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A REVIEW ON ALOE VERA: FROM TRADITIONAL USES TO MODERN COSMETICS

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ABSTRACT

Aloe vera (Liliaceae), commonly known as Ghritkumari, is a succulent medicinal plant with a long history of traditional and cosmeceutical applications. The plant stores a mucilaginous gel in its parenchymatous inner leaf tissue, which is rich in diverse bioactive constituents such as acemannan and other polysaccharides, anthraquinones, flavonoids, vitamins, minerals, and amino acids. In traditional systems like Ayurveda and folk medicine, it has been extensively applied for skin hydration, wound management, and digestive ailments. In contemporary cosmetic science, standardized Aloe gel is widely utilized as a base and active ingredient in moisturizers, anti-acne creams, sunscreens, lotions, and hair-care formulations due to its emollient, soothing, and film-forming properties. Pharmacological studies have highlighted its potential antioxidant, anti-inflammatory, antimicrobial, and wound-healing activities. However, its efficacy and stability are highly influenced by geographical source, leaf maturity, processing method, and preservation of the final formulation. Furthermore, a clear distinction must be made between the inner-leaf gel, generally recognized as safe for topical use, and the outer leaf latex containing aloin, which may cause irritation. The present review aims to comprehensively outline the botanical profile, traditional claims, phytochemistry, biological activities, cosmetic relevance, and safety aspects of Aloe vera.

KEYWORDS: Aloe vera, Ghritkumari, Acemannan, Cosmeceutical, Skin hydration, Aloin.

1. INTRODUCTION

Medicinal plants have been an integral part of traditional systems of medicine and personal care since ancient times. Among them, Aloe vera (L.) Burm.f., commonly known as Ghritkumari, has gained considerable prominence due to its succulent, fleshy leaves that store a mucilaginous clear gel in the inner parenchyma. The plant is extensively cultivated in tropical and subtropical regions worldwide and holds a significant position in Ayurveda, folk medicine and modern health-care formulations. Traditionally it has been employed for skin ailments and wound care, while in contemporary times its gel and extracts are widely incorporated into moisturizers, health drinks and various cosmetic preparations.[1][2][3]

The inner leaf gel of Aloe vera is a rich reservoir of bioactive constituents, predominantly polysaccharides such as acemannan, along with vitamins, minerals, amino acids and phenolic compounds. These phytochemicals have been extensively explored for their diverse biological potentials. In cosmetic science, its incorporation in skin-care formulations is largely attributed to its hydrating, emollient and skin-soothing properties, contributing to improved skin barrier function. Beyond cosmetic applications, experimental and clinical studies have investigated its antioxidant, anti-inflammatory, antimicrobial and wound-healing activities; however, the reported efficacy remains variable and is influenced by factors such as geographical source, maturity of leaves, processing techniques and standardization of the final preparation.[2][4][5][6]

In recent years, Aloe vera has emerged as a ubiquitous functional ingredient in modern cosmetic and cosmeceutical formulations, including moisturizing creams, lotions, face gels, sunscreens, shampoos and various personal-care products. Its global popularity as a skin-conditioning and emollient agent has driven extensive industrial utilization. This widespread incorporation has concurrently stimulated research focused on its detailed chemical profiling, assessment of product quality in terms of aloin content and stability, and evaluation of dermatological safety and efficacy using advanced skin bioengineering techniques and clinical assessments.[7][8][9]

Therefore, the present review aims to comprehensively compile and critically evaluate the available literature on Aloe vera, transitioning from its ethnobotanical and traditional claims to its contemporary cosmeceutical relevance. The review elaborates on its botanical characteristics and geographical distribution, key phytochemical constituents including polysaccharides and anthraquinone derivatives, diverse pharmacological activities reported in

preclinical and clinical studies, and its expanding applications in modern cosmetic formulations. Furthermore, special emphasis is placed on quality control parameters, toxicological considerations, and regulatory aspects to ensure safe and effective utilization.

2. Botanical Profile of Aloe vera

Aloe vera (L.) Burm.f., synonym Aloe barbadensis Miller, is a perennial, xerophytic, succulent plant belonging to the family Asphodelaceae (formerly placed under Liliaceae). It is widely cultivated in tropical, sub-tropical and arid regions across India, Africa, and the Americas for commercial and medicinal purposes. Morphologically, the plant is characterized by its stemless or short-stemmed habit with a rosette of thick, fleshy, green to grey-green, lanceolate leaves possessing serrated margins. These leaves are composed of three distinct layers, and the innermost layer consists of a clear, mucilaginous, jelly-like parenchymatous tissue rich in water and polysaccharides, which forms the commercially valuable Aloe gel used in food, pharmaceutical and cosmetic industries.[1][2][10][11]

Aloe vera is well adapted to arid environments due to its crassulacean acid metabolism and succulent leaf habit, which enables efficient water storage and survival under relatively dry and water-stressed conditions. Anatomically, the leaf is differentiated into three distinct layers with varying chemical composition and functional applications. The outermost green rind or cortex provides protection, the middle layer contains vascular bundles, and the innermost colorless parenchyma forms the clear mucilaginous gel. It is crucial to differentiate this inner clear gel from the yellowish bitter exudate, commonly referred to as Aloe latex or aloin-containing juice, which is secreted by the pericyclic cells located immediately beneath the epidermis of the outer leaf skin. The gel and latex possess entirely different phytochemical profiles and are utilized for distinct commercial purposes.[2][12]

2.1 Botanical Classification

Taxonomical Classification of Aloe vera

Kingdom: Plantae

Clade: Angiosperms / Monocots

Order: Asparagales

Family: Asphodelaceae (earlier Liliaceae)

Subfamily: Asphodeloideae

Genus: Aloe

Species: Aloe vera (L.) Burm.f.

Synonym: Aloe barbadensis Miller

Common Name: Aloe vera, Ghritkumari, Gwarpatha.[13]

The plant is known by different names in different countries and languages

A) Based on Country

English: Aloe vera, Barbados Aloe, Curacao Aloe, Indian Aloe

India: Ghritkumari, Gwarpatha

Spain: Sábila

China: Lu Hui

Japan: Aroe, Rokai

France: Aloès

Brazil: Babosa.

B) Based on Language

Hindi: Ghritkumari, Gwarpatha

Sanskrit: Ghritakumari, Kumari, Grihakanya

Gujarati: Kunvarpathu

Bengali: Ghritakumari

Tamil: Katralai, Chirukattalai

Telugu: Kalabanda

Malayalam: Kattarvazha

Marathi: Korphad.[10][13][14]

2.3 Morphological Characters

Root: The root system is fibrous and shallow, serving to anchor the plant in the soil and facilitate the absorption of water and minerals.

Stem: The stem is very short, stout and often inconspicuous due to the compact, basal rosette arrangement of the leaves.

Leaves: The leaves are thick, fleshy, succulent and lanceolate with a greyish-green to green colouration. They are arranged in a dense rosette pattern and possess small spiny teeth along the margins. Internally, the leaves contain a clear, mucilaginous gel (inner parenchyma) and a bitter yellow exudate (latex) beneath the rind.

Flowers: The flowers are tubular, pendulous and typically yellow to orange-yellow in colour. They are borne in dense racemes on an erect, elongated flowering scape arising from the centre of the rosette.

Fruit: The fruit is a loculicidal capsule containing numerous seeds.[13][14]

2.4 Important Leaf Components

The Aloe vera leaf is composed of three distinct structural layers:

1. Outer green rind: The outermost protective covering of the leaf, consisting of cuticle and chlorenchyma, which provides mechanical protection and performs photosynthesis.

2. Clear inner-leaf gel: The central, water-rich mucilaginous parenchymatous tissue, which is commonly used in skincare and cosmetic formulations due to its moisturizing and skin-conditioning properties.

3. Yellow latex or exudate: A bitter yellowish fluid situated beneath the rind in the pericyclic tubules, containing anthraquinone glycosides, including aloin.

These three materials should not be treated as interchangeable, as their chemical compositions, functional properties and safety profiles differ significantly.[2][12][15]



Fig. 1: Aloe vera Plant
(*Aloe barbadensis* Miller)



Fig. 2: Aloe vera Leaf with Gel
(*Aloe barbadensis* Miller)

3. Traditional Uses of Aloe vera

Aloe vera has a long history of use in various traditional and ethnomedicinal systems including Ayurveda, Traditional Chinese Medicine, Unani and Egyptian medicine. Historical records indicate its use since ancient times for skin care, wound care and general health maintenance. In different traditional practices, the mucilaginous gel and in some cases the bitter latex have been incorporated into simple topical and oral preparations for managing

minor skin ailments, burns, and digestive discomfort. Its traditional use has persisted over centuries due to its easy cultivation in arid regions, succulent nature allowing year-round availability, and the ease with which the clear inner gel can be incorporated into simple topical preparations without complex processing.[3][16][17]

Traditionally, the clear mucilaginous gel has been applied topically for its soothing, cooling and moisturizing properties, particularly for minor cuts, burns and dry skin conditions. Aloe vera has also been an ingredient in various traditional formulations intended for management of minor dermatological complaints. These long-standing ethnomedicinal claims have served as a basis and have encouraged scientific communities to investigate its detailed phytochemical profile and possible pharmacological activities.[2][3][16][18]

However, traditional knowledge alone cannot be considered as definitive proof of efficacy for all claimed indications. Systematic modern scientific investigations including phytochemical standardization, pharmacological screening, and well-designed clinical studies are essential to validate its therapeutic benefits, optimize appropriate dosage forms and formulations, and evaluate its safety profile and possible adverse effects.[18]

4. Modern Uses of Aloe vera

At present, Aloe vera is commercially utilized in multiple sectors including cosmetics, personal care, food, dietary supplements and herbal pharmaceutical products. The plant has gained significant industrial importance due to its widespread availability and versatile nature. Its clear, water-rich inner gel is particularly valued in skin-care and cosmetic formulations because of its high water content (98-99%), excellent skin compatibility, natural moisturizing ability and capacity to be easily incorporated into diverse product bases such as gels, creams, lotions and shampoos.[2][7][19][20]

The plant is also being extensively investigated for its prospective pharmaceutical and nutraceutical applications owing to the presence of biologically active polysaccharides, particularly acemannan, along with other phytoconstituents such as anthraquinones, vitamins and enzymes. Various pre-clinical studies have explored its potential role in supporting wound healing, modulation of inflammatory processes, and other biological activities including immunomodulatory and antioxidant effects. However, it is important to emphasize that promising results obtained from in-vitro studies and findings from individual animal studies should not be directly extrapolated or automatically interpreted as conclusive proof of

clinical effectiveness in humans. Well-controlled human clinical trials are required to establish its therapeutic efficacy.[5][6][21]

Patent literature also discloses various Aloe vera-based compositions and novel delivery systems developed for potential medicinal, cosmetic and food applications, including stabilized gel preparations and combination formulations. However, the mere existence of a patent or a commercial formulation does not guarantee therapeutic efficacy, and the effectiveness of individual formulations must be supported by appropriate scientific data, stability studies and clinical validation.[22]

5. Important chemical constituents of Aloe vera

The therapeutic activities of Aloe vera are attributed to more than 75 bioactive constituents belonging to different chemical classes. The major chemical constituents of pharmacological importance are as follows:

5.1 Acemannan: The major bioactive polysaccharide present in the inner parenchymatous gel of Aloe vera. Chemically, it is a β-(1→4)-linked acetylated polymannose.

5.2 Aloin (Barbaloin): An anthraquinone glycoside mainly concentrated in the bitter yellow latex/exudate of the leaf. It is a mixture of Aloin A and Aloin B.

5.3 Aloe-emodin: An anthraquinone derivative found in the latex, known for its biologically active properties.

5.4 Emodin: A phenolic anthraquinone compound present in small amounts.

5.5 Aloesin: A chromone derivative present in the gel and rind, responsible for some of its biological activities.

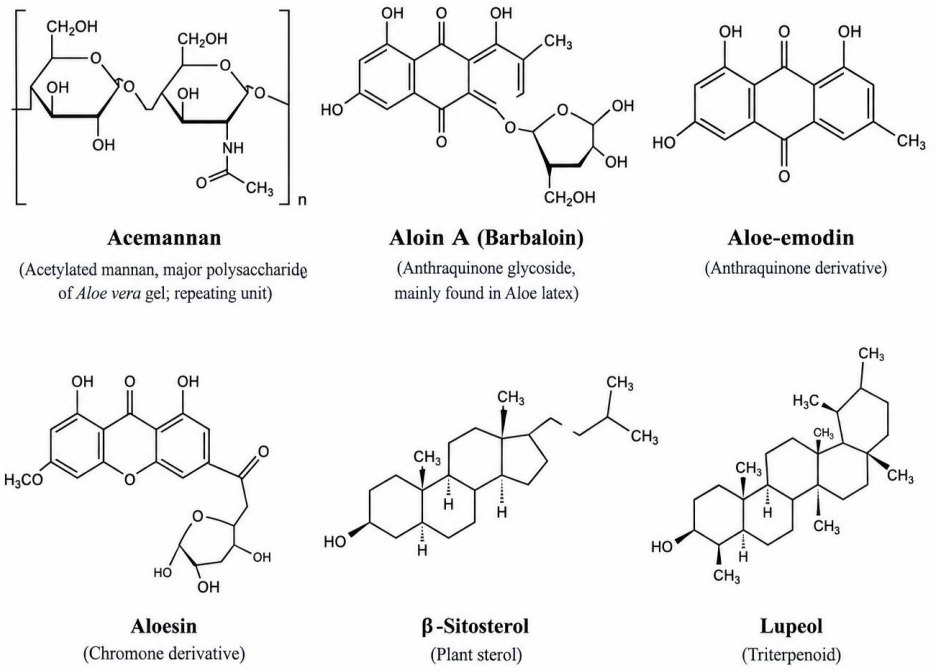
5.6 β-Sitosterol: A phytosterol with potential anti-inflammatory activity.

5.7 Lupeol: A pentacyclic triterpenoid with antiseptic and analgesic properties.

5.8 Campesterol: A phytosterol structurally similar to cholesterol**.**[5][7][23]

5.9 Chemical structure of Aloe vera[24][28]

Major Chemical Constituents of *Aloe vera*



Structures redrawn for educational use; based on Hamman *(2008) and Sánchez et al. (2020).*

6. Marketed Aloe vera-Based Cosmetic Products

Aloe vera is widely used as an ingredient in various commercially available cosmetic and personal care products. It is commonly incorporated into facial gels, moisturizers, skin creams and other skincare formulations intended for hydration and skin conditioning.[26][27]

Several brands offer Aloe vera-based products for skin hydration, moisturization and daily skincare, such as

Himalaya Aloe Vera Face Gel,

Joy Pure Aloe Light Moisturiser,

Fruit of the Earth Aloe Vera Skin Care Cream,

Vicco Turmeric Aloe Vera Skin Cream,

Lotus Herbals Aloe Vera Brightening Boost Gel

WOW Skin Science Aloe Vera Gel.

These products demonstrate the commercial use of Aloe vera in modern cosmetic formulations, although their composition, Aloe vera content and claimed benefits vary according to the individual formulation.



Fig. 3: Himalaya Moisturizing Aloe Vera Face Gel (100 ml)



Fig. 4: Joy Pure Aloe Light Moisturiser Skin Cream (200 ml)



Fig. 5: Fruit of the Earth Aloe Vera Skin Cream (113 g)



Fig. 6: Vicco Turmeric Aloe Vera Skin Cream (30 g)



Fig. 7: Lotus Herbals Aloe Vera Brightening Boost Gel



Fig. 8: WOW Skin Science Aloe Vera Gel (200 ml)

6.1 Table: 1. Phytochemical Constituents of Aloe Vera Gel[24][25][26][27][28]

S. No.	Class of constituents	Major examples	Properties / relevance
1	Polysaccharides	Acemannan, glucomannan, mannan, pectin	Help retain moisture and are studied for skin hydration.
2	Anthraquinones and anthrones	Aloin, aloe-emodin, emodin, isobarbaloin	Mainly associated with leaf latex; some show biological activity.
3	Chromones	Aloesin, aloeresin derivatives	Studied for antioxidant and skin-related properties.
4	Phenolic compounds	Caffeic acid, ferulic acid	Contribute to antioxidant activity.
5	Flavonoids	Quercetin, isorhamnetin and related compounds	Reported antioxidant activity; amounts vary by preparation.
6	Phytosterols and sterols	β-Sitosterol, campesterol, lupeol	Studied for skin-conditioning and anti-inflammatory properties.
7	Vitamins	Vitamins C and E, B-group vitamins, provitamin A compounds	Some contribute to antioxidant functions.
8	Minerals	Calcium, magnesium, potassium, sodium, zinc, iron	Contribute to the mineral composition of Aloe vera.
9	Amino acids	Alanine, arginine,	Components of proteins

		glycine, leucine, lysine	and biological processes.
10	Enzymes	Amylase, catalase, superoxide dismutase	Enzymes reported in Aloe preparations; activity may change during processing.
11	Saponins	Saponin compounds	Associated with cleansing properties in some descriptions of Aloe gel.
12	Organic acids	Salicylic acid and other organic acids	Studied for biological properties; composition varies.
13	Sugars	Glucose, fructose	Contribute to the carbohydrate composition of the leaf gel.
14	Fatty acids and lipids	Various fatty acids and lipid components	Contribute to the chemical composition of the plant and extracts.
15	Lignin	Lignin-related components	Structural plant component.

6.2 Polysaccharides

Polysaccharides are important components of Aloe vera gel. Acemannan is one of the best-known polysaccharides studied in Aloe vera. These substances have attracted interest because of their physical properties and possible biological activities. They are also relevant to the investigation of Aloe vera gel in topical products.[29][30]

6.3 Phenolic Compounds and Anthraquinones

Aloe vera contains phenolic substances, including anthraquinone-related compounds. Aloin and aloe-emodin are frequently discussed in the literature. Their distribution depends on the plant tissue and processing method. These compounds are important when evaluating both biological activity and product safety.[31][32]

6.4 Vitamins and Minerals

Aloe vera preparations may contain vitamins and minerals in varying amounts. Their concentrations depend on the plant material and the processing method. Therefore, the presence of a nutrient in the plant should not automatically be taken to mean that every commercial Aloe vera product provides a meaningful amount of that nutrient.[33][34]

6.5 Enzymes and Amino Acids

Various enzymes and amino acids have been reported in Aloe vera. Their amounts can vary with the preparation and storage conditions. These constituents contribute to the overall chemical profile of the plant but should not be assumed to produce a specific cosmetic benefit without supporting evidence.[35][36]

6.6 Sterols and Other Compounds

Aloe vera also contains plant sterols and other minor compounds. Researchers have studied these substances as part of the plant's overall phytochemical profile and possible biological activities.[37][38]

7. Pharmacological Actions

Several pharmacological activities of Aloe vera have been investigated. The findings depend on the type of extract, concentration, route of use and study design. Therefore, these activities should be described as reported or potential effects rather than guaranteed treatment outcomes.[39][40][41]

7.1 Anti-inflammatory Activity

Aloe vera constituents have been studied for their possible effects on processes involved in inflammation. This research has contributed to interest in its use in topical preparations. Nevertheless, evidence for one formulation or condition cannot automatically be applied to all Aloe vera products.[42][43]

7.2 Wound-healing Activity

Aloe vera gel has been investigated in studies of wound healing and skin repair. Some studies have reported encouraging findings, but systematic reviews have noted that results can vary according to the type of wound and the quality of the available evidence. Further well-designed research is needed to establish which preparations may be useful for specific wounds.[44][45][46]

7.3 Antioxidant Activity

Aloe vera contains several compounds that have been investigated for antioxidant activity. Laboratory research has examined their ability to interact with processes involving oxidative stress. However, laboratory antioxidant activity does not necessarily demonstrate a clinical benefit when a cosmetic product is applied to human skin.[47][48]

7.4 Antimicrobial Activity

Certain Aloe vera extracts and constituents have been investigated for activity against microorganisms. Results can vary with the extract, concentration and microorganism tested. Aloe vera should not be presented as a substitute for established treatment of an infection.[49][50]

7.5 Other Investigated Activities

Researchers have also examined Aloe vera for possible metabolic, immune-related and gastrointestinal effects. Much of this work differs in study design and strength of evidence. These areas require careful interpretation and should not be treated as established clinical benefits.[51][52]

8. Cosmetic Applications of Aloe vera

Cosmetic use is a major area of interest for Aloe vera. The clear inner-leaf gel is incorporated into products designed for skin and hair care. Its suitability depends on the quality of the starting material, the processing method and the final formulation.[53][54]

8.1 Moisturizing Products

Aloe vera is used in moisturizers, creams and gels. Research has assessed the effect of cosmetic formulations containing Aloe vera on skin hydration. The results depend on the formulation and concentration, so the moisturizing effect of one product should not be assumed for every product containing Aloe vera.[55][56]

8.2 Soothing Skin-Care Products

Aloe vera is included in some products intended to provide a soothing skin-care experience. Studies have examined skin hydration and changes in redness after topical application of Aloe materials. The evidence varies, and the effects may depend on the specific preparation.[57][58]

8.3 Face Gels and Creams

Aloe vera gel is commonly incorporated into face gels and creams. It can contribute water-rich material to a formulation and can be combined with other cosmetic ingredients. The quality, stability, preservative system and compatibility of the complete product are important for its performance and safety.[59][60]

8.4 After-Sun and Skin-Comfort Products

Some after-sun and skin-comfort products contain Aloe vera. These products are intended for topical skin care, but the presence of Aloe vera does not establish that a product prevents or treats sun damage. Appropriate sun protection remains important.[61]

8.5 Hair-Care Products

Aloe vera is used in shampoos, conditioners and hair gels. In these products, it may function as a conditioning or formulation ingredient. Claims about hair growth or treatment of scalp disorders should be supported by evidence specific to the product and intended use rather than inferred from traditional use alone.[62][63]

8.6 Importance of Cosmetic Product Quality

The quality of Aloe vera cosmetic products can vary. Processing, storage, contamination and the amount of residual aloin are important considerations. Product evaluation should therefore include suitable quality-control measures and safety testing.[64][65]

9. Safety and Toxicity

Safety is an important part of the evaluation of Aloe vera. The clear inner-leaf gel and the yellow latex have different compositions and should be distinguished in both research and commercial products.[66][67]

Aloe vera latex contains anthraquinone-related compounds, including aloin. The presence and amount of these substances depend on the plant material and processing method. Products intended for cosmetic or other uses should be manufactured and tested according to appropriate quality standards.[68][69]

Topical products may cause irritation or an allergic reaction in some individuals. A product should be discontinued if an unexpected reaction occurs. Evidence about one preparation should not be generalized to all Aloe vera products because formulations can differ substantially.[70][71]

Safety evaluation should consider the plant part used, extraction method, concentration, contaminants, storage and intended route of use. Manufacturers should use suitable testing and clear product specifications to support consistent quality.[72][73]

10. Future Prospects

Further research may help improve the use of Aloe vera in modern cosmetic formulations. Important areas include better characterization of its chemical constituents, standardized extraction methods, product stability, skin compatibility and quality control. Researchers can also investigate how different Aloe vera concentrations interact with other cosmetic ingredients. Well-designed human studies may help distinguish the effects of Aloe vera itself from those of the complete formulation. More consistent reporting of the plant part, extraction method and product composition would make studies easier to compare.[74][75]

Future developments should focus not only on potential benefits but also on product safety, reproducibility and accurate labelling.

11. CONCLUSION

Aloe vera (Aloe barbadensis Miller) is a widely cultivated succulent plant with a long history of traditional use and a significant place in modern cosmetics. Its clear inner-leaf gel, rich in polysaccharides such as acemannan along with vitamins, minerals and other constituents, has attracted considerable scientific interest. Today, Aloe vera is incorporated in a wide range of personal-care products including moisturizers, creams, gels, shampoos and other skin and hair care formulations.

Research has investigated its moisturizing, soothing, antioxidant, anti-inflammatory and wound-healing properties, primarily through in-vitro and limited clinical studies. However, the strength of the evidence varies considerably according to the plant part used, extraction method, concentration and intended use. It is therefore important to avoid presenting every reported activity as a proven clinical benefit.

The distinction between the clear inner-leaf gel and the yellow latex containing anthraquinones such as aloin is essential for product quality, safety and regulatory compliance. Safety evaluation should consider the plant part, extraction method, concentration, contaminants, storage and intended route of use, while manufacturers should adopt suitable testing methods and clear product specifications to ensure consistent quality.

Overall, Aloe vera remains an important and promising ingredient in cosmetic research. Further standardized research with better characterization of chemical constituents, validated

extraction methods, product stability studies and well-designed human trials may help clarify its benefits, limitations and optimal use in modern cosmetics.

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