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# Cosmetic Technology

Especially for Terry Corporation

## Aloe in cosmetic formulations

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**A**loe vera is a perennial succulent known commonly as the "healing," "burn," "first aid," or "medicine" plant. The Latins called it *savilla*. It originated in South Africa and has since spread throughout the warm, dry regions of the world. It is cultivated as a

house plant in colder regions. Tales of its extraordinary healing powers date over 3500 years.

The Aloe family belongs to a larger class of plant, known as the Xeroids, that close their stomata to avoid loss of water under arid conditions. They can

survive without water for extended periods. Modern scientific study of Aloe vera began as a result of the invention of the X-ray. "X-Radiation burns were nearly incurable until doctors began using an old folk remedy, the gel from the Aloe vera leaf." The results of years of



Figure 1: An Aloe vera plant.

research since then have helped man discover the benefits and numerous applications of aloe gel.\*

### Aloe, the Plant

More than 300 species of Aloe exist. It is a member of the lily family. The three primary commercial and medicinal species are: *Aloe ferox* (Miller), chiefly growing on the South African mainland, from which cape aloe is produced; *Aloe perryi* (Baker), from Socotra and Zanzibar, yielding Socotrine aloe; and *Aloe vera barbadensis* (Miller), native to the African coastlines of the Mediterranean, from which West Indian or Curacao aloes are produced. *Aloe barbadensis* [vera] reportedly possesses the greatest medicinal properties. It is also

\*The term *aloe* as used herein refers to pharmaceutical aloe; *aloe gel* refers to natural Aloe vera gel.

most widely available. This Aloe is commonly known as Aloe vera, or the "true" aloe. Much of the research on aloe vera gel conducted in the Soviet Union and Japan uses a variety called *Aloe arborescens*.

### Cultivation

The mature Aloe vera plant is about 2 ft tall and grey-green in color. The leaves are thick, rubbery, and smooth, with serrated edges that form a rosette at the base (see Figure 1). No stems hold the plant up; it is supported by a thick gel present throughout the leaves. The gel of the older, outer leaves is said to have the greatest healing properties; new leaves grow from the center.

Aloe vera propagates either from the seeds of its flower, or by sending shoots up around the base; the shoots can be transplanted. It takes about three years

for a plant to mature, after which it can be harvested for seven or eight more years.

In the United States, Aloe vera is commercially grown and produced in the Rio Grande Valley. A small amount is also grown in the Belle Glade area of Florida.

### History

Documented history of aloe use dates back to a 1552 BC manuscript that was discovered near Thebes. This document records various extractions of the Aloe vera plant for use in treating infections, rubbing on the skin, and preparing the drug, aloe. In 74 AD, the Greek physician Dioscorides's medical log — *De Materia Medica* — described aloe as "an effective purgative," but also suggested its ability to heal. A similar text was written about the same period in

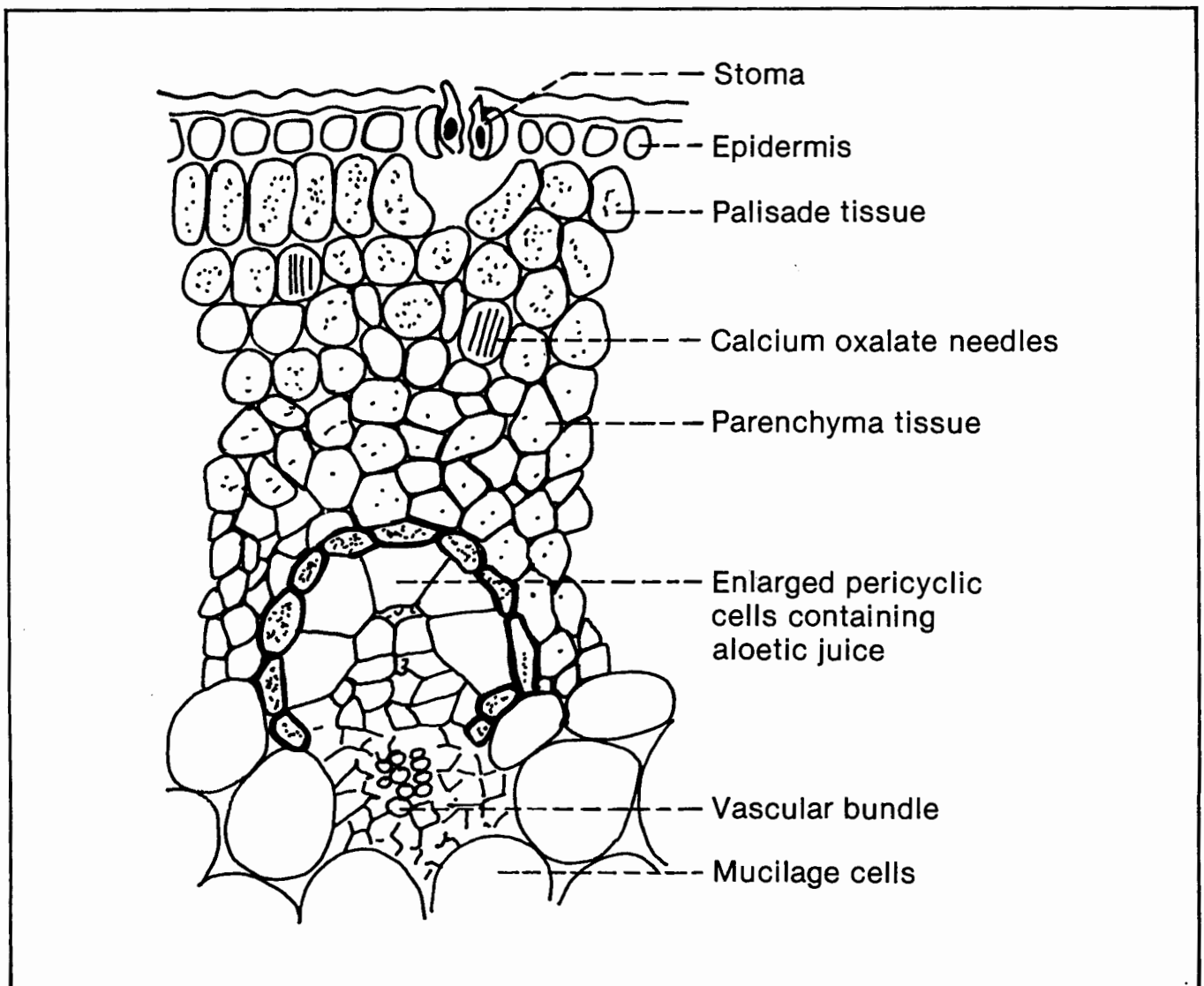


Figure 2: Cross-section of an aloe leaf, magnified.

Rome by Pliny, who described aloe principally as a purgative. Acceptance and use of aloe grew widely throughout the Mediterranean, the Middle East, Spain, Portugal, and the Caribbean Islands. Jesuit priests had some knowledge of the aloe plant.<sup>1</sup> They brought it with them to the New World, mainly to the South.

Commercial exploitation of medicinal aloes began in Persia during the ninth century; the manufacturing method has remained virtually unchanged for centuries. The basic process involves cutting off the base of the leaves, allowing the juice-like latex to drain into troughs, and collecting it in pails. The water is boiled off from the latex, producing a dark, resin-like substance. This is the aloe of pharmacy (Aloe USP) used mainly as a "laxative."<sup>1</sup> Commercial cultivation of aloe plants in the United States was started near Homestead, Florida, in 1912. By 1950, Texas and Florida farmers had begun to cultivate aloe. Cosmetic companies have found aloe to be a beneficial ingredient in a number of products.

### Types of Aloe

At least two products are derived from the aloe plant, and care should be taken to use the appropriate description of the derivative for desired results. Pharmaceutical aloe (*Aloe USP*) "is a dark chocolate-brown material with a resin-like appearance and properties."<sup>2</sup> The "juice" used to make this substance is obtained from the pericyclic cells shown in Figure 2. Aloe extracts derived from Aloe USP "contain resins, aloin, anthraquinones, and anthraglycosides as main constituents which, besides their well-known laxative properties,

have the properties of screening out erythemogenic UV rays."<sup>2</sup>

Another product, aloe gel, is derived from the inner parenchyma cells shown in Figure 2. This gel is used mainly in cosmetics, but it may have some internal applications.

Some cosmetic gels are produced by putting the leaf through rollers. This process yields both the gel and the latex; the latter is believed to be irritating. "Most of the scientific and folk literature on the healing, moisturizing, and emollient properties of aloe vera refers to properties of its *gel*, hence it is this gel that is used in cosmetics designed to promote such benefits."<sup>2</sup>

### Chemistry

It was long believed that the primary importance of the aloe plant was its pharmacological use as a cathartic. Aloin is the chemical responsible for this effect and was the only active chemical identified in the drug aloe until the twentieth century. Aloin is still aloe's main laxative ingredient.

In 1935, Collins successfully treated radium burns with fresh aloe gel. This sparked investigation of its active ingredients.<sup>3</sup> The first extensive study of the chemical breakdown of aloe gel was conducted over 40 years ago by Rowe and Parks.<sup>4</sup> Other researchers have investigated the chemistry of aloe gel in recent decades. Leung stated that many studies were not controlled, ignoring possible "seasonal, climatic, and soil variations which may strongly affect composition of the gel."<sup>2</sup>

Researchers have reported evidence of the following substances: polysaccharides containing glucose, mannose, galactose, xylose, arabinose; tannins;

steroids; glucuronic, citric succinic, and malic acids; enzymes (oxidase, cellulase bradykininase, catalase, amylase, etc.); free sugars (mainly glucose); a protein containing 19 amino acids when hydrolyzed; biogenic "stimulators;" saponin; various minerals; magnesium, lactate; three sterols; no vitamins or hormones.

Recent Japanese patents report the finding of aloctins and lectins<sup>5</sup> in aloe gel possessing anticarcinogenic properties. El Zawahry<sup>6</sup> mentions the presence of mucopolysaccharides.

No one key substance has been isolated as *the active* ingredient; instead, there seems to be an interrelationship among the different elements, suggesting a synergistic effect.

The stability of fresh aloe gel is affected by air, light, and heat. The gel is especially susceptible to microbial degradation. It deteriorates rapidly unless it is refrigerated or stabilized in another manner.<sup>2</sup> In order to preserve the chemical potency of the gel, a stabilization process is necessary. The formulation of an Aloe gel product should subject the gel to as little chemical and physical processing as possible in order to preserve its original properties.

When the gel is first extracted, it is very thick and slimy. It has a glair similar to quince-seed mucilage. The enzyme system then begins the hydrolysis of the acetylated polysaccharide, giving the gel its viscosity soon after it is produced. After 24-36 hr at ambient temperature, the viscosity is reduced to nearly that of water. Refrigerating the gel can delay this hydrolysis.

A number of stabilization processes have been developed; their effectiveness varies.<sup>7</sup> Improperly stabilized gel may not be beneficial as a cosmetic ingredient. Leung writes: "there have not been any controlled studies reported that correlate gel stability to its effectiveness, nor are there any meaningful analytical procedures developed to measure degree of decomposition."<sup>2</sup> Further research in this area is needed.

### Sensitivity to Aloe

The earliest record of an allergic reaction to aloe appeared in 1926.<sup>8</sup> That report, however, deals with the *drug* aloe. In reporting this case, Jadassohn mentions that he believed emodin to be the sensitizer. (Aloe *gel* does not contain emodin.)

Of the few reports on sensitivity to aloe, one deals with tincture of benzoin compound,<sup>8</sup> another with a single case involving aloe gel.<sup>9</sup> The latest report deals with sensitivity to *Aloe arbor-*

Table I: Recommended quantities of aloe for cosmetic products.

	Aloe gel (Stabilized)	Aloe Powder	Aloe Lipo-Quinone Extract
Lotions and creams	5%–20%	.025%–.1%	5%–10%
Suntan lotions	5%–20%	.025%–.1%	5%–10%
Suntan oils	—	—	5%–20%
Cleansers, fresheners, masks	5%–20%	.025%–.05%	—
Lipsticks or balms	—	—	2%–5%
Antiperspirants	5%–20%	.025%–.1%	2%–5%
Medicated creams, salves, ointments	20%–90%	.05%–.1%	20%–90%
Shampoos	1%–5%	—	Up to 1%
Hair conditioners	5%–20%	.025%–.1%	Up to 1%

*escens*, a different species of Aloe.<sup>10</sup> In each case, control patients produced no positive patch test.

One case of allergic contact dermatitis to aloe (species not identified) is reported in the Soviet literature.<sup>11</sup>

In his book on allergy to balsams, Hjorth also appears to report on aloe [resin] of the pharmacopoeias.<sup>12</sup>

#### Uses of Aloe

The effectiveness of aloe gel in the treatment of internal and external conditions has been reported in numerous scientific and medical journals. The five major properties of the gel are:

- Anti-inflammatory
- Healing
- Moisturizing<sup>13</sup>
- Substantivity to hair and skin
- Increasing skin respiration.

Scientifically confirmed applications of aloe gel (but not double-blind studies) have been reported throughout the world. Soviet scientists are the leaders in this research.

Antibacterial properties of aloe gel were claimed in studies by Lorenzetti and colleagues at the Ohio State University College of Pharmacy.<sup>14</sup> Fresh "juice" was drained from the leaves, heated 15 min at 80°C, and freeze-dried to produce a stable product. Using the agar diffusion technique, a solution was tested for bacteriostatic activity against *Staphylococcus aureus*, *Streptococcus pyogenes*, *Corynebacterium xerosis*, and *Salmonella paratyphi*, among other organisms. After incubation at 37°C for one day, significant inhibition of growth was evident.<sup>14</sup> Similar results were found in a more recent (1979) study using crude aloe gel and commercially prepared aloe.<sup>15</sup> (At least one other test shows that the yeast-like fungus *Monilia* multiplies rather than being inhibited.)

In January 1969, doctors at Brooke General Hospital, Fort Sam Houston, Texas, and Baylor University College of Dentistry tested the toxicity of three medications used to reduce the symptoms and promote healing of inflammatory lesions of the oral cavity. One of them, aloe gel, was found to be least toxic to tissue cells while producing the desired result.<sup>15</sup> Three separate reports by Tenney, Carrington, and Bovic studied treatment of similar pain and swelling following gingivectomies; rinsing with aloe gel relieved chronic periodontitis as well as symptoms of canker sores and stomatitis.<sup>1</sup>

As a result of the discovery of roentgen rays, a dermatitis peculiar to excessive exposure developed. In 1935, Col-

lins used fresh aloe gel to treat these burns. Itching was stopped and the burns healed without scarring; normal pigmenting occurred when the skin was exposed to sunlight.<sup>1</sup> In a more recent

report, Brown<sup>16</sup> successfully treated his patients' radiation burns by use of an aloe ointment. Aloe is used in treating not only radiation burns, but also sunburn, scalds, and burns of any degree.

Table II: Aloe suntan lotion (SPF-4).

	Ingredients	% by Weight
<b>A</b>	Water Glycerin Glucamate SSE-20 (Amerchol, Edison, NJ) Carbopol 934 (B.F. Goodrich, Cincinnati) Preservatives	q.s. 4.0 1.5 0.15 q.s.
<b>B</b>	Glucate-SS Cetyl alcohol Cetyl palmitate Glyceryl stearate P.E.G. 100 stearate Stearic acid Escalol 507 (Van Dyk, Belleville, NJ) Mineral oil	1.5 1.0 1.0 0.22 0.28 4.0 4.0 5.0
<b>C</b>	A.M.P. — 95	0.32
<b>D</b>	Aloe gel, color stabilized	10.0
	<b>Procedure:</b> (1) Heat water to 80°C. (2) Dissolve Carbopol-934 in the hot water. (3) Add rest of Phase A and adjust temperature to 80°C. (4) Heat Phase B to 80°C. (5) Add B to A at 80°C. (6) Add Phase C. (7) When batch is at 131°F, add Phase D. Mix to below 100°F.	

Table III: Aloe peel-off mask.

	Ingredients	% by Weight
<b>A</b>	PVA 35/45 cps (15% solution) PVA 20/25 cps (20% solution)	35.0 35.0
<b>B</b>	Aloe vera aqueous extract concentrate Alcohol Methylparaben Carbowax 1540 (Union Carbide, Danbury, CT) Glycerin Propylene glycol	2.0 20.0 0.2 2.0 0.6 3.0
<b>C</b>	Polysorbate Perfume oil	2.0 0.2
	<b>Procedure:</b> Make PVA solutions separately heating up to 85°C-90°C while stirring to be certain of complete solution. Mix ingredients in B; when solution is clear add the mixture of C and B and stir well. Add the mixture of B and C to A and stir well. Let stand overnight to let air rise to surface and escape.	

In January 1973, El Zawahry reported results of treating patients with chronic leg ulcers, seborrhea, acne vulgaris, and alopecia using fresh aloe gel.<sup>6</sup> The gel was applied three to five times daily to the leg ulcers of three men who reported having the ulcers for periods of 7-15 years. The leg ulcers, which had resisted treatment for years, decreased in size and showed good healing progress within five weeks. This phenomenon encouraged El Zawahry to use aloe gel for alopecia and hair loss, since it appeared to stimulate epithelial growth. Three patients with seborrheic alopecia stated within one week that their scalp oiliness and hair loss decreased; after one month, they began to have hair regrowth. The drying effect on seborrhea by aloe gel encouraged the doctor to treat acne vulgaris. After one month, two women were entirely free from acne lesions and one showed marked improvement. El Zawahry also reported no irritation from or adverse reactions to aloe gel use.

#### Internal Use

The most common internal application of aloe is in the treatment of peptic ulcers. In a 1963 study, 18 peptic ulcer patients were treated with an aloe gel emulsion. Complete recovery in all cases was confirmed and recurrences were delayed or prevented in cases expected to flare up after satisfactory treatment by taking a tablespoon of Aloe vera gel at bedtime. According to the study's authors, "There can be little doubt of its utility as a therapeutic agent in this serious disease."<sup>17</sup> The case for internal use of aloe gel is based on its ability to reduce the flow of gastric acids in rats by about 30%, due to the presence of aloenin and magnesium lactate.<sup>18</sup>

#### Formulating Properties

Table I shows the recommended amount of aloe gel for a given application. In using the stabilized gel, one simply replaces a portion of the water in the formula with the gel, stirring to disperse as with any water-soluble addition, such as preservatives.

It is necessary to dust freeze-dried aloe gel over the surface of the water phase, under *shearing* agitation, until it is completely dispersed and hydrated. Some prefer to make a concentrate to be used as needed. In such a case, the newly dispersed aloe gel must be adequately preserved.

Lipo-quinone extract, a water-free oil extract of aloe, is used in suntan oils, lipsticks, and in other water-free cosmetics.

#### End Uses

Aloe gel is used in drugs and cosmetics as a moisturizer. Meadows showed that 5%-10% aloe gel reduced the loss of moisture in a cosmetic emulsion.<sup>13</sup>

The presence of the several sugars along with magnesium lactate present in aloe gel have been shown to soften skin.

Suntan preparations utilize the anti-inflammatory properties of aloe gel, along with its moisturizing effects.

Table IV: Mild aloe shampoo.

	Ingredients	% by Weight
<b>A</b>	Sipon LSB (Alcolac, Baltimore) Sipon L-22	30.0 20.0
<b>B</b>	Water Sodium chloride DMDM — hydantoin (Glyco, Greenwich, CT) Color-stable aloe gel	q.s. 1.0 0.3 5.0
<b>C</b>	Standapol AB-45 (Henkel, Teaneck, NJ)	6.0
<b>D</b>	Citric acid	q.s. to 6.0 pH
	<b>Procedure:</b> (1) Mix Phase A together at room temperature. (2) Mix Phase B at room temperature. (3) Add B to A at room temperature — mix until clear. (4) Add Phase C to AB — mix until clear. (5) Add Phase D — mix until uniform. Note: To decrease viscosity, use less Standapol AB-45.	

Table V: Aftersun moisturizer.

	Ingredients	% by Weight
<b>A</b>	Water Aloe vera aqueous extract concentrate Propylene glycol Sorbitol 70% Triethanolamine 99 Butylparaben Methylparaben Propylparaben	67.15 5.0 5.0 3.0 1.0 0.05 0.35 0.1
<b>B</b>	Mineral oil, light Emersol 132 (Emery, Linden, NJ) Lexemul (Tegin) 515 (Inolex, Philadelphia) Adol 52 NF (Ashland, Columbus) Synthetic spermaceti wax Wecobee 8 (PVO, Boonton, NJ) Silicone 200 fluid Solulan 98 (Amerchol, Edison, NJ)	9.0 4.0 1.5 1.0 1.0 0.5 0.5 0.5
<b>C</b>	DMDMH-55 Fragrance	0.2 0.15
	<b>Procedure:</b> (1) Heat A and B to 80°C. (2) Add B to A while mixing. (3) Cool while mixing to 45°C; add fragrance and DMDMH (C) while mixing. (4) Cool to 37°C.	

Aloe gel's substantivity to hair and skin is a benefit evident mainly in shampoos and hair rinses.

Preliminary tests have shown that aloe gel increases skin respiration, a function involved in the healing process.

The major property of aloe gel is its healing action, but inadequate double-blind studies have been conducted.

The formulas in Tables II-VII illustrate the uses of aloe gel in various cosmetics.

### Incompatibilities

Aloe gel has a pH of 4.5-5.5; hence it is best used in emulsions with a similar pH. However, because of the presence of the enzyme cellulase, such gum-like thickeners as the cellulose derivatives (methyl cellulose, for instance) must be replaced by noncellulosic gums such as the alginates, Irish moss, and xanthan gum. (But there is a question of carriageen's safety.)

The color changes from water-white when freshly made, to a faint pink, and finally to varying degrees of amber, depending on numerous factors such as light, heat, oxygen, age, and certain metal traces.

Table VI: *Aloe vera* moisturizer.

	Ingredients	% by Weight
A	Nimlestrol D (mineral oil & lanolin alcohol) (Emery, Linden, NJ)	2.0
	Super corona lanolin (Croda, New York)	0.5
	Mineral oil	8.0
	Cetearyl alcohol	2.0
	Stearic acid	4.0
	Isopropyl lanolate	1.0
	Spermaceti	1.0
	Glyceryl stearate	4.0
B	Triethanolamine	1.0
	Glycerin	2.0
	Propylene glycol	2.0
	Methyl paraben benzoate	0.3
	Propyl paraben benzoate	0.1
	Terra Dry aloe vera powder (Terry, Melbourne, FL)	0.05
	Sorbitol 70%	2.0
	Water	69.1
C	Fragrance	q.s.
	<b>Procedure:</b> (1) Heat A to 80°C, mix until uniform. (2) heat B to 80°C, mix until complete solution is obtained. (3) Add B to A slowly with continuing agitation. (4) Cool with gentle agitation to 45°C. Add C. (5) Continue mixing and cooling to 40°C.	

Table VII: Facial mask with aloe.

	Ingredients	% by Weight
A	Glycerin	5.00
	Water	50.70
	Aloe gel	20.00
	Propylene glycol	5.00
B	Bentonite USP, gel white H	16.00
	Titanium dioxide	1.50
C	Jojoba oil	1.00
	Vitamin A	0.10
	Vitamin D	0.10
	Vitamin E	0.10
D	Fragrance	0.20
	DMDMH hydantoin	0.30
	<b>Procedure:</b> Heat A to 80°C. Stir in B until uniform. When temperature is 45°C or lower, add C and D.	

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