotrienol has a 9 % oral bioavailability. For α-tocopherol, the time to maximum concentration was 9.7 h and for γ-tocotrienol, it was 2.4 h.

The current status of psoriasis therapy is not dependent on the proposed protective mechanisms of Vitamin E, however some researches have shown that vitamin E is effective in psoriasis.[90] An animal study suggests that applying a methanolic extract of *Andrographis nallamalayana* topically to psoriatic lesions for 12 days alleviates symptoms. Elizabeth Usedom et al. cite a case study in which a 36-year-old woman with psoriasis was given nutritional supplementation and food management without concurrent regular psoriasis treatment. The diet omitted all processed foods and sweets, according to the authors, and the nutritional supplementation included 29.1 mg of α-tocopherol, 206 mg of extra natural tocopherols, and >35 vitamins, minerals, and amino acids. The patient then experienced complete illness remission six months later.[91] These represent the studies that support the role of vitamin supplementation in the management of psoriasis, but the addition of various other compounds astonishes the role of vitamin E in psoriasis. Mohammad Abid Keen, Iffat Hassan., had reported that a natural product called Mirak, is reported for psoriasis' treatment has become available in many

European countries. Natural spring water, volcanic dirt, and vitamin E cream make up Mirak. As a result, it has a small therapeutic impact as compared to placebo and no noticeable adverse effects.[92]

3.2. Water-soluble vitamins

Water soluble vitamins possess the structural and functional diversity that have the same primary purpose in proper cellular processes, growth, and development. Vitamin C, vitamin B_2, vitamin B_6, and vitamin B_{12} are examples of water-soluble vitamins. These vitamins are essential in the treatment of psoriasis when used in conjunction with other first-line treatments against psoriasis.[93] As a result, water-soluble vitamins work by preventing keratinization or by acting as antioxidants. In addition, Fig. 2 depicts the entire mechanism of action of water-soluble vitamins.

The chronic inflammation associated with psoriatic lesions influences the generation of free radicals and superoxide anion, resulting in oxidative stress.[94] Oxidative stress refers to a cellular imbalance in the amount of reactive oxygen species and antioxidants. It can lead to the formation of atherosclerotic plaques. Reactive oxygen species damage vascular endothelial cells, increasing the permeability of tiny capillaries and, as a result, allowing the passage of inflammatory cells, which worsens the development of inflammation in psoriasis.[94] Antioxidants (flavonoids, vitamin C β-carotene) are chemicals that, through various chemical transformations, protect from the detrimental effects of free radicals. According to studies, a diet high in water-soluble vitamins helps improve skin blemishes. So, people with psoriasis should eat more fresh fruits and vegetables, as well as polyphenol-rich foods. EPA and DHA acids help to reduce oxidative stress as well.[93] Water-soluble vitamins such as thiamin, ascorbic acid (vitamin C), riboflavin, vitamin B_6 (pyridoxine, pyridoxal, and pyridoxamine), niacin, folacin, vitamin B_{12}, biotin, and pantothenic acid should correspond to pharmaceutical treatment for psoriasis patients. This section of the manuscript will discuss and highlight the significance of water-soluble vitamins in psoriasis.

3.2.1. Vitamin C

Vitamin C, a fairly water-soluble vitamin is necessary for the human body's normal growth and development. They act as an antioxidant reservoir that aids in the maintenance of the collagen protein in connective tissue, protects against infections, and aids in iron absorption.[95] Ascorbic acid can be found in varying amounts in fruits and vegetables, as well as organ meats (e.g., liver and kidney). As a result, vitamin C insufficiency can cause scurvy, extensive connective tissue weakening, and capillary fragility. Vitamin C has demonstrated therapeutic potential in various dermatological disorders. An experimental study was carried out to investigate the role of Liver X receptor α (LXR α) in the psoriasis pathology demonstrated when 22-r-hydroxycholine was given in combination with ascorbic acid and atorvastatin normalised the female hormone treated psoriatic keratinocytes.[96] In addition, vitamin C can also be used as an adjunct therapy in psoriasis due to its anti-oxidative properties.[97,98] Indian gooseberry, citrus fruits like limes, lemons, oranges, tomatoes, etc., green leafy vegetables such as broccoli, fortified cereals, and its juices are the richest sources of ascorbic acid. Vitamin C's antioxidant activity is one of its most important characteristics. The antioxidant action of vitamin C aids in the prophylaxis of diseases such as cancer, psoriasis and cardiovascular diseases.[99] The mechanism of ascorbic acid's effect is not well elucidated yet. Exogenous ascorbic acid is necessary for collagen production and tissue healing in humans, as well as a cofactor in the 4-hydroxyproline Xaa-Pro-Gly-sequences formation in collagen and other proteins. Ascorbic acid converts to dehydroascorbic acid reversibly inside the human body.[100] These two vitamin variants are thought to play a role in redox reactions. Vitamin C is involved in tyrosine

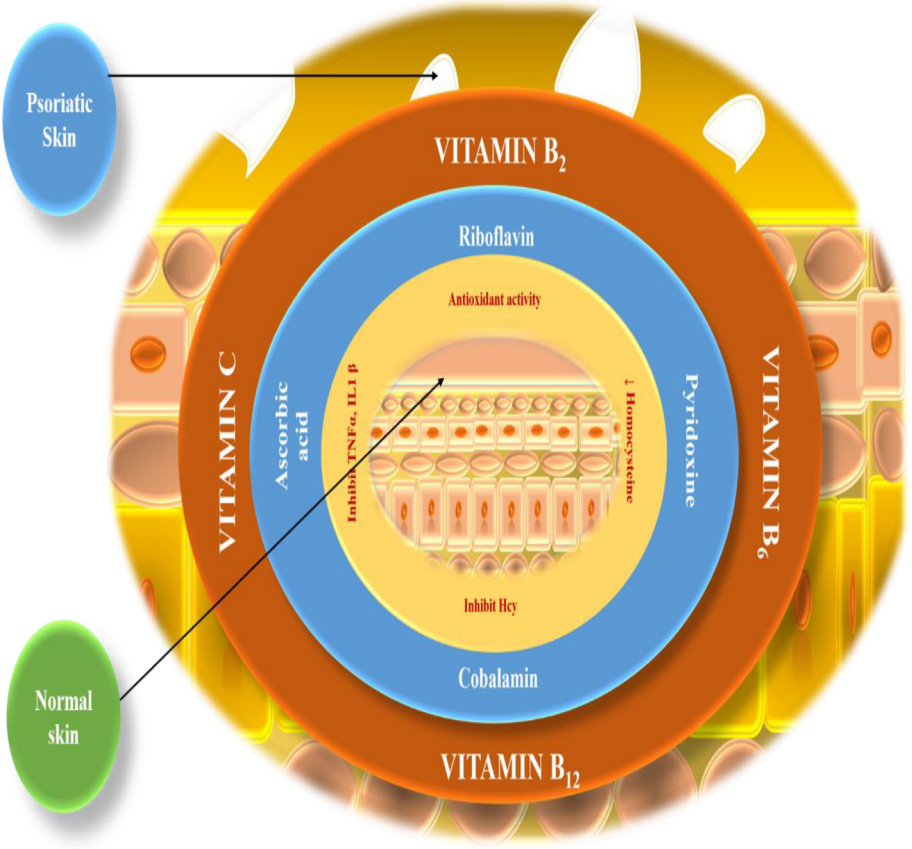

Fig. 2. Study suggested that antioxidants can help support psoriasis management. Water-soluble vitamins serve as a powerful antioxidant and may be helpful for psoriasis by preventing damage linked to oxidative stress.

biotransformation, folic acid conversion to folinic acid, glucose metabolism, lipid protein synthesis, iron metabolism, infection resistance, and cellular respiration.

Vitabrid C[12] is a complex of vitamin C-Vitabrid coated with glyceryl monostearate, according to Ji Hyun Lee et al. study for a long time, vitamin C has known to be a powerful antioxidant. Vitabrid is a hydrated zinc oxide with a smaller structure that causes minimal skin irritation. With its antibacterial properties, zinc oxide also aids in the restoration of the skin's dispersed functions of skin barrier and improves wound healing. It also reduces neutrophil chemotaxis in psoriatic individuals, which has an anti-inflammatory impact. Because VitabridC[12] is coated with hydrophobic glycerine monostearate, it enters the skin more effectively than other vitamin compounds.[101] As a result, it has been observed that vitamin C is quickly degraded within 3-4 h of contact to air; VitabridC[12] constantly produces vitamin C for more than 12 h. The authors of the study speculated that Vitabrid C[12] medication could have considerable anti-inflammatory benefits on cutaneous inflammation. As a result, VitabridC[12] significantly reduces the expression of pro-inflammatory mediators such as TNF-α, IL-1, IL-6, IL-8, IL-17A, IL-22, CXCL1, CCL17, CCL20, and COX-2, which were all found to be higher in psoriatic skin lesions.[102]

A study on the effects of vitamin C in psoriatic patients was conducted by Sami R. Al-Katib et al. A single-blind randomised clinical trial with 74 participants with clinically confirmed psoriasis was conducted. The research was carried out for a year. The patients were broadly categorised into two groups, with first receiving only NB-UVB and the other receiving NB-UVB + vitamin C supplementation of (500 mg) twice daily for a period of 12 weeks to measure their response. Vitamin C Glutathione (G.S.H.) levels were significantly higher in this randomised experiment, while Malondialdehyde (M.D.A.) levels were much lower ($p<0.05$) in NB-UVB + vitamin C compared to NB-UVB only group.[103] In the NB-UVB + vitamin C group, a significant positive correlation was established between vitamin C and G.S.H. levels after treatment ($p<0.05$), while a significant negative correlation was found between vitamin C and M.D.A. levels after treatment ($p<0.05$). Vitamin C supplementation played a major impact as a safe antioxidant in psoriatic patients treated with NB-UVB phototherapy, according to the authors.

3.2.2. *Vitamin B_2*

Riboflavin or vitamin B_2, is a water-soluble vitamin. Blythto initially catalogued riboflavin as a yellow pigment found in milk in 1879. Chemically, it is 7,8-dimethyl-10-ribityl-isoalloxazine, with a flavin isoalloxazine ring connected to the sugar side chain. Riboflavin aids in the metabolism of lipids, carbohydrates and proteins, which further aids in energy production.[104] Vitamin B_2 is needed for development of RBCs, breathing, antibody manufacturing, and human reproduction and growth, among other things. As a result, riboflavin is critical for maintaining healthy skin, nails, hair growth, and overall health. The precursor of flavin mononucleotide (FMN, riboflavin monophosphate) and flavin adenine dinucleotide (FAD) are the main candidates in the mechanism of action of riboflavin.[105] Riboflavin's antioxidant activity stems mostly from its function as a precursor of F.A.D. and as a cofactor in the formation of the reduced antioxidant glutathione. Reduced glutathione peroxidases are one such example.[106] Antioxidant enzymes glutathione peroxidases are important. As a result, the FAD-containing enzyme glutathione reductase produces reduced glutathione.

When used to treat psoriasis, riboflavin has a half-life of 66-84 min riboflavin and its congener riboflavin-5-phosphate U.S.P. when given orally, and upon parental administration of riboflavin 5-phosphate, in moderate and enormous doses to a group of 348 volunteers suffering from psoriasis failed to produce any significant feedback in those patients under their study, according to Ashton L. Welsh et al. So, under the identical experimental settings, the scientists discovered that riboflavin in combination with inositol, given orally, speeds up the response of psoriatic patients to some level. As a result, the authors conclude that riboflavin alone was not much efficient in the same experimental settings than the mutual combination of riboflavin and inositol, which is thought to be more effective in treating psoriasis.[107]

3.2.3. *Vitamin B_{12}*

Vitamin B_{12}, also known as cobalamin, is a vital chemical with a complicated structure and a convoluted absorption and cellular trafficking pathway that includes molecular escort proteins in bodily fluids and intracellular chaperones.[108] Many mechanisms have been elucidated as a result of the discovery of this vitamin, while other elements still need to be clarified. Vitamin B_{12} is created naturally by bacteria and is required for D.N.A. synthesis and for the generation of cellular energy.[109] As a result, vitamin B_{12} comes in a variety of forms, including cyano-, methyl-, deoxy adenosyl-, and hydroxy-cobalamin. In supplements and prescription medications, the cyano form is the most common. Cyanocobalamin is available in a variety of pharmacological formulations, including pills, injections, and nasal sprays. Vitamin B_{12} deficiency is corrected by cyanocobalamin, which improves the symptoms and test abnormalities associated with pernicious anaemia. Growth, cell reproduction, hematopoiesis, nucleoprotein, and myelin formation are all aided by cyanocobalamin. Vitamin B_{12} works as a cofactor for the enzymes including methionine synthase and L-methyl malonyl-CoA mutase. Methionine synthase is required for the synthesis of purines and pyrimidines, which are the building blocks of D.N.A. In the down-regulation of propionate, L-methyl malonyl-CoA mutase transforms L-methyl malonyl CoA to succinyl-CoA, a key process necessary for both fat and protein metabolism.[110]

A wide majority of literature suggests that patients with psoriasis presents with high levels of homocysteine than normal and usually this is attributed to deficiency of folic acid and vitamin B_{12} with the associated reasons such as obesity, smoking and alcohol intake.[111] Due to inflammatory changes in intestinal mucosa, during psoriasis dietary folate absorption is reduced.[112] As in the form of N-5-methyltetrahydrofolate, folate is required to donate a methyl group to carry out the homocysteine conversion into methionine.[113] This suggests the reason behind the significance of vitamin B_{12} deficiency, which leads to the impaired metabolism of homocysteine and exacerbation of psoriasis. In the development of psoriasis, homocysteine initiates the immune-inflammatory processes, overactivates the Th1 and Th17 cells and facilitates the suppression of Tregs. In addition to this homocysteine promotes the activation of NF-κB which is significant in immunopathologies of psoriasis. Hence, it becomes reasonable to treat psoriatic patients with vitamin B which can lower the levels of homocysteine.[114] Vitamin B_{12} deficiency is thought to be caused by a shortage of vitamin B_{12} cofactor in the aforementioned process, which results in the accumulation of methyl malonyl CoA.[115]

Vitamin B_{12} reduced total P.A.S.I. score and had considerable superiority over glycerol and petroleum-derived emollient cream for the management of mild to moderate plaque psoriatic conditions over 16 weeks, according to Ester Del Duca et al. The evaluation of hemi-body (M-side treatment) and contralateral hemi-body (C-side treatment) over the itinerary of the study represents that there were statistical significant differences in P.A.S.I. between the Mand C-treatment sides at every time point from week 2 (T2) to wash out phase (F1). As a result, the P.A.S.I. result on the M-treated body side reduced by 15 % (mean) and 8 % (median), although no score value was below 50 % on the C-treatment. As a result, the authors of the study concluded that applying vitamin B_{12} ointment to sensitive and troublesome skin areas is particularly important. As a result, the authors proposed that vitamin B_{12} ointment is a newer therapeutic approach that should be considered in the update of psoriasis treatment protocols.[116]

3.3. *Clinical trials on vitamins*

Several vitamins and their analogues are well-matched for the treatment of psoriasis; clinical trials are conducted to ensure the drug's safety and efficacy in humans. There have been numerous clinical trials on vitamins or their compounds for the therapeutic advancement of psoriasis

in recent years.[117] Vitamins and their compounds have been the subject of numerous clinical investigations. As a result, Table 3 includes some of the ongoing and completed clinical trials.

4. Other treatments

For the severe form of psoriasis, there are a number of additional conventional and first-line treatments available. Methotrexate, cyclosporine, coal tar, salicylic acid, and other therapies are among them. As shown in Table 4, there are a variety of additional psoriasis treatments and management options.

Methotrexate is a folate derivative that inhibits a number of synthetic enzymes. This inhibition causes suppression of inflammation as well as prevention of cell division.[118] As a result of methotrexate's toxicity, it is only used to treat some types of arthritis and severe psoriasis when other treatments have failed or people are resistant to those treatments. Subcutaneous methotrexate injections are indicated for severe active debilitating psoriasis. Methotrexate mediates its action by inhibition of enzymes involved in nucleotide synthesis, such as dihydrofolate reductase, thymidylate synthase, and aminoimidazole carboxamide ribonucleotide transformylase (A.I.C.A.R.T.), as well as amido phosphoribosyltransferase.[119] Cell division is prevented when nucleotide synthesis is inhibited. Methotrexate has a bioavailability of 64 %-90 %, which decreases at oral administration of more than 25 mg due to

Table 3
Clinical Trials of drugs related to vitamins in treatment of psoriasis (updated till 24/Oct/2020).

S. No.	CTR No.	Aim/Title of the study	Company/Sponsor	Inclusion criteria	Exclusion criteria	Phase	Status
1.	NCT04036188	Triamcinolone with vitamin D synergistic efficacy in psoriasis.	Wright State Physicians	Age 18 or above; mild to severe psoriasis	No prior medications or supplements; no unstable and uncotrolled illness	1	Recruiting
2.	NCT00350116	Topical vitamin B_{12} in chronic plague psoriasis.	Ruhr University of Bochum	18 years; chronic plaque psoriasis	Incapability of vitamin B_{12}; necessity of systemic therapy; use of other potentially psoriasis modifying drugs	3	Completed
3.	NCT01903317	Evaluation of vitamin D levels in plague psoriasis.	University of California, Irvine	18 years; plaque type psoriasis; consent document; scheduled visits and treatment	Age not over 18 years and pregnant	Not applicable	Withdrawn
4.	NCT02735187	Efficacy and safety of blue light (453 nm) treatment for mild psoriasis vulgaris over three months compared to vitamin D.	Philips Electronics Nederland BV	Consent; good health; skin type I-IV; PASI and BSA≤10	Inmates of prison or psychiatric ward; participation in another CT within 30 days; pregnant; photosensitivity; porphyria	Not applicable	Completed
5.	NCT03874975	Combined oral vitamin D and UVB alone in treatment of psoriasis vulgaris.	Assiut University	Diagnosed to have psoriasis vulgaris	Malignancy; pregnant; renal dysfunction	1	Not yet recruiting
6.	NCT03334136	The effect of vitamin D supplementation on psoriasis severity.	University Hospital of North Norway	Plaque Psoriasis; PASI>0; Serum 25-OH vitamin D <60 nmol/L	Age above 79; primary hyperparathyroidism; renal stones; diabetes	Not applicable	Completed
7.	NCT02271971	Effect of vitamin D supplementation on metabolic parameters of patients with psoriasis.	Pontificia Universidad Catolica de Chile	Moderate to severe psoriasis; methotrexate treatment for 1 month	Phototherapy; history of psoriatic arthritis; rheumatoid arthritis; diabetes; vitamin D supplements; pregnancy	Not applicable	Completed
8.	NCT01704599	Addition of modulators of homocysteine to adalimumab therapy in treatment of moderate to severe plague psoriasis.	Wayne State University	18 years or older; moderate to severe plaques	Erythrodermic; skin conditions other than psoriasis; pregnancy	1, 2	Terminated
9.	NCT03904680	Studying the effect of methotrexate alone versus methotrexate and vitamin D on the cardiovascular risk of psoriatic patients.	Cairo University	Psoriasis patient not on systemic treatment; PASI>10	Autoimmune diseases; liver or kidney diseases; diabetes; dermatological diseases; infection; pregnancy or lactation	4	Not yet recruiting
10.	NCT01989429	Efficacy study of comparing topical M518101 and vitamin D_3 in adult psoriasis patients.	Maruho Europe Limited	18 years or above; 20 % BSA affected	Pregnancy; lactation; hypersensitivity reactions	3	Completed
11.	NCT00789880	Analysis of response of subjects with atopic dermatitis or psoriasis to oral vitamin D_3.	National institute of Allergy and Infectious Disease	Standard diagnostic criteria; residing in US	Psoriasis; exfoliative erythroderma; pregnant or lactating women; bleeding disorders	2	Completed
12.	NCT02622386	The effect of riboflavin on moderate to severe plague type psoriasis.	University of Michigan	18 years or above; good general health	Systemic medications; cyclophosphamide; hypersensitivity to riboflavin	2	Suspended
13.	NCT01105286	The psoriasis plague test comparing eight different formulations of vitamin D analogues for the treatment of psoriasis.	LEO Pharma	Consent form; 18 years or above	Pregnant; systemic treatment with biological therapies	1	Completed
14.	NCT02993471	The study of lxekizumab in participants with plague psoriasis.	Eli Lilly and Company	Chronic moderate or severe psoriasis; BMI of 18.5 to 40 kg/m^2, more than 10 % BSA involvement	Psoriasis other than chronic plaque type; pregnant or lactating women; chronic infectious diseases	1	Completed
15.	NCT01582932	Evaluate safety and tolerability of calcipotriene foam 0.005 % in pediatric subjects with mild/ moderate plague psoriasis.	Mayne Pharma International Pty Ltd	2-11 years	Inflammatory skin disease; unstable psoriasis in treatment area; pregnant or lactating women	1	Completed

Table 4
Comparative study of other drugs and their mechanism used in psoriasis treatments.

S. No.	Other Drug	Mechanism	Reference
1.	Salicylic acid	↓ intracellular cohesion corneocytes by dissolving the intracellular material; ↑ hydration and softening.	105, 106
2.	Coal tar	↓ production of IL-15; ↓ the activity of inducible nitric oxide synthase; inhibit the single transducer and activator of transcription 3	105
3.	Steroid and calcipotriene	↓ hyperproliferation, Differentiation and apoptosis.	107
4.	Corticosteroids	↓ keratinocyte proliferation.	108
5.	Tacrolimus	Inhibit phosphatase calcineurin and inhibit T cells.	109
6.	Methotrexate	Inhibit enzymes responsible for nucleotide synthesis including dihydrofolate reductase	110
7.	Cyclosporine	Inhibit T-cell function and interleukin (IL)-2	111

saturation of methotrexate carrier-mediated transport. In adults, a modest dose has a half-life of 3-10 h. High dosage methotrexate has an 8-15 h half-life. A total of 95 patients (60 % men) were enrolled in the study, according to Tora Lindqvist et al.[120]

Cyclosporine, when binds to a T cell, intracytoplasmic calcium levels rise, causing calmodulin activation of calcineurin phosphate. After that, calcineurin phosphatase dephosphorylates nuclear factor activated T cells, allowing the protein to translocate into the nucleus and enable transcription of pro-inflammatory genes including IL-2, interferon-γ, IL-4, transforming growth factor-β, and up-regulation of the IL-2 receptor.[121] Various clinical trials have shown that cyclosporine is effective in treating plague-type psoriasis, including remission and maintenance therapy. In 80 % to 90 % of patients, cyclosporine at doses of 2.5-5 mg/kg/day for 12 to 16 weeks results in a rapid and significant improvement of psoriasis. Psoriasis Area and Severity Index (P.A.S.I.) 75 was established in 50 % to 70 % of patients at 3 mg/kg/day, while P.A.S.I. 90 was established in 30 % to 50 % of patients.[122]

Salicylic acid is a topical keratolytic drug that has been used in the treatment of psoriasis for many years.[123] It can be used with Tacrolimus and calcineurin inhibitors to improve the latter's absorption into psoriatic plaques by causing corneocyte desquamation via two pathways. By dissolving the intercellular cement material into the horny cells, it lowers their intercellular cohesion. It also lowers the pH of the stratum corneum, which improves hydration and softness. In addition, salicylic acid has side effects in the treatment of psoriasis: probable chronic or acute systemic intoxication with oral mucosa burning, frontal headache, central nervous system symptoms, and metabolic acidosis, tinnitus, nausea, and vomiting.[124]

5. Conclusion

Psoriasis is a systemic inflammatory illness with a complex hereditary architecture that affects around 2 %-3 % of the world's population. The therapeutic paradigm is shifting away from short-term therapy of acute rashes and toward long-term management that takes into account both skin symptoms and concomitant disease. In addition, cyclosporine, salicylic acid, methotrexate, vitamin D, and other vitamin analogues are used in the treatment of psoriasis. Psoriasis treatment and management require fat-soluble vitamins (A, D, and E) as well as water-soluble vitamins (B complex and C). Fat-soluble vitamins decrease keratinization and target R.X.R. and R.A.R. receptors pharmacologically. Water-soluble vitamins, on the other hand, operate within the skin to prevent proliferation, keratinization, homocysteine reduction, and antioxidant action. Furthermore, the results of numerous preclinical and clinical investigations, including *in vitro* and *in vivo* studies, have validated the potential therapeutic evidence of both fat-soluble and water-soluble vitamins in the management of psoriasis.

The chemical identification of several vitamins by HPLC, which are active and beneficial in treating psoriasis, is also highlighted in this paper. The review considers a comparison of vitamins and other medications used to treat psoriasis, such as methotrexate, cyclosporine, and salicylic acid, based on their action mechanisms. Vitamins offer good benefits in the treatment of mild psoriasis, with fewer side effects than other medications, according to the study. Trials are also needed to investigate the therapeutic role of fat-soluble and water-soluble vitamins in the treatment and management of psoriasis.

CRediT authorship contribution statement

Suyash Agnihotri: Writing – original draft. **Jasleen Kaur:** Writing – original draft. **Priya Masand:** Visualization. **Anurag:** Data curation. **Vipan Kumar Parihar:** Writing – review & editing. **Alok Sharma:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors are grateful to the Department of Pharmaceutical Technology, Meerut Institute of Engineering and Technology, Meerut for providing all of the required resources.

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