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Dr. M. Zahid Rizvi

REVIEW ARTICLE

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The Phytochemical Architecture of *Aloe vera* : A Biochemical Review

Mohd. Zahid Rizvi and Arshad H. Rizvi
Department of Botany, Shia P.G. College, Lucknow, U.P., India

ABSTRACT

***Aloe vera* is a medicinal plant. It has been used for many years due to its therapeutic properties. This review is about the biochemistry of *Aloe vera*. It contains numerous vitamins, minerals, amino acids, carbohydrates, enzymes, anthraquinone, and many other compounds. The biological activities regarding each component of *A. vera* are revealed in this paper. The biological activities include antibacterial, antiviral, and anti-inflammatory properties. Some ingredients of *A. vera* account for antidiabetic, antiseptic, anticancer, antioxidant, and wound healing properties of *A. vera*.**

Keywords: Carbohydrates, anthraquinones, antibacterial, antiviral, anti-inflammatory, antidiabetic, anticancer, and antioxidant.

INTRODUCTION

Aloe vera is a succulent plant species of the genus *Aloe* having medicinal properties. It is a stemless or very short-stemmed plant growing to 60-100 cm (24-39 in) tall, spreading by offsets. The leaves are thick and fleshy, green to grey-green. The leaf margin is serrated having small white teeth. The flowers are produced in summer, 90 cm tall, each flower being pendulous, yellow tubular, and corolla 2-3 cm (0.8-1.2 cm) long. There are approximately 500 species of genus *Aloe* (Yates A. 2002). Aloe belongs to the Liliaceae family. In the food industry, *A. vera* is used in the production of health drinks and beverages, functional food products and other food products. In pharmaceutical industry, it is used in the manufacture of topical products such as ointments and gel. It has used in the production of tablets and capsules. It is used in the soap, facial cream, lotions, shampoo (Hamman. 2008).

Biochemical components and their biological activities

It has been reported that a range of compounds like water-soluble and fat-soluble vitamins, minerals, enzymes, polysaccharides, phenolic compounds and organic acids are present in the pulp of *Aloe vera* (Jani et al, 2007). Compounds present in *Aloe vera* are summarized in the Table 1.

Table 1. Biochemical constituents of *Aloe vera.*

Carbohydrates	Mannan, Acetylated (Acemannan), Glucomannan, Acetylated glucomannan, glucogalactomannan, galactan, arabinogalactan, galactoglucoarabinomannan, pectic substance, xylan, cellulose, saccharides include mannose, glucose, L-rhamnose, aldopentose
Enzymes	Alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cyclooxidase, cyclooxygenase, lipase, oxidase, carboxylase, superoxide dismutase
Amino acid	Lysine, Methionine, Leucine, Threonine, Isoleucine, Valine, Phenylalanine
Proteins	Lectins, lectin-like substance
Vitamins	Vitamin A, B12, C, E, choline, folic acid and α-tocopherol
Anthraquinones/ Glycosides	Aloe-emodin, Barbaloin, Isobarbaloin, Anthranol, Ester of cinnamic acid
Hormones	Auxins and gibberellins
Chromones	8-C-glucosyl-(2′-O-cinnamoyl)-7-O-methylaloediol A, 8-C-glucosyl-(s)-aloesol, 8-C-glucosyl-7-O-methylaloediol, 8-C-glucosyl-noreugenin, isoaloeresin D, isorabaichromone, neoalosin A
Minerals	Calcium, Chlorine, chromium, copper, iron, magnesium, manganese, potassium, phosphorous, sodium, zinc
Sterols	Cholesterol, campesterol, lupeol, β-sitosterol
Phenolic compounds	Sinapic acid, Quercitrin, Kaempferol, Apigenin, Gallic acid, Protocatechuic acid, catechin, ferulic acid, caffeic acid, coumaric acid, chlorogenic acid
Organic acids and other compounds	Salicylic acid, Arachidonic acid, uric acid, Lignins

Carbohydrates

Presence of mannan, acemannan, acetylated glucomannan was reported by Feminia et al (1999) and the anti-tumor activity of these polysaccharides on *in vitro* models and different animal species was reported by Steenkamp *et al* (2007). It has been found that acemannan have wound healing property and also have immunomodulatory activity (macrophage activation and cytokines production). Azghani *et al* (1995) was found that acemannan prevented the adherence of *Pseudomonas aeruginosa* to the human lung epithelial cells in a monolayer culture. Antineoplastic and antiviral activities of acemannan was also reported by Kahlon *et al* (1991). Esua *et al* (2006) have isolated three mallic acid acetylated carbohydrates or maloyl glucans namely 6-O-(1-L-maloyl)-α,β-D-Glcp (termed as Veracylglucan A), α-D-Glcp-(1→4)-6-O-(1-L-maloyl)-)-α,β-D-Glcp (termed Veracylglucan B) and α-D-Glcp-(1→4)-tetra-[6-O-(1-L-maloyl)- α-D-Glcp-(1→4)]-6-O-(1-L-maloyl)- α,β-D-Glcp (termed Veracylglucan C) and it was reported that two of them namely vercylglucan B and veracylglucan C exhibited high anti-inflammatory (Esua *et al*. 2006). The presence of arabinogalactan in low concentration in aloe gel was observed (Ni *et al*. 2004).

Enzymes

Superoxide dismutase, catalase, peroxidase, amylase activities of the leaf extract of *Aloe vera* was evaluated (Ahmed *et al*. 2013). Presence of bradykinase (an anti-inflammatory enzyme which reduce inflammation of the skin) in Aloe gel was reported (Yagi *et al*.1982).

Proteins

It was reported that lectins (glycoproteins) from *A. vera* have anti-cancer activities (Reynolds *et al*. 1999). Lectins of *A. vera* were found to inhibit the proliferation of cytomegalovirus in cell culture (Saoo *et al*. 1990).

Vitamins

Presence of vitamin B1, B2, B6, Choline, Folic acid, C, α-tocopherol, β-carotene was observed by Coats and Ahola (Coats & Ahola. 1979).

Anthraquinones/ Glycosides

Aloe emodin (anthraquinone) of *A. vera* has antimicrobial activity (Wu *et al*. 2006). Antiviral activity of purified aloe-emodin was reported against Herpes simplex virus Type l and TypeII. It was also mentioned that Aloe-emodin showed antiviral activity against varicella-zoster virus, influenza virus and peudorabies virus (Sydiskis *et al*.1991). The yellow exudates contains 1,8- dihydroxyxanthraquinone derivatives and their glycosides having cathartic effects are present in the yellow exudates of *A. vera* (Vazquez *et al.* 1996).

Hormones

Sahu *et al* (2013) reported that the auxins and gibberellins showed anti-inflammatory and wound healing activities. It was found that gibberellins, a growth hormone interacts with growth factor receptors of fibroblast and stimulate its proliferation for collagen synthesis (Sahu *et al.* 2013).

Sterols

Four main plant steroids found in *A. vera* are cholesterol, campesterol, lupeol, sitosterol. Antiseptic activity of lupeol was mentioned (Sahu *et al*. 2013). Tanaka *et al*(2006) reported about the antidiabetic effect of the five phytosterols such as lophenol, 24- methyl-lophenol, 24- ethyl-lophenol, cycloartanol, and 24-methylenecycloartanol derived from *A. vera* in type-2 diabetic mice.

Phenolic compounds

Eighteen phenolic compounds like sinapic acid, quercitrin, kaempferol, apigenin, gallic acid, protocatechuic acid, catechin, vanillic acid, epicatechin, syringic acid, chlorogenic acid, gentiric acid, caffeic acid, coumaric acid, ferulic acid, rutin, miricetin in the leaf, skin and flower of *A. vera* were identified by Lopez *et al* (2013) and these compounds exhibited antioxidant activity (Lopez *et al*. 2013). Miller et al showed anticancer and antioxidant activity of due to the presence of limonene (a class of monoterpenoids as a group of compounds) i.e. present in the *A. vera*.

Organic acids and other compounds

Some compounds like 1-heptanol-2-propyl, diazene, tetradecanoic acid methyl ester, hexadecanoic, benzenedycarbocyclix acid, eicosyne, oleic acid and squalene derived from*A. vera* act as antimicrobial and antioxidant agents (Lakshami and Rajalakshami. 2011). Antiseptic agents namely lupeol, salicylic acid, urea, nitrogen, cinnamonic acid, phenols and sulphur were found to contain in *A. vera* (Zawahery *et al*. 1973). Saponins (soapy substance) from the aloe gel showed antiseptic activity (Hirat *et al*. 1983).

CONCLUSION

As the *A. vera* plant is the rich source of these biochemical components like anthraquinone (aloe-emodin), organicacids, phenolic compounds, bradykinase enzyme, proteins. Aloe emodin has antimicrobial activity and antiviral activity against diseases like AIDS, Herpes Simplex virus disease. Besides these, Lectins (glycoprotein)and phytosterols of *A. vera* shows anticancer and antidiabetic activity. Anti-inflammatory agents of *A. vera* are polysaccharides like maloyl glucans, acemannan. Antioxidant agents like some organic acids and phenolic compounds are found to be contained in the *A. vera*. Due to the versatility in biochemistry regarding the biological activities, this plant can be considered as a alternative medicine. Although, it has been used in cosmetic, food and pharmaceutical industries worldwide, but it is expected that future research on this versatile plant and its bioactive compounds will be made it more beneficial to human beings.

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Corresponding author: Dr. Mohd. Zahid Rizvi, Associate Professor of Botany, Department of Botany, Shia P.G. College, Lucknow, U.P., India
Email: zahid682001@gmail.com