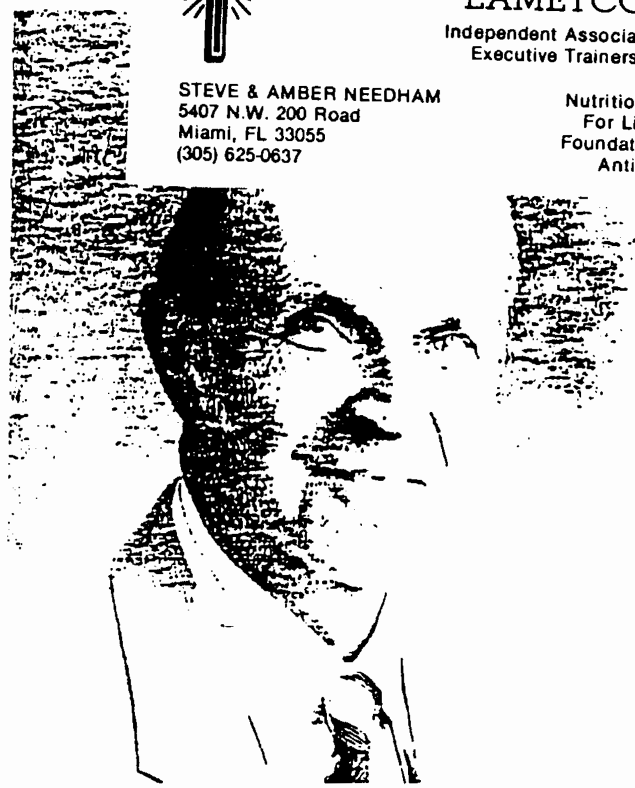
Aloe Leaf Handling and Constituent Variability

Ivan E. Danhof, Ph.D., M.D.



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What is the BEST aloe?

The question, "What is the BEST aloe?" is often asked. I answer the query with another question, "What do you want the aloe product to do?." The BEST aloe is one which contains the constituents that have the actions and benefits the final product should contain and does not contain materials with negative effects.

An aloe leaf contains more than two hundred different constituents - each of them in relatively small quantities . The juice contains, on average, more than 99 percent water, thus, all the constituents together amount to less than one percent. This implies that actions and benefits may be brought about by very small amounts of active ingredients. It also points to the fact that the leaf should be harvested and processed to assure that the active constituents are present in satisfactory amounts and are not adversely altered by the method of preparation .

To answer our initial question, the BEST aloe is a preparation which: maximizes the desired constituents, minimizes any ingredient with negative effects, maintains the constituents in an unaltered and active form, preserves the actions and benefits, and is present in the final product in amounts which, indeed, can bring about the desired result when the product is used as recommended.

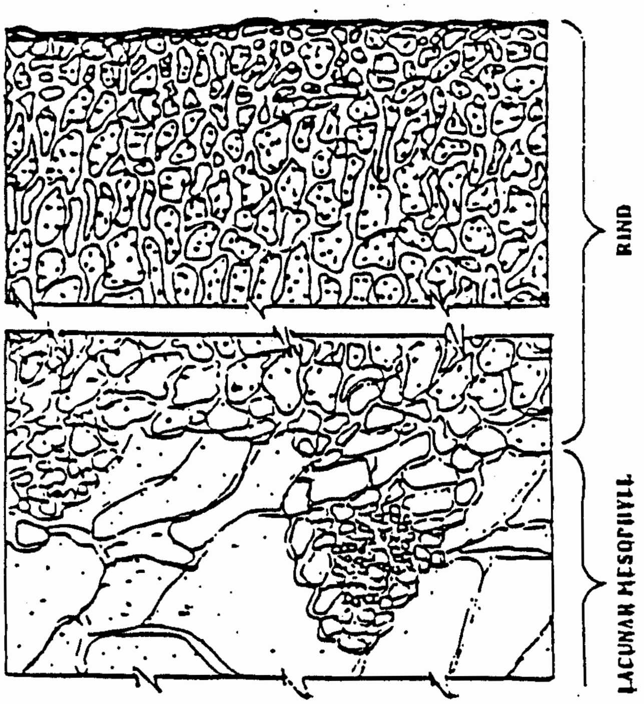

Figure I. A composite photomicrographic section through the outer layers of the leaf of Aloe barbadensis Miller, showing the thick green rind and the outer portion the lacunar mesophyll (mucilage).

Where are the aloe constituents made?

In Figure 1 (below) is a photomicrographic section through the outer portion of an aloe leaf. The rind consists of 15-18 layers of cells interspersed with chloroplasts (small round bodies), where the constituents are synthesized, and with inclusions containing calcium oxalate and magnesium lactate crystals.

Figure 1. A composite photomicrographic section through the outer layers of the leaf of Aloe barbadensis Miller, showing the thick green rind and the outer portion of the lacunar mesophyll (mucilage).

From : REMARKABLE ALOE,
Aloe Through The Ages
Ivan E. Danhof, Ph.D., M.D. Grand Prairie, Texas: Omnimedicus Press, 1987, pp. 54,54.

Just beneath the thick green rind are located the vascular bundles. As shown in Figure 2, the outer support of the vascular bundle is provided by the sheath cells. Inside the vascular bundles are three types of tubular structures: the xylem (transports water and minerals from roots to leaf), the phloem (transports starches and other synthesized materials to the roots), and the large pericyclic tubules (containing the yellow latex or sap which is very high in the laxative anthraquinones, especially aloin).

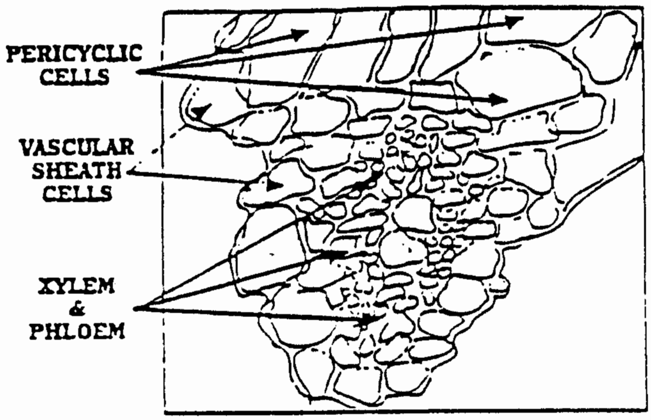

Figure 2. The various portions of the tubules of a vascular bundle are labeled. The pericyclic tubules contain the laxative agents of the yellow sap or latex. Xylem and phloem vessels serve in water and nutrient transport, respectively.

The anthraquinones absorb ultra violet rays of the sun and prevent overheating of the central portion of the aloe leaf, the water storage organ. Note that the pericyclic portion of the vascular bundle is adherent to the rind, while the remainder of the vascular bundle protrudes into the lacunar (large spaces) parenchyma or mesophyll which is very thick and slimy. This provides a movable layer between the more solid inner gel fillet and the stiff outer rind. This liquid layer is termed the mucilage.

The innermost and major portion of the leaf is the spongy parenchyma or mesophyll constituting the gel fillet. This layer has more structural integrity than the slimy mucilage layer.

All of the carbohydrate (polysaccharides) and glycoprotein (enzymes) constituents of the aloe leaf are made in the thick, green rind. Carbohydrates synthesized in excess of that needed for energy metabolism are transported to the gel fillet for storage of water and minerals and carbohydrates.

The carbohydrates are transported by the phloem vessels to small cellulose-containing vessels in the gel fillet, which constitutes most of the pulp of the fillet. Water is then osmotically attracted to the carbohydrates serving as the water storage organ of the plant.

The carbohydrates (and small amounts of lipids or fats) consist of carbon, oxygen and hydrogen. These are derived from carbon dioxide from the air taken into the leaf through the stomata (pores) at night, and water (H_2O) from the ground. There is no sunlight to energize the photosynthesis mechanism to change the CO_2 into carbohydrate. The entrapped CO_2 is stored as malic acid, which gives the internal part of the leaf an acidic pH of about 4.0. When the sunlight hits the leaf, some of the malic acid can be changed to the carbohydrate used as fuel by the plant's synthetic machinery. Only a portion of the carbohydrate is used for energy, the remainder being stored in the mucilage and gel fillet.

Protein consists of Carbon, Hydrogen, Oxygen, and Nitrogen, the latter coming from the soil transported in the xylem vessels.

How do the constituents vary in the different parts of the leaf?

In Table I are given percentages of total solids and water found in the four major fractions: rind, latex, mucilage (lacunar mesophyll), and gel fillet (spongy mesophyll).

TABLE 1

FRACTION	TOTAL SOLIDS %	WATER %	SPECIFIC GRAVITY
Rind	12.40	87.60	1.142
Yellow Sap & Latex	6.41	93.59	1.068
Mucilage	1.24	98.76	1.013
Gel Fillet	0.52	99.48	1.005

Note that the rind contains the greatest amount of total solids consisting of fibrous xylans and mineral salts. The yellow sap contains about half the amount of total solids of the rind, largely anthraquinones and mineral salts. The mucilage contains about two and one half times the total solids of the internal gel fillet, as the molecules are in transition from their source of formation in the green rind chloroplasts to their storage sites in the gel fillet.

How do various leaf processing methods affect these constituents?

Four major processing procedures are commonly in use in the aloe industry. They include:

(1) Roller Method - The leaves are passed through rollers similar to an old fashioned washing machine wringer. The fillet "pops" out, but more pressure is applied to the pericyclic tubules.

(2) Leaf Splitter Method - The leaf is forced against a thin wire, which can be placed varying distances from the vascular bundles. If the wire is permitted to go too close to the rind, the material will contain more anthraquinone as well as more of the mucilage. If the wire is permitted to go closer to the gel fillet, less anthraquinone will be present, but also less of the rich mucilage.

(3) Hand-filleting Method - The rind is removed by hand using cheese cutters and large knives. This method keeps the anthraquinone levels low, but the majority of the mucilage is left on the table top.

(4) Total Leaf Method - The entire leaf is coarsely chopped and the rind particles are removed by passing through filters of various porosities. The anthraquinones are

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removed by use of charcoal filters, but some active constituents, e.g., glycoproteins, are bound to the charcoal and removed. This method produces a product richer in carbohydrates, but also much higher in mineral salts than the other methods.

TABLE 2

METHOD	pH	ALOIN	TOTAL SOLIDS	H_2O
Roller	4.30	32	0.39	99.61
Leaf Splitter	4.24	18	0.42	99.58
Hand Fillet	4.27	6	0.48	99.52
Whole Leaf	4.09	1	1.38	98.62

How do exposure to heat and/or cold affect the constituents?

The carbohydrate and glycoprotein constituents of aloe are prone to rapid spoilage. Therefore, preservation methods must be employed. Several systems have been devised to preserve the integrity of the aloe.

Generally, preservative methods are classified as (1) cold processing/preservation, which employs chemical preservatives; (2) heat processing/preservation and (3) combination methods of (1) and (2) above.

(1) Chemical preservation - Sodium benzoate and potassium sorbate are commonly used as preservatives for aloe preparations. In addition, the parabens and urea derivatives are often used in aloe for topical applications. Use of sulfites, similar to the methods used in the wine industry, are sometimes employed.

(2) Heat processing/preservation usually employed some form of rapid or slow pasteurization.

(3) Combination methods used both chemical and heat preservation. The results of various heat and cold exposures on constituent patterns using the hand-filleting procedure of processing are shown in Table 3.

As the data illustrates, long exposure to heat (conditions 2 and 4 compared with 1) produced significant losses in active constituents, whereas relatively minor changes occurred with brief heat exposure (condition 3). Exposure of leaves to the cold (condition 5) - "stressing the leaves" - increased the carbohydrate levels somewhat, but with a slight decrease in the glycoprotein levels.

What is the BEST Aloe?

Each method of processing has its own advantages and disadvantages. Excessive exposure to heat does produce untoward and undesirable changes in leaf constituents. "Cold-processing" or brief exposure to heat, while associated with some variations, are satisfactory processes. Roller and leaf-splitter processes are associated with somewhat higher levels of anthraquinones than the hand-filleting procedures. Whole leaf processing results in higher amounts of carbohydrates as does the "cold-stressing" of the leaves prior to processing. The other methods are quite satisfactory with respect to the levels of carbohydrates shown to have healing properties.

It is important to remember that if 20% of a given constituent is required for an optimal activity, the use of 80% will not provide significantly greater benefits.

Thus, the type of aloe leaf constituent desired can be obtained by various handling, processing and preserving systems; the ultimate use determining the best approaches to be utilized.

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TABLE 3

TREATMENT	pH	ALOIN (ppm)	TOTAL SOLIDS (%)	WATER	LARGE + POLYSAC-CHARIDES	GLYCO-PROTEIN++
1. Hand-filleting	4.27	6	0.48	99.52	Present	Present
2. Leaves in sun for 6 hours	3.92 [a]	54	0.54 [b]	99.46	Markedly reduced	Virtually absent
3. Heat exposure: Flash pastuerization	4.24	8	0.46	99.54	Slightly reduced	Slightly reduced
4. Heat exposure: Sloe heat - 1 hr.	4.42	8	0.48	99.52	Markedly reduced	Virtually absent
5. Cold exposure: 5 degrees C - 7 days	4.76	7	0.56 [c]	99.44	Increased	Slightly reduced

\+ = shown to have healing properties
++ = shown to have enzymatic properties
a = accumulation of free aspartic and malic acids
b = loss of water from leaf gives spurious increase in total solids
c = partially due to water loss, but also increased synthesis of polysaccharides

Sunburn, continued from page 3

anthranilates. Aloe Vera contains salicylates and anthraniline like substances which may have sunscreen potential. These substances penetrate the outer skin covering and bind to the dermal tissue.

Aloe Vera possesses prostaglandin inhibitory properties and also has several other therapeutic actions. (Table 3) Experimental and clinical evidence has been presented to show that Aloe has a potential analgesic or anesthetic effect. It contains an aspirin like substance as well as high concentrations of a magnesium which has an anesthetic property. It has also been shown to be an anti-inflammatory and enhances blood flow.

Wound healing properties have been attributed to topically applied Aloe Vera. Therefore, the curative properties of Aloe Vera have scientific foundation. Topical Aloe Vera not only is an effective preventer of sunburn but can most effectively reduce the severity of sunburn.

References

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Table 1: Immediate and Long-Term Consequences of Excessive Exposure to Ultraviolet Light

IMMEDIATE EXPOSURE

Pain, blistering, skin peeling, edema: classic sunburn

"Systemic" sunburn or "sun poisoning"

Exacerbation of medical conditions (e.g., discoid lupus, SLE, herpes simplex, porphyrias, dermatomyositis, xeroderma pigmentosum, pemphigus, acne vulgaris, atopic dermatitis, seborrheic dermatitis, rosacea, erythema multiforme)

LONG-TERM EXPOSURE

Skin cancer (including basal cell carcinoma, swuamous cell carcinoma, and malignant melanoma)

Premature aging of skin: solar elastosis (wrinkling, dryness, atrophy, loss of elasticity)

Freckles, telangiectasias, hyper and hypopigmentation

Keratoacanthoma

Dysfunction of the immune system

* Modified from Roberts

Table 3: Physiological Properties of Aloe Vera

1. It penetrates skin and tissue
2. It anesthetizes the tissue
3. It is bactericidal virucidal and fungicidal
4. It is anti-inflammatory (anti-prostanoid)
5. It dilates capillaries and increases blood supply

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Table 2: Skin Types and Response to Ultraviolet Light*

Types / Characteristics	Examples	Recommended Sunscreen
1 Never tan, always burn easily	Celtic Irish; with blue eyes, red hair, freckles	15 or greater
2. Tan slightly, burn easily	"Fair skinned" individuals; with blond hair	12-15
3. Always tan gradually and moderately, sometimes burn	Most Caucasians	8-10
4. Always tan well, minimally burn	Hispanics, Asians	6-8
5 Rarely burn, tan deeply	Middle Easteners, Indians (heavily pigmented)	None
6 Deeply pigmented, do not burn	Blacks **	None **

* Modified from Roberts
** Blacks can burn or peel with significant exposure and may benefit from sunscreens