Aloe as a humectant in new skin preparations

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The literature describing the composition of aloe as well as its useful properties is rife with contradictions. Part of this confusion can be explained by the fact that there are over 300 species of aloe, with 3, or possibly 4, in commercial use. These are Aloe vera (more correctly known as Aloe barbadensis), Aloe perryi, and Aloe ferox, commercially known as Curacao Aloe, Socatrine Aloe, and Cape Aloe, respectively.

To add to the confusion, many of the analyses were made on pharmaceutical aloe, which is a far cry from the aloe used in, and offered for, cosmetic use. Cosmetic aloe is obtained from the peeled, spineless leaves of Aloe vera.[1] The parenchyma is the part used. It is a nearly water white, faintly opaque, fibrous gel, containing a mucilaginous liquid that can be readily separated from the fibers. This stabilized liquid is the commercial aloe sold for cosmetic use. Pharmaceutical aloe, on the other hand, is a dark brown, chocolate-like resinous mass obtained by boiling the natural gel until it is literally water-free. Light and heat catalyse chemical changes, resulting in a different composition.

Composition of aloe gel

The cosmetic grade of aloe "gel" contains approximately 0.5% total solids. The natural gel has a pH between 4 and 5 depending on the climate, season of the year, and where grown. This liquid has been analyzed by a number of workers. The major sugars found are mannose and glucose, with trace amounts of xylose, arabinose, galactose, and rhamnose in that order. They may account in part for the moisturizing properties of aloe, aided possibly by the presence of traces of magnesium lactate. Seventeen amino acids have been confirmed[2]; glutamic, malic, succinic, and citric acids are also mentioned. The acid type (malic or citric) and concentration varies with the storage of leaves in light or darkness.[3] Four sterols and a sapogenin have been reported. A variety of quinones and anthraquinones have also been found. Six of the enzymes present are: cellulase, carboxypeptidase, bradykininase,[4] catalase, amylase, and an oxidase. As for aloin and aloe emodin, there is no agreement on their presence. It is believed that aloin as such does not exist in a free state, but is conjugated as a glycoside in the fresh gel, if at all present; but as the enzymes act on the glycosides, aloin may be detected somewhat later. Aloe emodin is said to be absent. This is an oversimplification, for these are only a few of the many organic compounds present. As for minerals, they will vary largely, depending on the rains and terrain.

In view of the presence of a variety of quinones and anthraquinones, exposure of the fresh gel to air and light causes it to turn pink and eventually a light tan to brown. Heat and light, in particular, catalyze this reaction. Thus far, the best way to keep the natural gel from changing color too fast is to store it in a dark, cool place.

The natural gel, when sold as such, contains the enzymes at full activity. The thick, stringy, mucilage-like extract gets thinner on standing, probably due to the action of one or more of the enzymes. There are at least four different partially acetylated glucomannans that have various

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acetyl contents, which are thought to produce the thick, stringy, mucilage-like properties. As they are hydrolyzed, the viscosity is reduced.

When the natural gel is freeze-dried, it produces a light tan, tacky residue that is sufficiently friable to be pulverized at below freezing temperatures. If co-spray-dried with a suitable matrix, a free-flowing, lighter colored powder can be obtained. Even so, such powdered freeze-dried aloe gel is best stored in a cool, dark, dry area.

It has already been mentioned that the several sugars and the lactate content may account for the natural moisturizing properties of aloe, and may retard the rate of moisture loss from cosmetic creams and lotions. Following are some tests that demonstrate this property.

Materials and methods

The gel used in these tests was obtained from aloe vera grown in southern Texas. The gel was removed from the rind, ground, "clarified," and filtered. To it was added 0.2% sodium benzoate and 0.15% ascorbic acid, for minimal preservation. The gel was stored in a refrigerator under a nitrogen blanket between uses.

To demonstrate what effect aloe gel has on the evaporation rates of emulsions, and therefore on moisture loss, the gel was tested in 2 types of systems (1), comparing it in the simplest way to glycerin and propylene glycol in aqueous solutions, and (2), comparing it to these humectants in a simple nonionic emulsion. The weight loss, and therefore the water loss, of these systems was measured at 1 hour intervals for 3 hours to determine the amount of moisture loss in each system. The measurements were performed on samples of approximately 3.5-4.0 grams. They were dried in aluminum trays with a surface area of approximately 20.0 cm², at 45°C and at room temperature.

Aqueous solutions

In the first series of experiments, solutions of water and aloe gel, propylene glycol, and glycerin were tested. The water loss was determined as previously described. The samples were evaporated in the environment of that particular day. The room temperature and relative humidity were recorded for each experiment. Although the evaporation rate is a function of the relative humidity, the ratio of the oven sample evaporation rate to the room sample evaporation rate gives us a good comparison of the tested material's effectiveness in retarding evaporation.

In comparing pure water to 10% solutions of aloe gel, propylene glycol, and glycerin, it was found that the order of their effectiveness in retarding evaporation rates is glycerin, propylene glycol, and then aloe gel (fig. 1). The aloe gel retained approximately 25% more of its weight than pure water, and about 10% less than propylene glycol. However, when we assume that any weight loss came from water, we get a higher level of evaporation, and if we incorporate the fact that aloe gel is approximately 99.5% water, we see that the differences in the water loss of the solutions are smaller. Looking at the ratio of the oven water loss and the room water loss, which we will call R

$$\left(\frac{\%\ \text{oven loss}}{\%\ \text{room loss}}\right),$$

we arrive at the same ratio between the solutions as the water losses in the oven (fig. 2).

In the next series of tests solutions of 20% aloe gel, propylene glycol, and glycerin, along with mixtures of the humectants with the aloe gel, were compared to each other (fig. 3). In looking at the first 3 basic solutions we see about the same relative effectiveness of the materials as

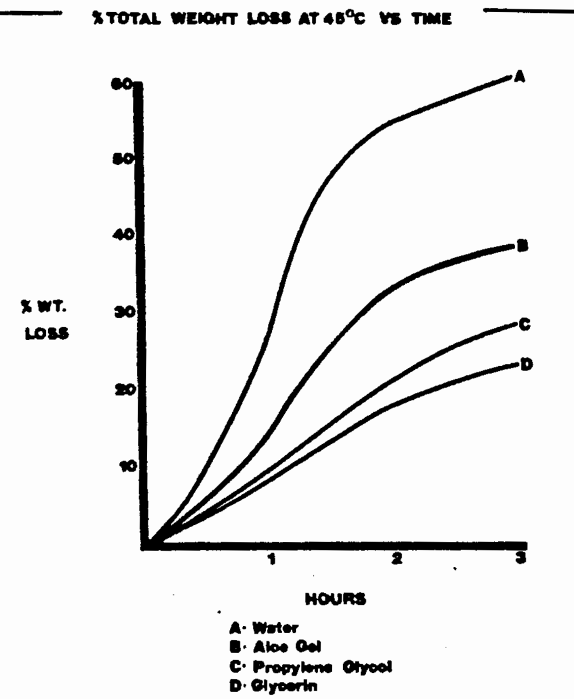

Figure 1

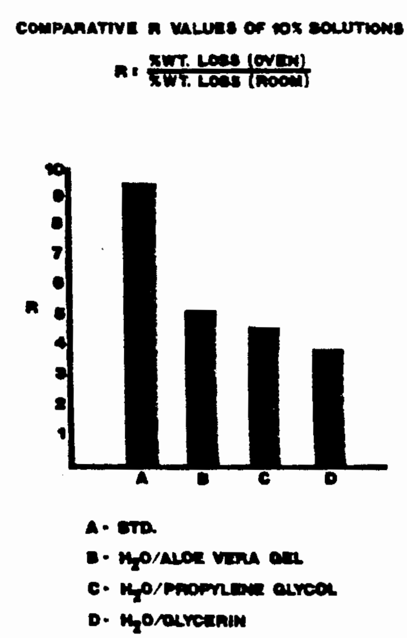

Figure 2

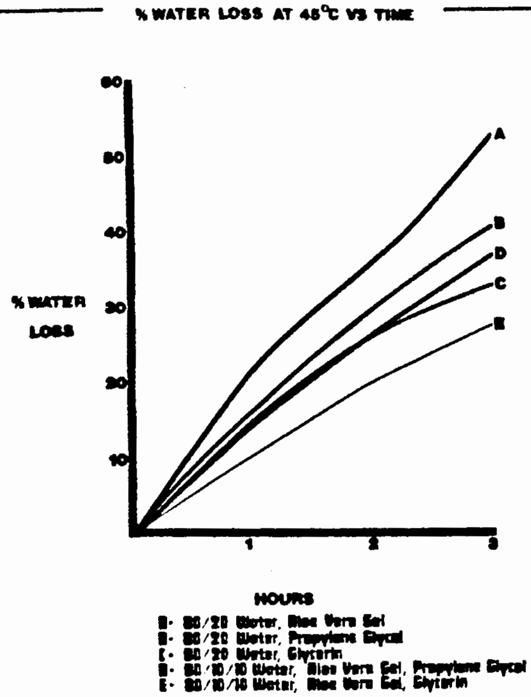

Figure 3

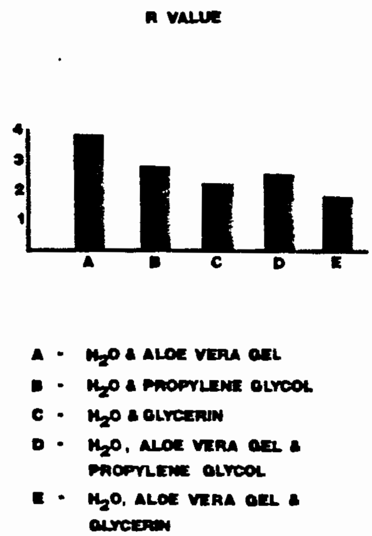

Figure 4

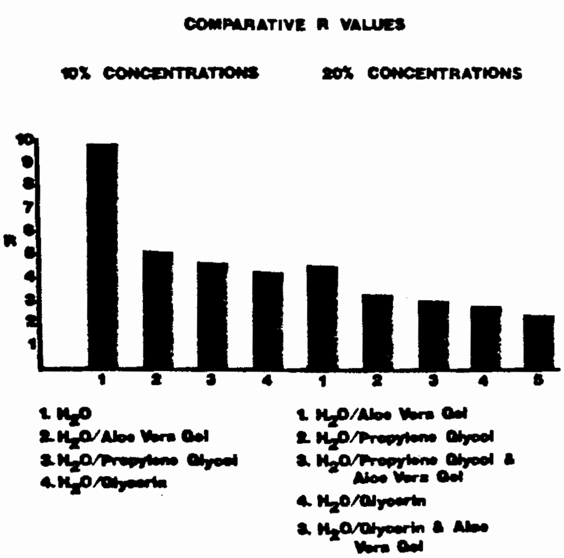

Figure 5

ALOE VERA GEL IN O/W EMULSION

	A	B
H_2O	60.0	50.0
TWEEN-80	2.5	2.5
MINERAL OIL	31.5	31.5
ARLACEL-80	1.0	1.0
STEARIC ACID	5.0	5.0
ALOE VERA GEL	···	10.0

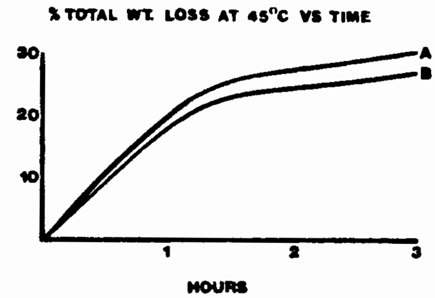

Figure 6

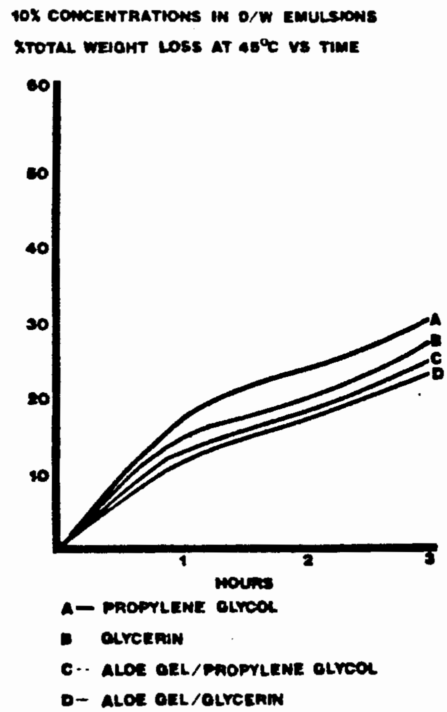

Figure 7

was shown with the 10% solutions; namely, glycerin, propylene glycol, and then aloe gel.

In the solution of mixtures, we find that we obtain better results with 10% of the humectant with 10% aloe gel, than with 20% humectant alone. When aloe gel is added to the propylene glycol (B), or to glycerin (C), it lowers their evaporation rate. And if we again consider that aloe gel is 99.5% water, we see even more water retention with the solutions of aloe gel in relation to the others. The *R* values also show this relationship (fig. 4). Although the actual percent of water loss was higher in this experiment than in the previous one, when comparing their *R* values, we see that they indicate the effect of doubling the humectant (fig. 5).

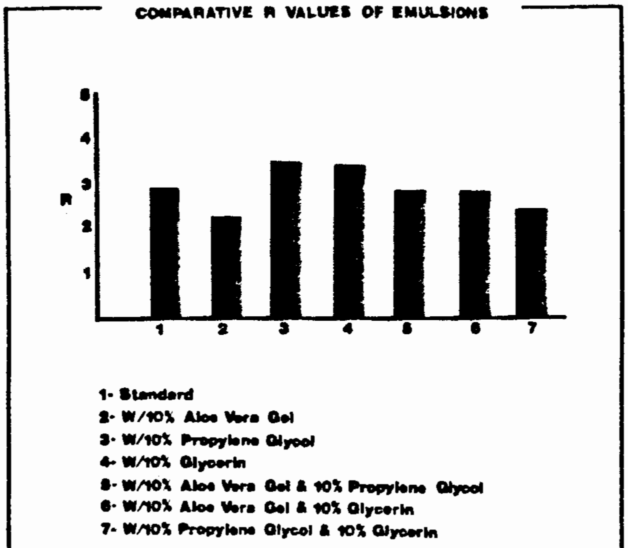

Figure 8

So, up to this point, we can say that aloe gel does have an effect on retarding the evaporation of aqueous solutions. And that it is less effective than propylene glycol or glycerin by themselves; but in combination with these, it improves their retardation effect more than at its correspondingly pure level.

Emulsions

The next question is, will aloe gel perform the same way in emulsions as it did in solutions?

A simple oil/water emulsion was prepared with and without 10% aloe gel. The emulsions were made the traditional way, except the aloe gel was added at 45°C to the emulsion and dispersed. It was found that adding the aloe gel last at 45°C permits the gel to retain its characteristic properties. Heating the aloe gel to 80°C along with the rest of the water phase accelerated gel breakdown.

In the o/w emulsion with aloe gel, we have retarded the evaporation rate as in the solutions (fig. 6).

We next compared propylene glycol and glycerin to aloe gel in the o/w emulsion and mixtures of the humectant with aloe gel in the emulsions. The same results were obtained as in the previous experiment (fig. 7). The glycerin/aloe gel combination proved most effective; propylene glycol/aloe gel next; glycerin alone next; and propylene glycol alone the least effective.

In comparing all the tested emulsion *R* values, we see that in 1 and 2 the effect of aloe gel is clear. When we move to 3 through 7, the values correspond to our conclusion (fig. 8). We see from these gravimetric tests that aloe gel aids in retarding evaporation of solutions and emulsions almost as well as the two humectants it was compared to, namely propylene glycol and glycerin. But when used together, a synergistic effect is shown.

As stated earlier, the method in which aloe gel is added is a factor determining its effectiveness as a humectant. When the emulsions were prepared with aloe gel in the water phase from the beginning, we see a greater increase in the loss of water.

With this knowledge we can assume that the chemicals present in aloe are not nearly as effective in retaining moisture when they are separated in their natural mucilaginous form, and that the physical structure of the aloe itself is greatly responsible for its attributes as a humectant.

Use in cosmetics and other products

Next, we will examine the use of aloe gel in various products. As already indicated, aloe gel could obviously be used in moisturizing products. The gel is compatible with nonionic, cationic, as well as anionic systems. However in anionic emulsions there is a limit to the amount of gel that may be incorporated in the product. When using a large percentage of gel, the quinones tend to react with bases and may cause color instability. (Although this is a definite disadvantage, it serves as a character test for aloe gel. If there is no color reaction, there is no aloe present, or it is present in a very small concentration.) Another factor that puts a limitation on the use of aloe gel is its natural pH, being about 4.0-5.0; if it is present in too large amounts or incorporated incorrectly into the product, there may be some neutralization of the emulsifying system. This usually occurs when the gel is present at levels over 30%.

Aloe gel is used in formula 1 at a high level, and serves as the only humectant. During compounding, the gel is added last at 45°C, after the Carbopol has been neutralized, thus preventing any pink quinone reaction. In this formula, the addition of the gel results in a firmer product.

Formula 1. Aloe anionic moisturizer

	%
Water	49.3
Carbomer 940	0.2
Anhydrous lanolin	5.0
Stearic acid	2.6
Stearyl alcohol	1.1
Light mineral oil	15.0
Triethanolamine 99	1.8
Aloe Vera Gel	25.0
Fragrance & preservatives	q.s.

Formula 2. Aloe nonionic moisturizer

	%
Water	75.2
Glycerin	3.5
PEG-75 stearate	2.6
Propylene glycol dicaprylate/dicaprate	2.0
PEG-25 castor oil	0.5
Light mineral oil	3.0
Glyceryl monostearate	3.0
Cetyl alcohol	1.0
Ceteareth-4	0.7
Laneth-10 acetate	1.0
Aloe Vera Gel	7.5
Preservatives & fragrance	q.s.

Formula 3. Aloe cationic suntan lotion

	%
Water	66.49
Propylene glycol	3.00
Phosphoric acid (85%)	0.31
PEG-10 soya sterol	1.00
PABA	0.50
Light mineral oil	4.00
Stearic acid	2.00
Isopropyl myristate	1.50
Glyceryl monostearate	2.00
Soya sterol	0.20
Myristamidopropyl dimethylamine	3.00
Propylene glycol hydroxystearate	1.00
Aloe Vera Gel	15.00
Fragrance & preservatives	q.s.

Formula 4. Aloe shave cream

	%
Brij 700 (1)	3.3
Cetyl alcohol	6.5
Water	44.4
Sorbic acid	0.2
Carbomer 934 (Carbopol 934)(2)	5.0
Sodium hydroxide (10% solution)	0.1
Fragrance	q.s.
Water	20.5
Aloe Vera Gel	20.0

(1) ICI Americas
(2) B.F. Goodrich

A slightly more complicated moisturizer, using other ingredients along with the aloe is shown in formula 2. The aloe gel/glycerin combination gives the product its effective moisture retaining potential.

It naturally follows that aloe would also be found in suntan products. Along with the labeling advantages of having aloe gel in a product, it serves the same purpose as in moisturizers, as a humectant. Formula 3 is an example of a cationic suntan lotion using PABA and aloe gel. Due to the gel's low pH it is very compatible with a cationic system and PABA. This product is very stable and does not darken with time, as do many products that contain PABA.

In hair products, aloe gel is used as is any other humectant. Aloe gel, however, may be used in lower amounts to achieve the same result as glycerin or propylene glycol due to its highly substantive nature.

The incorporation of aloe gel in soaps is an exceptionally interesting concept. Its effect would be that of a soap that cleans without leaving the skin dry. Because of the mildness of aloe gel, such soaps do not have the risk of irritation that is possible with glycerin soaps. The problem, as discussed before, is the stability of aloe gel in anionic systems, especially soaps, whose pHs run up to 10 or 11. The insoluble aloe polysaccharides are useful here. The new syndet soaps are another answer to the pH problem in soap. They have a pH around 5.5 and are usually nonionic.

An aloe shave cream would be another application of the polysaccharide in a soap type product. In this modified I.C.I. formula (formula 4) aloe gel functions as a lubricant as well as a moisturizer. Because of the aloe's mucilaginous nature it serves as a protective barrier between the skin and beard, much as silicons do.

In burn relief spray, aloe gel is already being used in a number of products. Along with the claims of its healing properties, it helps to retain moisture on damaged skin, which is a basic for healing. An extremely simple product that has proven to work well is a burn relief spray, consisting of lidocaine HCl and aloe gel. It is basic, suggesting a natural type of preparation rather than a medicinal one.

These are just a few of the types of products in which aloe gel may be used. Aloe gel may be used in any system in which moisturization or mildness is wanted, alone or in conjunction with other materials for that purpose.

Acknowledgement

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