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Remarks Aloe
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Aloe through the Ages

The Efficacy of the Aloe Plants Chemical Constituents and Biological Activities

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The plants of aloe species have been widely used for folk remedies in many countries and considered useful for a variety of sicknesses for several thousand years. The plants are native to the Mediterranean region, but now grown all over the world. In Japan, *Aloe arborescens* Mill. var. *natalensis* Berger has been traditionally used as folk remedies for gastrointestinal disturbances, burns, insect bites, and athlete's foot. Currently, some cosmetics and ointments prepared from the juice of the plants are on market.

The purpose of this paper is to review the usefulness of the aloe plants for use in dermatological preparations or for treatment of internal disorders.

Biological Activities of the Aloe Plants

Aloes have been described as a purgative drug in pharmacopoeias over the world. The other effects of the aloe juice on skin lesions, such as burns, frostbites, athlete's foot and insect bites, have also been recognized by many people for several hundred years. Soeda et al. tested the therapeutic effect on trichophytiasis in twelve human cases and the effect of the juice of Cape aloes on burns produced on the back skin of guinea pigs.[1] These experiments showed the useful effect of the aloe juice on treatment of trichophytiasis and burns. There are other papers reporting the ability of the aloe plants to promote the healing of burns and other cutaneous injuries.[2,3] Several workers report that the effective components for wound healing may be traumatic acid[4] and a kind of polysaccharide.[5]

Soeda and Stepanova report the prophylactic and therapeutic effects of aloe extracts on leukopenia caused by exposure of Cobalt-60 or X-ray radiation.[6,7] The extracts of the Cape aloes are also reported to show inhibitory activity against Sarcoma-180 and Ehrlich ascites cancer in mice.[8] Suzuki reports that a substance AS-40, which was obtained by salting the juice of *A. arborescens*, shows hemagglutinating and lymph-juvenating activities.[9] And, a fraction following the AS-40 in the separation by a Dextran gel-Sephadex column gives a substance P-2 showing the inhibitory activity against the Sarcoma-180 tumor cells in mice.

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Stepanova et al. describe that the content of mineral components varies greatly, depending on the place where the plants are grown and the time when it is picked.[46] Recently, Suzuki isolated glucoproteins named alexin A and alexin B from *A. arborescens*, and suggests the probability of usefulness of these substances for cancer, inflammation, burns, and skin diseases because of their hemagglutinating and cytoagglutinating activity for lymphocytes and transformed cells and its binding reactivity with some serum proteins.[47-49]

The biosynthetic studies on the components of the aloe plants are carried out with aloenin (1)[50] and the anthraquinones (8 and 16).[51] These compounds are clarified to be biosynthesized from acetate and malonate via a polyketide by the acetate-malonate pathway. Constantinescu et al. report that the anthraquinones are biosynthesized in the malpighian tissue of the plants.[17]

Conclusions

From the examples given above, it can be seen that the aloe plants have a great potential to cure some sicknesses and to protect the skin from some diseases. However, the relationship between the efficacy and the physiologically active constituents of the aloe plants is not completely ressolved. Nevertheless, the results obtained up to now by the studies on the biological activities and the chemical constituents encourage us to be convinced that aloe plants are very useful for the treatment of various diseases.

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Table I. Phenolic constituents of the Aloe Plants

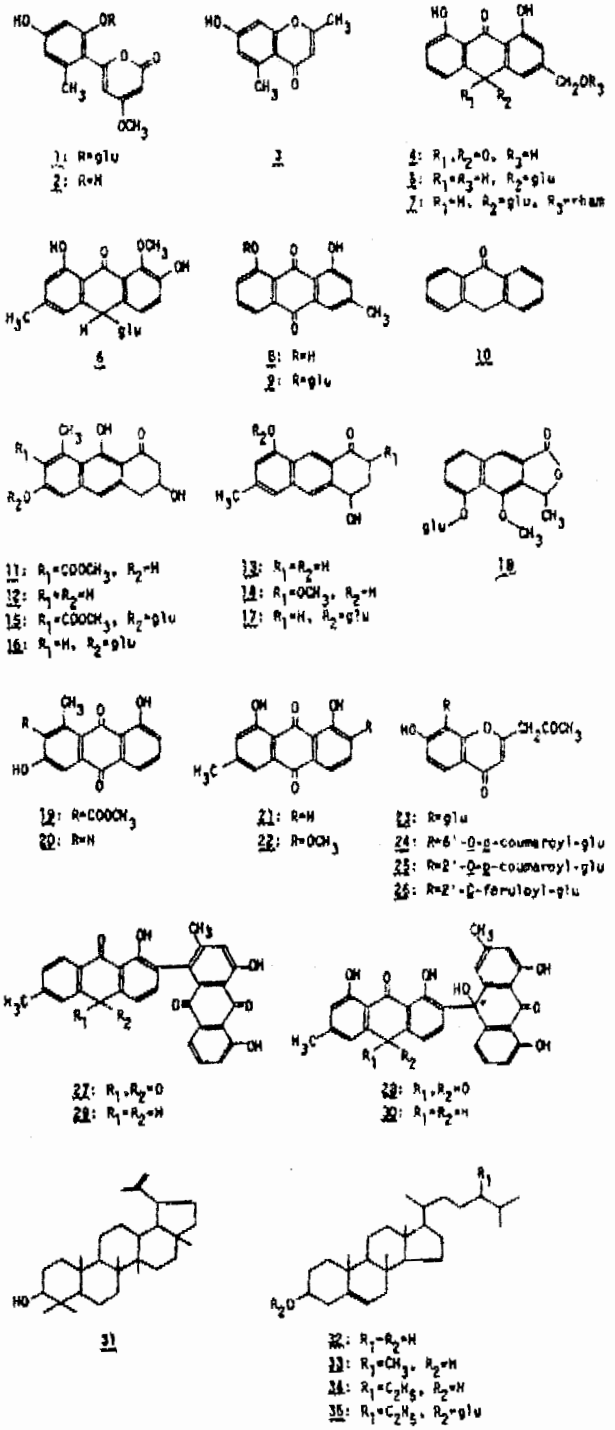
Compounds	Species	References
Aloe-emodin (4)	*A. arborescens; A. ferox; A. perryi; A. vera*	15—17
Barbaroin (5)	*A. arborescens; A. ferox; A. marlothii; A. perryi; A. vera*	15, 18—20
Homonataloin (6)	*A. arenicola; A. comosa; A. gariepiensi; A. krapohliana; A. nyeriensis; A. spinosa A. spectabilis; A. volkensii*	16, 20, 21
Aloenoside (7)	*A. africana; A. ferox*	16, 20, 22
Chrysophanol (8)	*A. vera*	23
Chrysophanol glucoside (9)	*A. ammophila; A. davyana; A. ecklonis A. saponaria; A. transvaalensis*	16
Anthranol (10)	*A. vera*	23
Aloesaponol I (11)	*A. saponaria*	24
Aloesaponol II (12)	*A. saponaria*	24
Aloesaponol III (13)	*A. saponaria*	25
Aloesaponol IV (14)	*A. saponaria*	25
Aloesaponol I glucoside (15)	*A. saponaria*	26
Aloesaponol II glucoside (16)	*A. saponaria*	26
Aloesaponol III glucoside (17)	*A. saponaria*	26
Isoeleutherol glucoside (18)	*A. saponaria*	26
Aloesaponarin I (19)	*A. saponaria*	24
Aloesaponarin II (20)	*A. saponaria*	24
Helminthosporin (21)	*A. saponaria*	25
Isoxanthorin (22)	*A. saponaria*	25
Aloesin (23)	*A. aculeata; A. arborescens; A. candelabrium A. castanea; A. globuligemina; A. lettyae; A. marlothii; A. perryi; A. vanbalenii; A. vera; A. wickensii*	27—30
6"-O-p-Coumaroyl-aloesin (24)	*A. arborescens*	29, 31
2"-O-p-Coumaroyl-aloesin (25)	*A. arborescens*	31
2"-O-Feruloyl-aloesin (26)	*A. arborescens*	31
Aloenin (1)	*A. arborescens; A. saponaria*	11, 24
Asphodelin (27)	*A. saponaria*	32
Bianthraquinoid pigment B (28)	*A. saponaria*	32
Bianthraquinoid pigment C (29)	*A. saponaria*	32
Bianthraquinoid pigment D (30)	*A. saponaria*	32

Soeda et al. tested the anti-bacterial and anti-fungal activities against sixteen strains, and found antimicrobial activity of the aloe juice against *Pseudomonas aeruginosa* and *Proteus vulgaris*.[1] Fujita et al reported that the lyophilized powder of the leaf extracts of *A. arborescens* shows antifungal activity against *Trichophyton mentagrophytes*; the powder exerts its main effect on colony growth by prolongation of the lag phase and inhibition of growth rate.[10]

Since the leaf materials of the aloe plants are frequently used as folk remedies for gastrointestinal disturbances, the effect on gastric juice secretion was tested using aloenin (1) and aloe-ulcin, which had been isolated from the leaves of *A. arborescens* and the Cape aloes, respectively.[11,12] These constituents exhibited inhibit-

Table II. Triterpenoid and steroids in the Aloe plants

Compounds	Species	References
Lupeol (31)	A. vera	33
Cholesterol (32)	A. vera	33
Campesterol (33)	A. vera	33
Sitosterol (34)	A. arborescens; A. vera	13,33
Sitosterol 3-O-glucoside (35)	A. arboreacens	13



ory activity on gastric juice secretion.[13] However, it is pointed out that aloe-ulcin is magnesium lactate because of complete coincidence of its spectroscopic evidence.[18] The metabolism of aloenin (1) by rats was investigated[14]; it was found that the rats metabolize aloenin (1) to 4-methoxy-6-(2,4-dihydroxy-6-methylphenyl)-2-pyrone (2), 2,5-dimethyl-7-hydroxychromone (3), and glucose; then these are excreted in the feces and the urine. Also, the distribution of the radioactivity originating from ^{14}C-labeled aloenin was investigated, and it is clarified that the tracer found in the kidney and the liver accounts for 60% of the amount administered in 24 hours after feeding and then decreases rapidly in the next 24 hours.

Chemical Constituents of the Aloe Plants

Phenolic constituents of the aloe plants have been well investigated, and many phenolic compounds are found in aloe species, as shown in Table I.[11,13,15-23] On the other hand, the presence of glucose and mannose has been reported as major components in the sugar fraction of *aloe* plants.[13,33,34] It is found that polysaccharides composed of glucose and mannose are present in the plants, and 10^4-10^6 is the order of their molecular weight.[35-41]

Furthermore, amino acids in the plants are reported by many workers.[33,34,42-44] Arginine, asparagine, and glutamic acid are relatively abundant, but no unusual amino acid is found in the amino acid fraction. The presence of lipid constituents, such as isoprenoids,[13,33] alkanes,[13] *n*-alkyl alcohols, and fatty acids and their esters,[13,34] is described in Table II. Organic acids, such as succinic, malic, lactic, and *p*-coumaric acids, are found in the leaves.[13,27,45] McCarthy investigated the seasonal variation of the total organic acids by measuring the total acidity of the aloe leaves, and he shows a definite seasonal variation with the maximum production in the summer months.[20] The mineral constituents in the aloe leaves have been examined;[13,46] potassium, sodium, and manganese ions are found as the major components in the