ALOE BARBADENSIS MILLER: A COMPREHENSIVE REVIEW

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ABSTRACT: At present food, nutraceuticals, and pharmaceutical industries desperately searching for new natural compounds with interesting therapeutic potentials from numerous sources. However, there are lots of plants having pharmaceutical benefits but Aloe vera is probably the most applied medicinal plant worldwide since biblical times. Aloe vera is a perennial succulent plant known as the "miracle plant" belonging to the family Liliaceae, commonly known as ghee kwar. It is the most extensively used variety in commercial products because of its therapeutic properties. Aloe vera informed to be contained as much as 75 nutrients, with 200 active components including lignin, anthraquinones, sugar, minerals, saponins, enzymes, vitamins, amino acids, and salicylic acid. Biologically active compounds extracted from aloe vera had been reported to possess several pharmacologic characteristics, specifically to promote healing of the wound, burn, and frostbite, along with antioxidant, laxative, anti-inflammatory, antifungal, antiviral, antibacterial, antitumor, hypoglycemic, gastroprotective antitumor properties. However, on the other side isolated bioactive components such as anthraquinones, phytosterols and saponins are extensively using in nutraceuticals and pharmaceutical products to cure many health ailments. Antioxidant activity is possessed by anthraquinones that are involved in free radical scavenging activity during the inflammatory response and prevent cell necrosis.

Keywords: Aloe vera, *Aloe barbadensis,* Composition, Gel, Leaf, Skin.

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ALOE VERA

Taxonomy and Origin

Genus aloe vera is a perennial succulent herb, having nearly 420 species, which are classified in Aloaceae, Asphodelaceae, or Liliaceae families. Aloe vera is part of the Liliaceae family (Dagne *et al*., 2000) but some nominated the aloe separate family, named "Aloaceae". It is usually known as *Aloe barbadensis* Miller, *Aloe, Aloe vera, desert lily, elephant's gall,* or *burn plant.* According to the international botanical nomenclature rules, its legitimate name is *A. vera (L.) Burm. f.* The word, Aloe, originated from the Hebrew word "halal" or Arabic word "alloeh" which means a substance that is bitter and shiny (Ramesh *et al*., 2012) while "vera" is a Latin word that means "true" (Liu *et al*., 2013). It is supposed that the geographical origin of aloe vera is in Sudan and afterward introduced in the Mediterranean region (Foster *et al*., 2010).

Table 1: Taxonomy of *Aloe vera* (L.).

Kingdom	Plantae
Order	Asparagales
Family	Aloaceae
Genus	*Aloe*
Species	*Aloe vera* (L.) *Burm. F.*

Botany of Aloe Vera

Aloe vera skin is viewed as the bunch forming perennial plants and resembles a cactus plant. It has a fibrous thick root with large basal leaves that are green in color, dagger-shaped, soft, tapering along with spiny margins, and packed with viscous gel. Typically, they have 12–16 leaves per plant, having weight up to 1.5 kg, length up to 65-95 cm, and 7-10 cm at the base, when mature (Ramesh *et al*., 2012). The transverse cut of the leaf exposes that the upper side is concaved and the lower side is slightly convex in shape. The aloe vera plants mature at about 4 years of age and have a life duration of nearly 12 years. The thick cuticle layer shielded the surface of the leaves' epidermis, beneath which mesophyll are packed closely. The mesophyll is discriminated in upper thick celled chlorenchyma and lower thinner-walled cells called parenchyma. Young plant's leaves have some whitish spots that disappear and became spotless and greyish green in color leaves as fully matured. The parenchyma cells are packed with a clear jelly-like material. However, vascular tissues are packed with yellow sap, which is famous for the laxative effect (Eshun and He, 2004). Mostly yellow, red, pale purple flowers are stripped that grow in the center of the leaves. The aloe vera's flower stalk had a length of up to almost 1.5 m in length. Triangular capsuled-shaped fruit filled with numerous seeds (Joseph and Raj, 2010).

Aloe vera leaves produce two different exudates. Out of which, one is bitter in taste and yellow in color other one is called latex and present in the cells of cutinized epidermal pericyclic of the leaves. It is believed that bitterness is because of the occurrence of chemical compounds like aloe-emodin, aloin, and other associated components with a laxative effect. The latex is a clear, slippery mucilage type produced by the parenchymal tubular cells and collectively referred to as the gel (Surjushe *et al*., 2008). Thus, a leaf can broadly be divided into three distinct portions as followed: 1. Yellow sap primarily contains most of the anthraquinones, 2. Colorless gel, 99% water sugars, amino acids, sterols, lipids, minerals, and vitamins, 3. Rind, includes tips, bases, outer rinds, and thorns designed for protective function and made up of carbohydrates and proteins. Aloe vera is virtually free of disease, occasionally because of fungal infection, black spots may appear on the upper side. Most of aloe vera's species are non-toxic but some are tremendously toxic as contains hemlock-like substance.

Biochemistry and Structural Composition

Aloe vera is an exceptional vegetal having many chemical compounds responsible for many therapeutic effects. In 1941, Prof. Tom D. Rowe was the 1st scientist for revenue vibrant steps to analyze the aloe vera's plant chemically thoroughly. Detailed analysis of the aloe vera plant revealed the occurrence of 75 nutrients and nearly 200 different biologically active components including amino acids (17), anthraquinones (of many structural types), enzymes, lignin, minerals (Fe, Cu), vitamins (A, B, C), phenolic compounds, salicylic acid, saponins, sterols and sugars (Vogler and Ernst 1999).

Aloe Vera Leaf Composition

The leaf has been divided into 2 parts; one is the outer rind green in color, together with the layer of vascular tissues and the second is the inner layer of cells of the parenchyma having colorless gel and a yellow color sap. Depiction of inner parts of aloe vera's leaf is unclear, because of various terms used alternatively such as gel, pulp, leaf parenchyma, mucilage tissue, or jelly. In principle, the term "pulp" and "parenchyma tissue" indicates the whole soft fleshy portion of the leaf including organelles and cell walls together, however, "gel" or "mucilage" indicates the thick transparent liquid present in parenchyma cells. Aloe vera pulp has 3 structural divisions such as sticky liquid, deteriorated organelles, and cell walls (Steenkamp and Stewart, 2007). The fresh aloe vera pulp constitutes about 98% water, whereas gel contains nearly 99.5% water having a pH of 4.5. The remaining 0.5 to 1% solid material consists of nearly 200 chemical substances. On a dry matter basis, with a few seasonal fluctuations, the largest component in aloe vera gel is polysaccharides (55%) then followed by sugars that are about 17%. Other minority components like minerals are 16%, proteins account for 7%, lipids about 4%, and phenolic compounds are less than 1% (Luta and McAnalley, 2005). The gel encompasses several vitamins such as vitamins A, B complex, C, and E. Some authors proposed the occurrence of cyanocobalamin in a very low quantity that normally occurs in animal-sourced food like meat, milk, and egg (Ahlawat and Khatkar, 2011). This heterogeneous composition of pulp hypothesized that it might contribute to various pharmacological functions and therapeutic actions that had been observed for various products of aloe vera gel (Raksha *et al*., 2014; Hamman, 2008).

Skin

The skin of aloe vera is viewed as the chief by-product of its processing and it is discarded as a use waste material. Very few bioactive substances are known for their potential use in the context of nutritional benefits and industrial use that are present in aloe vera skin. Anthraquinones are concentrated in aloe vera's skin. Aloin level is significantly higher in the leaf's epidermis than gel. Additionally, aloe vera's skin has a great number of different types of polysaccharides that are packed in the palisade cells of the epidermis along with chlorophyll which had good heat tolerance and stability. Chlorophyll is comparatively more stable in alkaline media. Therefore, aloe vera's skin waste is turning into treasure as a raw material of chlorophyll, which provided a new path to the utilization of this waste into value-added products that will also be very economical. It has a variety of minerals also such as Ca+, Fe+, Mg+, and Zn+ higher in content compared to the gel. (Park and Lee, 2006).

Exudate and Gel

The exudates and the gel are two distinguished parts of a leaf. The distinction between them a little bit difficult because during separation some chemical compounds from the exudate may be introduced into the gel. This mixing could create misunderstandings about the chemical and medical characteristics of specific fractions. For convince, the chemical compounds in the leaf are divided into two parts: one is compounds of exudate and the other is gel's compounds (Ni *et al*., 2004).

Composition of Exudate

The exudate has plentiful anthraquinones that are mainly phenolic. For many years' exudate compounds had been used for their cleansing properties and in alcoholic drinks for their bitterness (Saccu *et al*., 2001). Exudates of approximately 300 species had been studied and nearly 80 chemical complexes had been identified through high-performance techniques such as liquid chromatography (Park and Lee, 2005). High-performance liquid chromatography (HPLC) with UV detector had been used for identification and quantification of 13 phenolic compounds from *Aloe barbadensis* that are named as 10-hydroxyaloin A, 8-C-glucosyl-7-O-methyl(S)-aloesol, 8-O-methyl-7-hydroxyaloin A and B, aloe-emodin, aloeresin E, aloesin, aloin A and B, neoaloesin A and isoaloeresin D and from *Aloe arborescens* that are named as 10-hydroxyaloin A, aloe-emodin, aloenin B, aloenin, aloin A and B and (Park *et al*., 1998). Species called *Aloe ferox to* make a larger amount of bitter sap along with other beneficial compounds when compared to *Aloe barbadensis*. The photochemical profiling of *Aloe secundiflora* had been studied by using HPLC-MS and that Anthrone (aloenin and aloin derivates) contents were highest along with phenyl-pyrones and chromones (Rebecca *et al*., 2003).

Six different species of aloe were examined for aloin contents by HPLC. The highest amount of aloin was observed in *A. arborescens*, lower in *Aloe vera*, and lowest in *Aloe saponaria*. Fluorescence microscopy revealed that aloin was concentrated in the parenchyma and vascular tissues (Liu *et al*., 2013). Aloin naturally occurs as a blend of two diastereoisomers namely aloin A and B (Cao *et al*., 2007). They are phenolic and are very unstable in an aqueous alkaline solution. That's why aloe-prepared drinks don't have it. Moreover, the phenolic components, leaf's exudate comprised of a small number of free sugars, polysaccharides along with aliphatic and volatile compounds. Glyoxalases I and II had been extracted from the leaf's rind that was further compared to other plant and animal-originated glyoxalases (Zonta *et al*., 2013).

Gel Compounds

Several scientists point out the potential health benefits of aloe vera gel. However, researches justifying the efficiency of gel. On the other hand, therapeutic characteristics credited to the specific contents of gel are disproportionate because of the "cocktail" of the chemical constituent along with their synergic action in the treatment and prevention of various disorders (Capasso *et al*., 1998; Capasso *et al*., 2000). The number of species of aloe vera had been inspected to confirm the chemical features of the gel. Aloe vera's gel comprises nearly 98% to 99% water with acidic pH (4–5). Because of a higher content of water, the caloric value is very little; therefore, the ingestion of one serving (200 ml) of gel is provided with <5.0 kcal (Eshun and He, 2004). Around 80% of the solids of gel are water-soluble.

Table: 2 Chemical composition of aloe vera gel.

Water/moisture: 98.5–99.5%, pH 4–5
Carbohydrates: 0.25% (25–50% of dry matter), Acetylated glucomannan, acetylated mannan, arabinogalactan, pectic, galactogalacturan, glucogalactomannan, mannan, galactan, galactoglucoarabinomannan,
Soluble polysaccharides: Acemannan, glucomannans (acetylated partially)
Free monosaccharides: 93% mannose, 3% glucose, 3% galactose
Nitrogen fraction: N2 protein (0.013%)
Amino acids: 18 (7 essential, 20% arginine)
Glycoproteins: Lectins
Enzymes: 13 enzymes, aliiase, alkaline phosphatase, Aloctin A (12% carbohydrates), aloctin B (50% carbohydrates), amylase, bradykinase, bradykinase, carboxypeptidase, carboxypeptidase, catalase, catalase, cellulase, cyclooxidase, cyclooxygenase, GSH-Px, lipase, peroxidase, peroxidase, phosphor enol pyruvate carboxylase, SOD, superoxide dismutase
Vitamins: Ascorbic acid, carotenoids, Vitamin complex B, tocopherols
Minerals and trace elements: 25% of dry matter
Minerals and electrolytes: Ca, Cl, K, Mg, Na, P
Trace elements: Al, Cr, Cu, Fe, Mn, Se, Zn
Organic acids: 9,12-octadecadienoic acid, acetic, arachidonic acid, gibberellin, lactic, malic acid, *n*-Hexadecanoic acid, oxalic acid, Salicylic acid, sorbate, succinic acids, sulfurous acid, triglycerides, uric acid, γ-linolenic acid
Phenolic compounds: Aloe-emodin, aloenin, aloeresin, aloesin, aloin A and B (together known as barbaloin)
Phytosterols: *β*-sitosterol, campesterol
Other compounds: Alyphatics hydrocarbons/esters long chain; volatile compounds (acid, aldehydes, ketones)
Anthraquinones/ anthrones: 12 anthraquinones (phenolic known as laxatives), aloe-emodin, aloetic acid, anthracene, anthranol, chrysophanic acid, emodin, ester of cinnamic acid, ethereal oil, isobarbaloin, resistannol
Essential oil: 1-octadecyne, 1-octanol, 1-Tetradecyne, 9,12,15-octadecatrienoic acid methyl ester, 9-ocatadecenal, allyl pentadecyl ester, butyl heptadecyl ester, didodecyl phgthalate, eicoane, hexyl pentadecyl ester, oleic acid, phytol, squalene, tetracontane 1-lodo-2-methylundecane, tridecanoic acid, α-tocopherol
Saponins: Glycosides
Steroids: Campesterol, cholesterol, lupeol, sistosterol
Hormones: Auxins, gibberellins
Miscellaneous: Chromones and lignins, 8-C-glucosyl-(2-O-cinnamoyl)-7-Omethylaloediol A, 8-C-glucosyl-(S)-aloesol, 8-C-glucosyl-7-O-methyl-(S)-aloesol, 8-C-glucosyl-7-Omethylaloediol, 8-C-glucosyl-noreugenin, isoaloeresin D; isorabaichromone, neoaloesin A; lignins
Lipids: Arachidonic acid, cholesterol potassium sorbate, steroids, triglycerides, β-sitosterol, γ-linolenic acid

Carbohydrates

The isolated fraction of aloe vera gel chiefly contains free sugars, fibers, and soluble saccharides. They are isolated from the mucilage layer that surrounded the parenchyma. They are composed of both monosaccharides and polysaccharides (Yaron, 1991). It contained polymers of glucose and mannose that have a higher molecular weight (up to 275 KDa). Long-chain polysaccharides are more important, made up of monosaccharides like glucose and mannose, called the glucomannans or acetylated mannan having β (1, 4) linkage. Monosaccharides like D-mannose and D-glucose were also identified along with the traces of arabinose, fucose, galactose, rhamnose, and xylose. The free monosaccharides cover about 25% of the dried gel, and glucose consists of 95% of the total soluble sugars. Compounds like campesterol, cholesterol, lupeol (triterpenoid), and β-sitosterol were also found. Structural studies of gel's polysaccharides have shown that the gel has 4 diverse linear polymers had β (1, 4) glycosidic linkages between mannose and glucose, which are partially acetylated glucomannans. Glucomannans are mostly absent in most of the species of aloe plants (Rodríguez *et al*., 2010). Upon hydrolysis of sugars, the gel's viscosity reduces. Some sugars possibly help to prevent 'leaky gut syndrome' by binding to the specific receptors and form the barrier in the gut, when taken orally. Other reporters suggested the presence of polyuronide that had higher molecular weight polymers of glucose, mannose, and hexouronic acid. Uronic acid is present in gel upon fermentative hydrolysis it gives galacturonic acid and oligosaccharides. (Atherton, 1997).

Polysaccharide Composition

Isolation and characterization of polysaccharides, from different species such as *A. arborescens*, *A. barbadensis*, *A. ferox*, *A. plicatilis* (L.) Mill, *A. saponaria*, *A. vahombe*, and *A. vanbalenii* Pillans, had been completed till 1990. Arabinogalactans and rhamnogalacturonans were abundant in *Aloe ferox*, whereas glucomannans were more concentrated in other aloe species. Aloe vera parenchyma is mostly made up of polysaccharides. The polysaccharides might be acylated, not acylated, or partially acylated. A very little agreement had been shown on the polysaccharides composition of the gel that might be linked to the determination methods and factors like change in the soil composition, climatic conditions, and the cultivation methods (Femenia *et al*., 2003). According to the reported results by different investigators, showed that there is a considerable difference in the chemical and structural configuration of the isolated polysaccharides, especially in the case of *A. barbadensis*. Extracted polysaccharides were mostly made up of mannose units that were unsystematically substituted with glucose subunits. Lesser quantity of other Monos such as galactose, mucose, rabinose, rhamnose, xylose, or uronic acids had also been identified. It is not confirmed yet, whether the occurrence of these sugars is a fundamental part of the structure, or whether they are the result of the presence of polluting carbohydrates.

The stored polysaccharides are mainly acetylated glucomannan, which is present in parenchyma cells' protoplast and many other varieties of polysaccharides are concentrated in the matrix of the cell wall. Partially acetylated glucomannans in raw aloe gel were responsible for thick stringy mucilage character. A detailed carbohydrate analysis revealed that the cell walls mainly held polysaccharides, consist of mannose, pectin, and cellulose whereas the leaf's skin contained a significant amount of the xylose containing polysaccharides (Choi and Chung, 2003). Most of the investigators nominated acemannan (partially acetylated mannan) as the chief polysaccharide of the gel, while others nominated pectin as the chief polysaccharide. Other polysaccharides like arabinorhamnogalactan, arabinan, galactogalacturan, galactan, glucogalactomannan, galacto gluco arabino mannan, and glucuronic acid-containing polysaccharides have been extracted from the gel (Ni *et al*., 2004).

From the aloe vera plant, galacturonate polysaccharides, highly purified had been separated and analyzed for their molecular weight and chemical composition. This polysaccharide had been considered as a species with higher molecular weight and possesses a distinctive composition, as it includes higher galacturonic acid and lower methyl ester content (McConaughy *et al.*, 2008). Malic acid and three acylated polysaccharides i.e. Veracylglucans A, B, and C had been isolated from the gel (Esua and Rauwald, 2006). Commercially available, Carrysin-TM is an acetylated polymer extracted from aloe vera's gel. Acemannan separated by chromatography showed that polysaccharides were chiefly composed of three subunits i.e. 93% mannose, 3% glucose, 3% galactose, and 1% arabinose (Rodríguez-González *et al.*, 2011).

The alcohol-soluble fractions of the gel have been studied and revealed that acidic hydrolyzes of these fractions at high temperatures produced the mixture of acid-resistant fraction and oligosaccharides and accounted for about 37%. The acid-resistant separations of gel comprise galactose (18%), arabinose (18%), glucose (9%), galacturonic acid (5%) and xylose (9%). Acid-resistant separation showed the different compositions of water-soluble polysaccharides that were consisted of mannose 84%, glucose 6%, and galactose 4% (Chow *et al*., 2005). The nuclear magnetic resonance (NMR) technique was used for analyses of the structure of acid-resistant fractions. After treated with enzyme endo *β*-mannanase, that produced had enough pure oligosaccharides, also confirmed the occurrence of *β*-Glc-1-4-Man, 4-*β*-Man-1, *β*-Man-1, 4[*α*-Gal-1, 6] Man plus disaccharides, trisaccharides, and tetrasaccharides of *β*-1, 4-linked mannose. There was also *a β-1,6* linkage between galactose and mannose. (Saleem *et al*., 1996). Another polysaccharide named "aloeride" shares about 0.015% of the crude dry weight of aloe vera gel. Its molecular weight ranged between 4-7 million Da, containing arabinose (10.3%), galactose (23.9%), glucose (37.2%), and mannose (19.5%). Polyuronide had a molecular weight of about 374 kilo Da, whereas aloeferon is about 70 kDa (Pugh *et al*., 2001).

Mannan

Generally, plants' mannans played a structural role as it acts as hemicelluloses and also binds to cellulose to provide strength. Mannan plays also a storage task in vegetative tissues and seeds as non-starchy carbohydrate reserves. In addition to it, the evidence showed that they might act as signaling molecules in the plants for development and growth. Mannans are homo polysaccharides, comprised of long chains of β-(1→4)-D-mannopyranosyl along with 5% galactose (Moreira and Filho, 2008). Acemannans present in *Aloe vera* gel, another name is "carrysin", and with the backbone of β-(1→4)-D-mannosyl subunits acetylated at the positions of C-2 and C-3 that exhibited acetyl ratio of about 1:1. It may also have a few side chains that are made up of galactose subunits attached to position C-6 (Femenia *et al*., 1999). The configuration in acemannan, β-(1→4)-glycosidic bond, has significance in terms of their therapeutic effects since humans have no enzymes to break down this bond. In fresh aloe vera, the polysaccharides' molecular weight ranges from 30-40 kDa to 1000 kDa. The ratio of glucose and mannose is 1:3, whereas other authors have also reported different ratios i.e. 1:6, 1:15, or 1:22 reported (Talmadge *et al*., 2008). These divergences in glucose: mannose ratio had been described by variation in species. Aloe vera's plant galactomannans are made up D-mannopyranosyl subunits having a linkage of β-(1→4) along with side chains of single D-galactopyranosyl residues having α-(1→6) linkage (Boudreau and Beland, 2006).

Maloyl Glucans

Three acylated carbohydrates of malic acid had been isolated from the gel of aloe vera and characterised as veracylglucan A, veracylglucan B and veracylglucan C. Veracylglucan A ($C_{10}H_{16}O_{10}$), detected in a very low amount having a molecular weight of the 296 Da and very unstable. Veracylglucan B ($C_{16}H_{26}O_{15}$) has 458 Da molecular weight, while veracylglucan C (C56H82O51) had 1570 Da and pH of 3.8 and 4.7 respectively (Esua and Rauwald, 2006).

Arabinan and Arabinogalactan

Mainly arabinogalactan had galactose and arabinose, but sometimes it may have other sugars such as galacturonic acid and/or glucuronic acid (Ni *et al*., 2004).

Anthraquinones

Anthraquinones are mainly concentrated in the sap of aloe vera leave and they are the phenolic compounds. Stenhouse first identified the principal active compound and Smith in 1851 named it "Aloin". The chief constituent of *Aloe* is the hydroxy-anthraquinone derivatives (25-40%) such as aloin and isomers of 7-hydroxyaloin. When these compounds are ingested in large quantities, they exert a powerful gut cleaning effect but in low concentration, it appeared to increase the absorption in the intestine and showed analgesic and antimicrobial potential (Ahlawat and Khatkar, 2011). Other compounds that occur in minute quantity include chrysophanol, Aloe-emodin, derivative-aloresin B also known as alosin (30%), aglycone aloesone, and p-coumaryl derivatives-aloeresins A and C. Aloin is bitter fluid, yellow when dried, slightly soluble in water, and converted into *Aloe*-emodin when hydrolyzed. The latex had 10-25% barbaloin content and the leaf has 1% on the dry weight basis. The leaves contain several free anthraquinones like aloin, aloetic acid, anthracene, anthranol, barbaloin, isobarbaloin, cinnamic acid's ester, emodin, ethereal oil, resistannol, and chrysophanic acid.

According to IASC (International *Aloe* Science Council, 2015), in non-medical use of aloe vera-based products the upper acceptable limit of aloin is <50 ppm. Phenolic anthraquinones had been isolated and examined by using column chromatography (Rajendran *et al*., 2007). 13 phenolic compounds such as 10- hydroxyaloin A, 8-C-glucosyl-7-Omethyl-(S)-aloesol, 8-O-methyl-7-hydroxyaloin A and B, *Aloe*-emodin, aloenin, aloenin B, aloeresin E, aloesin, aloin A and B, isoaloeresin D, neoaloesin A in *Aloe arborescens and Aloe barbadensis* had been quantified and isolated by the HPLC method. Barbaloin is chiefly known for its laxative effect and is used as a key compound in pharmaceuticals containing aloe vera. Saponins, a glycoside, share about 2.91% of the leaf gel having cleansing and antiseptic ability (Hirat and Suga, 1983). Sterols include Campesterol, Cholesterol, Lupeol, and β-Sitosterol were reported in the gel (Coats 1979). Salicylic acid is an aspirin-like compound present in gel and posed pain-relieving properties (Atherton, 1997).

Formulations of aloe vera's juice were assessed for their antioxidant action and results revealed the significant free radical scavenging activity (72.19%) that was higher than BHT (70.52%) and α-tocopherol (65.65%) (Hu *et al*., 2003). Screening for phytochemical constitutes was performed, a positive result was obtained for flavonoids, tannin, terpenoids, and saponin but negative for steroids (Arunkumar and Muthuselvam, 2009). Twenty-six bioactive phytochemicals recognized in the ethanolic extract of gel and found that hexadecanoic acid (22.2%) was the chief compound then octadecanoic acid, tricosane, and 1-octadecanol (16.2%, 5.59%, and 5.20% respectively). Stigmasterol and Sitosterol were present in the amount of 2.1% and 2.8% respectively (Bawankar *et al*., 2013).

Nitrogen Fraction

Most of the polysaccharides preparations had very low or nearly no nitrogen, hence the determination of the protein content by Kjeldahl method of gel lyophilized available commercially had been very low, about 0.013% (McKeown, 1983). Aloe vera gel juice had 18 amino acids out of 22 and 7 were essential amino acids. Arginine was relatively in ample amount comprised about 20% of the total (Rodríguez *et al*., 2010).

Glycoprotein

A glycoprotein called alprogen, having anti-allergic potential, was extracted from aloe gel. In addition to it, C-glycosyl chromones, novel anti-inflammatory compounds, had been also isolated from the gel. Lectins showed haema glutinating activity, were found in *A. chinensis, A. vera*, and *A. arborescens*. 2 proteins, Aloctin A and B, had been isolated from *A. arborescen*. Aloctin A had 18 KDa, molecular weight, and composed of two subunits with 18% of carbohydrate content. Aloctin B had nearly 24 KDa molecular weight, with two subunits having 50% carbohydrate content. A glycoprotein from the outer part of the leaf, 35 KDa molecular weight, called ATF191, was successively isolated from *A. arborescent*. Another glycoprotein of 29 KDa molecular weight, having cell proliferation activity, was also separated from the gel (Rodríguez *et al*., 2010).

Enzyme

Aloe vera gel has six enzymes including amylase, bradykinesia, catalase, carboxy-peptidase, oxidase, and cellulase. The enzyme carboxypeptidase produces analgesic and anti-inflammatory effects on the site of the wound by inhibiting the bradykinesia (Fujita *et al*., 1976). Enzymes such as lactic dehydrogenase, acidic phosphatase, alkaline phosphatase, and lipase had also been identified in the gel. The gel also had glutathione peroxidase as well as several isoenzymes of superoxide dismutase (Meadows, 1980). Aloe vera's extracts had been linked with different enzymatic activities such as superoxide dismutase, glutathione peroxidase, and other peroxidases. The SOD activity is revealed in 7 electrophoretic bands, two of them were manganese dependent and others were zinc-copper dependent (Rodríguez *et al*., 2010). Histamine is produced by the body in response to many allergic reactions that may cause intense itching and pain. Magnesium lactate present in gel obstructs histidine decarboxylase activity and inhibits histamine formation. This inhibition of histamine formation explains the anti-allergic potential of the gel. (Ahlawat and Khatkar, 2011).

Vitamins

Aloe vera contains various vitamins such as vitamin A, B-complex, C, E, F, folic acid, excluding D (Lawless and Allen 2000). Some investigators reported the occurrence of vitamin B_{12} (Cynocobalamin) in traces (Coats, 1979; Atherton 1997).

Minerals

In aloe vera juice, chloride and potassium are concentrated as compared to other plants whereas sodium concentration is lower. Zinc, iron, magnesium, copper, chromium, and calcium were also found in the aloe vera products (Rajendran *et al*., 2007). However, in the rind and pulp, calcium is a core mineral while potassium was higher in the gel. Others reported the presence of aluminum, phosphorus, boron, strontium, and silicon in aloe vera gel (Wang, 1993).

Other Components

Flavonols like myricetin, quercetin, and kaempferol had been extracted from the leaf (Sultana and Anwar, 2008). Alkaloids, indoles, and polyphenols are the key mediators for antioxidant activity. Aromatic chemical compounds had been identified from *Aloe arborescens* Mill. leaves through gas chromatography-mass spectrometry (GCMS) There were nearly 5 phenols, 6 acids, 8 ketones, 9 miscellaneous compounds, 9 esters, 42 alcohols, 21 aldehydes, and 23 terpenoids with a remarked amount of several isomers hexanol and hexenal (Umano *et al*., 1999).

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