Aloe vera Gel

Laurence Zerafa, B.Pharm.

This article is based on the author's 1979 thesis [3] which was aimed at reviewing the present literature on Aloe vera and on a practical aspect try to verify the reports on the curative powers of the plant's fresh mucilage on burnt rabbit skin. A description is given of a method for the preparation of a fresh crude mucilage from fresh Aloe vera leaves, the physical and other characteristics of the Aloe vera gel, and the effect of Aloe vera mucilage on normal and burnt skin.

Introduction

As described in the last issue of the Pharmacist [1] besides the aloes of laxative properties the plant Aloe barbadensis Miller (unofficially Aloe vera Linne) yields from its central fleshy parenchymal tissue a mucilage or gel which although as yet has no officially medicinal status is purported to have beneficial effects on burns and wounds of the skin, and to relieve stomach and duodenal ulcers. These 'recently' discovered effects of Aloe vera gel are well documented in past history and folk uses of this plant. In spite of the popularity of this plant, as yet modern science has not identified the curative agent responsible for the healing powers of the plant proven in man and animal. This fact may explain why the plant bears no official status within medical circles in the western world pharmacopeias.

However, the increase in demand for the leaf and its mucilage, and products derived from it for cosmetic applications has generated widespread interest and research, especially in the USA where the plant thrives well in the Caribbean basin and in southern states like Texas and Arizona. Efforts to establish an official status for the plant and its mucilage has led to the establishment in June 1982 of the National Aloe Science Council (NASC) [2].

A fresh liquid mucilage from Aloe vera leaves

The fresh mucilagenous pulp of A. vera leaf can be applied to the skin in two ways [3].

1. The fresh whole leaf can be split longitudinally and the internal gel side can be applied directly to the skin, or slabs of the gel can be cut to size and again applied to the skin. This corresponds to the NASC definition of RAVG.
2. A liquid mucilage can be prepared by extracting manually or mechanically the internal pulp from the centre of the leaf, dicing it, homogenizing it and then filtering it. This liquid mucilage or gel can be applied directly to the skin or by means of wet dressings This corresponds to the NASC definition of AVG but with no additives or preservatives.

APPROVED DEFINITIONS FOR ALOE VERA LEAF AND PREPARATIONS DERIVED FROM IT:

Among the first jobs of the NASC was to define the nature of Aloe vera products. According to these approved definitions as given by the NASC(4) some of the products of Aloe vera are:

Whole Leaf Aloe vera
Whole Leaf of the Aloe barbadensis Miller-including the rind and internal portions of the plant.

Aloe vera Latex
The bitter yellow liquid contained in the pericyclic tubules of the rind of Aloe barbadensis Mill; the principle constituent of which is Aloin.

Raw Aloe vera Gel (RAVG)
Naturally occurring unprocessed, undiluted parenchymal tissue obtained from the decorticated leaves of A. barbadensis Mill, and to which no other material has been added.

Aloe vera Gel (AVG)
Stabilized Aloe vera Gel — Naturally occurring processed, undiluted, parenchymal tissue obtained from the decorticated leaves of A. barbadensis Mill and to which no more than 5% additives including preservatives, shall have been added as part of the processing.

100% Aloe Vera
Processed, preserved liquid derived from parenchymal tissue obtained from the decorticated leaves of Aloe barbadensis Mill and defined by a value of 1000 using the reporting procedure adopted by the NASC. This Aloe vera gel can be suitably diluted to give **Whole Aloe vera Gel** which contains a minimum of 50% of the natural pulp found in RAVG. **Aloe vera Juice** an ingestable product containing a minimum of 50% AVG. **Aloe Vera Drink** an ingestable product containing less than 50% and more than 10% of AVG and also **Aloe vera Extract**, a dilution of Aloe barbadensis Miller with water or other suitable solvent that contains less than 10% Aloe vera gel and is suitable for ingestion or topical use.

Alternatively the gel may be marketed in a concentrated form. Thus we have:

Aloe vera Concentrate
AVG from which natural water has been mechanically removed and which would have a value of 1500 minimum on the NASC scale.

Aloe vera Gel/Spray Dried
Acquiesce derivative of the leaf of A. barbadensis Miller which has been sprayed dried on a suitable a matrix.

Aloe vera Gel Freeze Dried
AVG which has been freeze dried with or without matrix.

Finally there is **Aloe vera Oil** which is the lipid portion obtained from the leaves of Aloe barbadensis Miller by various solvent extraction processes.

For the experiments described below a liquid mucilage was used for several reasons, which included ease of application, ease of storage and handling and assuming that any healing agents are found intracellularly then homogenization in breaking up the cell walls would liberate any such active ingredients.

The problems with the use of a liquid mucilage are that its production involving several steps is time consuming and, since it involves many steps where it is manually handled, risks of microbial contamination are high and for its intended use the product should be sterile. On a large scale production unit the two problems can be solved by mechanization and use of an aseptic process and use of preservatives.

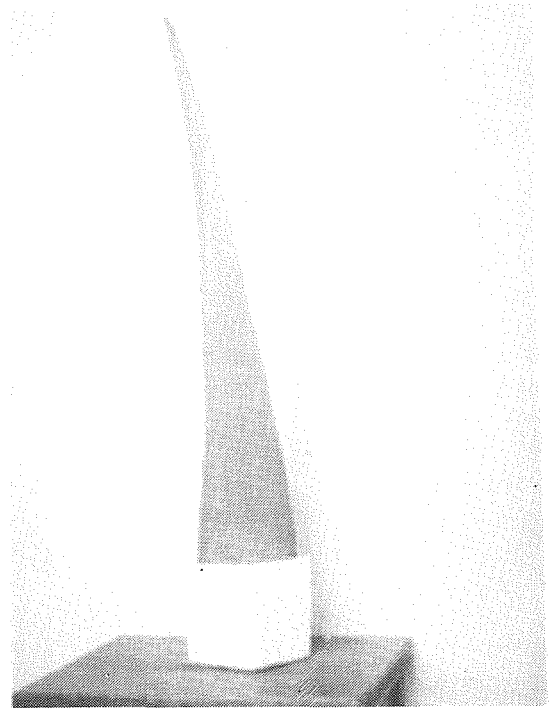
In the small scale production described below the contamination problem was tackled by proper cleaning of all apparatus, containers and working surfaces and use of gloves while handling the leaf and pulp. Finally the liquid preparation was immediately stored at a low temperature below 4°C or frozen at —12°C to eliminate microbial proliferation.

THE SMALL SCALE PRODUCTION OF LIQUID ALOE VERA GEL

The method used involved the following five basic steps.

1. Choosing the leaves
2. Cutting and bleeding the leaves
3. Extraction of the mucilagenous pulp
4. Liquidization of the mucilagenous pulp
5. Removal of cell wall particles.

1. **Choosing the leaves** — leaves from the locally growing A. barbadensis Miller plant were used. The twelve plants chosen growing in the Tal-Qroqq University grounds were of undetermined age but all at the flowering stage. Location varied and none were under any special form of cultivation. The largest, outer most succulent leaves were chosen because of their high yield of gel.
2. **Cutting and bleeding the leaves.** The leaves can be cut neatly at the base with no difficulty. On cutting, the leaves exude a yellowish thick latex from the junction between the outer green rind and the inner white pulp. This latex on drying forms the dark hard solid which is the aloes of laxative properties. To facilitate the drainage of this latex the leaves were held vertically upright overnight, base down over empty containers. This process is known as bleeding and after this process the cut end of the leaf seals itself.



Bleeding the leaves

When not used immediately the leaves could be stored in plastic bags at room temperature in a dark cupboard for up to 3 weeks with only some loss in weight due to minimal evaporation of water and some pink discolouration at the cut end due to formation of oxidation products. When frozen and then thawed the leaves loose their firm consistency rendering further processing impossible.

3. **Extraction of the mucilageneous pulp or RAVG.** The outside surface of the leaf is thoroughly cleaned with tap water and then dried. Of several methods the most efficient one used involved first cutting off the pointed apex and 1 cm from the base of the leaf. The two spiny edges were removed by cutting them away to a depth which just reaches the mucilageneous layer see diagram (1). The flat upper and convex lower surfaces of the leaf were then furrowed longitudinally to a depth which just reaches the mucilageneous layer using a sharp scalpel blade. By inserting the blunt edge of a knife between the two furrows the rind was lifted and peeled away in several strips from both sides of the leaf diagram (1). The appearance of the whole pulp at this stage is a translucent slippery whole mass still retaining the shape of the original leaf.
4. **Liquidization of the mucilageneous pulp.** After cutting into small cubes the pulp could be

liquidized in an electric blender by means of four rotating metal blades at high speed for ten minutes. Liquidization breaks up the cellular structure of the pulp as seen under the microscope diagram (2).

5. **Removal of cell wall particles.** The foam resulting from the homogenization of the pulp was first allowed to break up to form two indistinct layers after two hours, a lower more fluid layer and an upper less fluid layer containing the cellular debris. Centrifugation though effective was not practical and filtration was chosen as the method of use to separate the two layers. Ordinary gauze supported on a Buchner funnel was found adequate to collect the lower liquid layer which on microscopical examination was nearly devoid of particulate matter diagram (2). Methods similar to the one described above are described by other workers in the States, Don L. Smothers[5] and R.C. Benson.[6]

Yield of liquid mucilage — gross analysis shows that the whole leaf yields about 70% of crude solid mucilage while the filtered mucilage is about 65% of the weight of the whole leaf. Considering that leaves on average weigh about 400g this gives an average figure of 260g of liquid mucilage per leaf.

Physical and other characteristics of the Aloe vera gel

The liquid gel so obtained is a white to slightly green translucent liquid. It is slippery to the feel but when well rubbed into the skin it dries up to form a non sticky invisible pliable film which can be washed off easily with soap and water. Various similar preparations are available commercially on the American market.

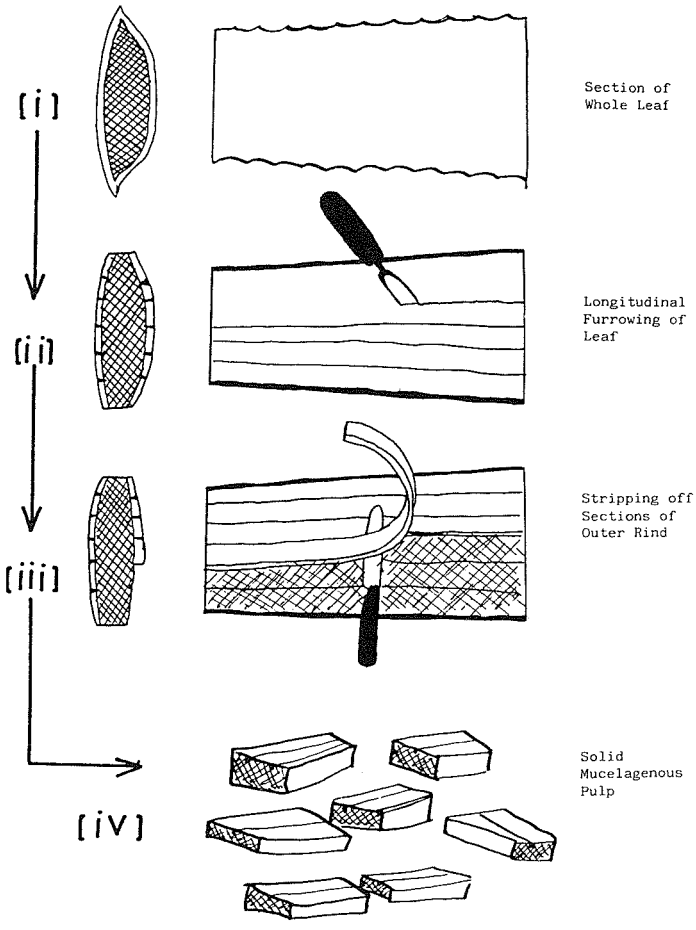


Diagram 1
Extraction of Mucilagenous Pulp from Aloe vera leaves.

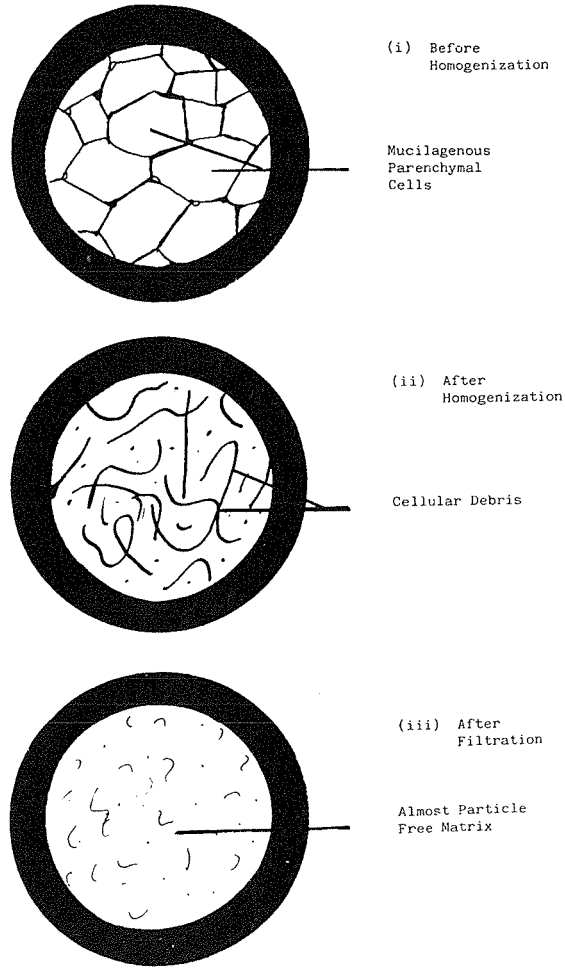


Diagram 2
Microscopical Examination of Aloe vera mucilage.

The physical properties of three commercial preparations is compared below.

a. Aloe vera gel (decolorized). Terry Corporation Florida USA
b. Liquid Aloe vera (single strength filtered) Agrolabs Inc. New York USA
c. Veragel Aloe vera gel (liquid 1:1) Madis Botanical Derivatives New Jersey USA

APPEARANCE — pale to colourless liquid, slightly viscous, clear to slightly hazy a, b, c.
ODOUR — Faint vegetable a, b.
TASTE — Characteristic b.
SPECIFIC GRAVITY — 1.002 — 1.020 a, b, c.
pH — 4.5-6, 3.5-6, 4.5-7.5 a, b, c.
SOLIDS — 0.5-1.2%, 1% max a, b.
SOLUBILITY IN WATER — 100% a, c.
SOLUBILITY IN OTHER SOLVENTS — Soluble in propylene glycol, glycerine (c) Insoluble in alcohol over 20% (higher alcohol content produces white flocculent precipitate) chloroform, acetone, ether and other organic solvents (c).
BOILING POINT — 212°F (a).
TOTAL PLATE COUNT — less than 10 cfu/ml, 50 colonies/g max. less than 500/g a, b, c.
PATHOGENIC BACTERIA — negative a, b, c.
YEAST MOULDS — negative b.
STORAGE — store in a tightly sealed container in a cool place. Refrigeration is recommended once the container has been opened a, b.

In general these properties are similar to each other except for some differences in the pH range which may depend on the type of stabilizers and preservatives added during preparation. The author's preparation when freshly prepared invariably had a pH of 4-4.5 but as was noted no preservatives or stabilizers were ever added.[3]

Other preparations of liquid Aloe vera Gel available commercially are:
a. Aloe vera gel. The Lanaetex Products Inc., New Jersey, USA.
b. Co Vera. Costec Inc., Illinois, USA
c. Aloe vera juice. Chemetics Laboratories Inc., Texas, USA.
d. Aloe vera gel stabilized. Aloe Vera International of Arizona Inc., Arizona, USA.
e. Natural Aloe vera gel. Tri-K Industries Inc., New Jersey, USA
f. Aloe vera (raw). Aloe products Corp., Texas, USA
g. Aloe vera gel. Aloe Laboratories of Texas Inc., Texas, USA.
h. Aloe 11 Aloe vera gel processed. Aloe Vera Scientifics Inc., Arizona, USA.

Stability of Liquid Aloe Vera Gel

This gel unless stored properly or contains preservatives is liable to degradation. The main ways by which degradation of the mucilage can occur are by external microbial contamination (air borne funghi and bacteria) and internal enzymic degradation.[7] The high water content and the protein and calorie content of the fresh mucilae facilitate the growth and multiplication of microorganisms. Degradative enzymes are present within the cellular parenchyma and these are released when the mucilage is produced.

Microbial growth occurs within a week of storing the mucilage in an uncovered container at room temperature. The visible signs of this growth are black patches on the surface with a growth of fine hairs or hyphae extending above the surface. The gel also acquires a characteristical strong smell and very bitter taste. Microbial growth with enzymic effects is also responsible for the depolymerization of the polysaccharide fractions of the gel. This takes place over a longer period. The visible effects are a slow deposition of brown-green particles which settle at the bottom. The consistency of the gel changes from a mucilageneous to a more fluid water solution[3]. This depolymerization of the polysaccharide results in a loss of activity of the mucilage.

Another visible sign of degradation is the change of colour of the gel from colourless (or very light green) to a distinct pink colour. This according to E. Roboz and A.J. Haagen Smit[8] is due to the formation of pink oxidation products which they prevented from being formed by avoiding contact with the air. The rate of formation is increased by heating the mucilage[5].

Microbial contamination and subsequent degradation of the liquid Aloe Vera gel can be reduced or eliminated by freezing the gel as this author did or by the addition of preservatives. Freezing and the addition of stabilizers will minimize the degraditive effects of enzymes on the gel.

EFFECT OF ALOE VERA MUCILAGE ON NORMAL AND BURNT RABBIT SKIN

The object of the series of experiments was to check on a small limited scale whether the mucilage of Aloe vera gel prepared as described above has any harmful or beneficial effects on normal and burnt rabbit skins. The two types of burns used were thermal contact, and U.V. radiation burns.

Animals used. — Ten New Zealand white rabbits were used. They were of undetermined sex, about 3 months old and weighing 2 to 3 kgs. Housing consisted of standard laboratory cages kept in a well ventilated room at room

temperature. Ample food and water were available continuously.

Preparations of rabbits for experiments. — To produce the burns the areas of rabbit skin chosen were the lower back areas for the thermal contact burns and the ears for the UV radiation burns. The areas were first shaved mechanically using scissors and electric hair clippers; the ears completely and about 0.12m² of the whole lower back. Total depilation was achieved using a commercially available depilatory cream. Care was taken to ensure uniformity of treatment of both 4 inch² areas on the back since one ear and one back area was going to serve as a control for the opposite area or ear.

Experimental thermal contact burns. — Of the different methods tried to produce thermal contact burns of deep partial thickness type (see diagram 3) after Whealer[9] which heal spontaneously over a period of about two weeks and hence rate of healing could be observed, the method chosen involved applying as uniform a temperature as possible for a given time. The time-temperature relationship chosen was 58°C for 10 seconds. The setup to produce this temperature is described by diagram 4. A temperature gradient is set up between two ends of a lagged polished brass rod with the temperature of the cold end being monitored by a thermometer inserted inside the brass rod. Once the thermometer end of the rod reached 59°C the burn was produced. With an assistant firmly holding the rabbit the exposed end of the rod was brought into firm contact with a pre-marked area on the rabbit's depilated back for 10 seconds. Immediately after, the brass rod was again applied to the next area nearby. Treatment of one area was started immediately with the other control area receiving no treatment at all. The uniformity of these two burns was confirmed by an approximate same rate of healing when left untreated.

Experimental U.V. radiation burns — For these burns, after both ears of a rabbit had been depilated, the rabbit without any restraint, was irradiated with U.V. light supplied by 2 U.V. lamps placed over the cage. The U.V. lamps emitted light at 254 mm through a 25 cm by 5 cm rectangular opening. Overnight exposure produced moderate sunburn while exposure for a night, a whole day and another night consecutively gave a severe sunburn.

Diagnosis of the degree and depth of burning.

Burns of the skin can be of two types according to the varying depth of the three dimensional thermal injury. Thus, there is

a) a partial thickness burn, and

b) a whole thickness burn Muir[10] 1974

Partial thickness burns may be either superficial (first degree) or deep (second degree). Whole thickness burns may also be referred to as third degree burns, Muir[10] 1974. See diagram (3).

The clinical course of the burn area varies with the type of burn. Whereas partial thickness burns may be expected to heal spontaneously if no complications like infection arise, whole thickness burns require immediate excision and skin grafting for proper treatment Sevitt[11] 1957.

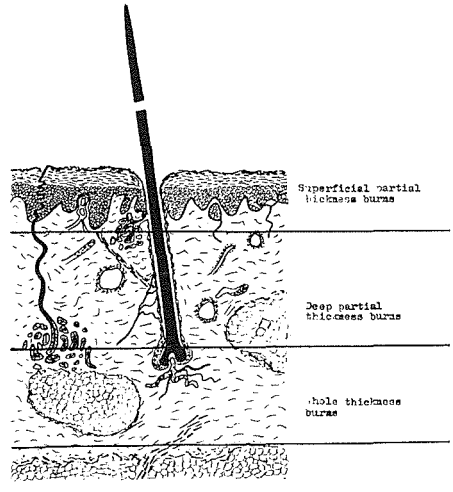


Diagram 3
Depth of burning in relation to structure of the skin. (After Whealer[9])

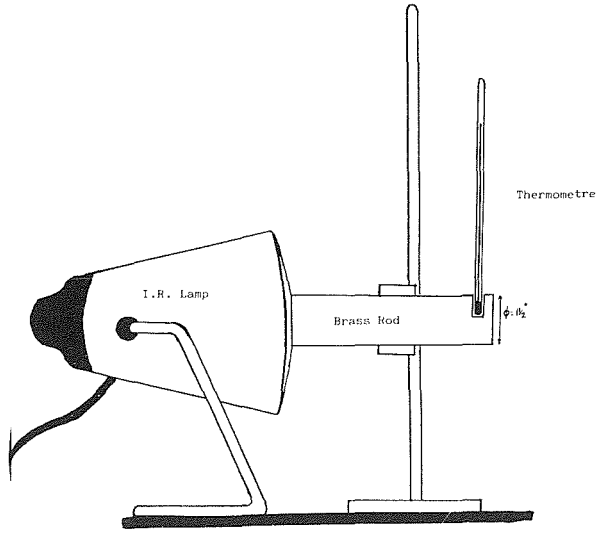


Diagram 4
Apparatus for contact burns

Diagnosis of the depth of burning can be done by testing the sensation in the burned skin (the so called pinprick test) Muir[10] 1974, Jackson[12] 1953 and by examining the surface appearance of the burn Sevitt[11] 1957 and[13]. With these tests it was concluded that none of the contact and radiation burns were of the third degree thickness type. Thermal contact burns had a central area of the second degree type which merged into an outer area of first degree burn. U.V. radiation burns were either mild or severe depending on duration of exposure 16 hours or 40 hours consecutively. None were third degree and distinction between first degree and second degree was less distinct.

Treatment.

The only line of treatment used was the liquid mucilage of Aloe vera prepared as described above. Prior to actual use the mucilage was warmed to room temperature after storage at 4°C or at —12°C. The mucilage was applied by means of dressings held over the burn or else a piece of cotton wool was wetted with the liquid mucilage and then massaged over the burn after which it was allowed to dry to form an invisible pliable film. In between applications the treated area or ear, as well as the untreated back area or ear were not washed or cleaned of any wound debris.

Treatment was applied daily except Saturday and Sunday, for a period up to three weeks but usually only for a few days. Number of applications per day varied from a minimum of three applications with the dressings to a much higher frequency when no dressings were used. Unless a dressing was applied no treatment was applied between 4.30 p.m. and 8.30 a.m.

Observations, records and deductions from course of healing

Observations were made prior to each application. With normal skin, recordings were made on how long it took for normal hair regrowth to take place, with bruised skin how long it took for bruises to dry up and hair regrowth to take place. With second degree burns how long it took to form a thick eschar, for this eschar to separate, the appearance of this granulation tissue, when granulation tissue was no longer visible and how long it took for normal hair regrowth to occur.

With U.V. radiation the degree of redness, the formation, duration and separation of any hard eschars and time taken for subsequent hair regrowth to occur were noted

The final normal hair regrowth was taken as a sure sign that the area had healed completely.

Experiments and results

The effect of liquid Aloe vera gel or mucilage on normal depilated and burnt skin of a small number of rabbits can be summarised as follows:

i. on normal depilated skin — of four areas treated all areas showed an initial more rapid hair regrowth when compared to control areas. After a few days this effect was no longer apparent.

ii. on first degree contact burn — only one area was treated and this showed that when its crust has fallen off, hair growth occurred at an earlier stage when compared to the control area. Within a few days there were no differences between treated and untreated areas.

iii. on second degree contact burns — of four areas treated all showed darker crust formation which was discarded at an earlier stage and hair growth over the treated areas proceeded at a faster rate in the initial stages of regeneration.

iv. on U.V. radiation burns, three areas were treated. The mucilage showed no apparent effect on the latent effects of the radiation but when healing started the mucilage had an effect on crust formation which was thicker and was discarded at an earlier stage in the aloe treated area. Hair growth also occurred at an earlier stage.

In all cases treated there were no cases of irritation and none of the areas treated with aloe mucilage showed any worsening of the conditions.

Conclusion

These results show that the mucilage of Aloe vera does have a beneficial effect on the initial regenerative stages of normal depilated, burnt and bruised rabbit skin.

Hair growth occurs at an earlier stage in these areas. If hair growth is assumed to be a clear indication that healing is proceeding than the mucilage of Aloe vera has a healing action on bruised and burnt skin.

The results confirm the beneficial effects of Aloe vera mucilage as described by other workers such as Rowe T.D.[14] 1940, Rowe T.D. et al[15] 1941 who experimented with the use of the fresh pulp of the leaf in the treatment of experimentally produced third degree X-ray reactions on the skin of white rats, C.C. Lush-

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macist, thanks to his/her direct personal relationship with the patient or relatives is in an ideal position to bring the above risks to the knowledge of the client and to tender the necessary cautions and advice.

In this context I would suggest that with the traditional mortar and pestle, as the emblems of the art and science of pharmacy, be incorporated the word VIGILO as the motto of the modern pharmacist.

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baugh and B.B. Hale[16] 1953 who worked with rabbits which were subjected to experimentally induced acute radiodermatitis by radiating locally the shaved backs with 11,000 and 28,000 rep of beta radiation from Sr^{90}, Rovatti and Brennan[17] 1959 who used rabbits subjected to thermal contact burns with a hot steel plate and Goff and Levenstein[18] 1964 who carried out carefully controlled experiments where they measured the effects of topical preparations including Aloe vera extract upon the healing of skin incision wounds using measurements of the tensile strength of the healing wound as indication of rate of healing. In all these cases results showed that aloe vera pulp, mucilage on preparations derived from it have a beneficial effect on the healing of these different types of skin wounds.

Though the author's results confirm the beneficial healing effect of Aloe vera mucilage they are far from being statistically significant on their own. The number of areas treated was too few and only description rather than photographic evidence is presented. Whenever possible any difference between treated and untreated area were confirmed by colleagues.

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