

A SEMINAR PAPER ON

Industrial and Medicinal Efficacy of Aloe Vera (*Aloe barbadensis* Mill)

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ABSTRACT

Aloe vera is the oldest medicinal herbs ever known and the most used medicinal plant worldwide, belongs to the family Lilliaceae, commonly known as Ghriti Kumari. Aloe vera is used since long times for vigor, soundness, medicinal and industrial purposes. Aloe vera has its health benefits include its application in wound healing, lung cancer, intestinal problems ,treating burns , diminishing frost bite damage, protection against skin damage from x-rays, increasing High Density Lipoprotein (HDL),reducing Low Density Lipoprotein (LDL), fighting Acquired Immune Deficiency Syndrome (AIDS), reducing blood sugar in diabetics, allergies and improving immune system. Phyto-chemistry of aloe Vera gel has stated the availability of more than 200 bioactive chemicals. Aloe vera gel has important components including 19 of the 20 amino acids which is needed by the human body. In industries, aloe vera is also used on different purposes, such as cosmetics, food & beverage etc. The present research paper is an attempt towards the industrial and medicinal efficacy of aloe vera.

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CHAPTER I

INTRODUCTION

Aloe barbadensis Miller, commonly known to as aloe vera, is belonging to family Liliaceae of aloe, one of more than 400 species that originated in South Africa, but have been indigenous to dry subtropical and tropical climates, including the southern USA (Reynolds *et al.*, 1999). Aloe vera is a succulent plant. Succulents are xerophytes, Storage tissue has higher water holding capacity ranging from 99–99.5% (Hamman *et al.*, 2008) and 0.5–1.0% solid material has over 75 different potentially active compounds including water and fat-soluble vitamins, minerals, enzymes, simple and complex polysaccharides, phenolic compounds, and many investigators have endeavored to establish the active principles in aloe vera gel. Proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds, with different carbohydrates was found in polysaccharide from inner leaf parenchymatous tissue or pulp (Hamman *et al.*, 2008).

The plant is employed inwardly to campaign most digestive problems, including constipation, poor appetite, asthma, diabetes, immune system enhancement, irritable bowel syndrome and peptic ulcers (Pandey *et al.*, 2016). Aloe is used against skin irritation, skin exposure to UV and gamma radiation, scalds, sunburn wounds, eczema, psoriasis, acne, dermatitis, ulcers, to stimulate cell regeneration. Plants have hypoglycemic, cytotoxic, antiulcer, anti-diabetic effects, antibacterial, antioxidant, cardiovascular effect on human. Healing properties, anti-inflammatory, antiviral and antitumor, moisturizing, anti-aging effect, antiseptic properties of plant stimulates the immune system, only a few species of Aloe have been considered for commercial importance, of which aloe vera is considered the most potent and, thereby, the most popular plant in the research field (Saito *et al.*, 2016). Aloe vera plant has six antiseptic agents, salicylic acid, tupoel, nitrogen, urea, cinnamon acid, sulphate and phenol. Its antifungal quality is emphasized in many fields of medicines. For aloe raw material the industry volume is distributed to be about \$125 million dollars.

A recent market analysis report indicates that in 2008 Americans have spent almost 40 billion dollars on functional foods, drinks and supplements for the improvement of their appearance as well as to provide energy and added nutrition to handle health issues such as hypercholesterolemia and diabetes. Today, the aloe vera industry is rising and the gel is practiced in many products such as fresh juice, gel and other formulations for medicinal, health and cosmetic purpose (Alexander, 1967). The aloe vera industry claims credible testing regulation to examine the quality and quantity of bioactive chemicals appeared in the utmost

products (Bozzi *et al.*, 2007).The product demands must be tested by exquisite clinical trials, verified and certified by the government regulatory authorities to manufactured consumer confidence and safety of the aloe vera products. The plant can be produced in drought prone areas and it is a hardy perennials tropical plant whose dynamic is yet to be utilized, despite being known as a fresh crop resource with the foremost promising expectation in the earth.

Objectives:

- To highlight the industrial efficacy of aloe vera
- To review the medicinal value of aloe vera

CHAPTER II

MATERIAL & METHOD

Scientific approach requires a close understanding of the subject matter. This paper mainly depends on the secondary data. Different published reports of different journals mainly supported in providing data in this paper. This paper is completely a review paper. Therefore no specific method has been followed in preparing this paper. It has been prepared by browsing internet, studying comprehensively various articles published in different journals, books, proceedings, dissertation available in the libraries of BSMRAU and personal communication. I would like to express deepest sense of gratitude to my major professor and course instructors for their efficient and scholastic guidance, precious suggestions to write this manuscript from its embryonic stage. All the information collected from the secondary sources have been compiled systematically and chronologically to enrich this paper.

CHAPTER III

REVIEW OF MAJOR FINDINGS AND DISCUSSION

Phyto-chemistry of Aloe Vera

Aloe vera has 200 different types of molecules. Aloe gel has polysaccharides (55%), sugars (17%), minerals (16%), proteins (7%), lipids (4%) and phenolic compounds (1%) on dry matter basis (Luta and McAnalley, 2005) (Fig. 1). The aloe vera gel has many vitamins including the important vitamins A, C and E. Vitamin B1 (thiamine), niacin, Vitamin B2 (riboflavin), choline and folic acid (Lee and Choi, 1994). Polysaccharides are derived from mucilage layer of the plant under the rind, surrounding the inner parenchyma or gel. The most important are the long chain polysaccharides, comprising mannose and glucose, known as the glucomannans [β (1, 4)-linked acetylated mannan]. Calcium, magnesium, zinc, copper, chromium and iron were found in the aloe products.

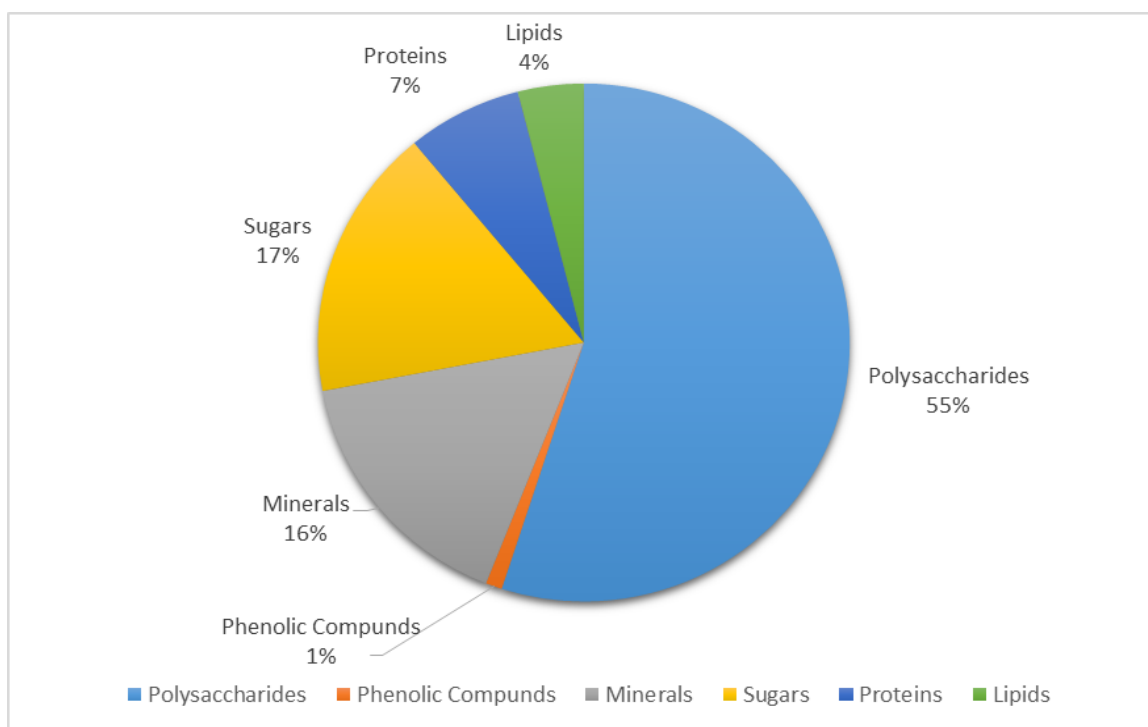


Fig 1. Chemical composition of aloe vera gel (on dry weight basis)

(Source: Luta and McAnalley, 2005)

Industrial efficacy of Aloe vera

In the food industry, aloe vera has been utilized as a resource of functional food especially in the preparation of health food and drinks. In pharmaceutical industry, it is found in topical ointments, gel preparations and available as tablets and capsules. The most useful use of aloe is in cosmetic and toiletry industries where we can get it in soaps creams, soaps, ointments, beauty lotions, shampoos ,sprays and facial cleaners (Eshun & He, 2004) to name a few of the thousands of products available. For finished product containing aloe vera, the volume of the industry is alleged to be around \$110 billion dollars (Ahlawat and Khatkar, 2011). Aloe vera gel derived from the leaf pulp of the plant has become an enormous business worldwide because of its application within the food business. It is utilized in functional foods especially for the preparation of health drinks with no laxative effects. Thus, an efficient & easy processing technique requires to be developed especially for the aloe beverage industry to spread product quality and safety by preserving the bioactive chemicals naturally present in the intact aloe vera leaf. The aloe vera finds its usefulness in pharmaceutical industry is also substantial as evident by availability of gel preparations, topical ointments, capsules and tablets (Eshun and He, 2004).

Aloe vera was 20th among best-selling dietary supplements in the USA according to the 2012 Nutrition Business Journal Annual Report ,There has been a general increasing trend in sales from US\$ 31 million in 2000 to US\$72 million in 2011 (Fig 2).

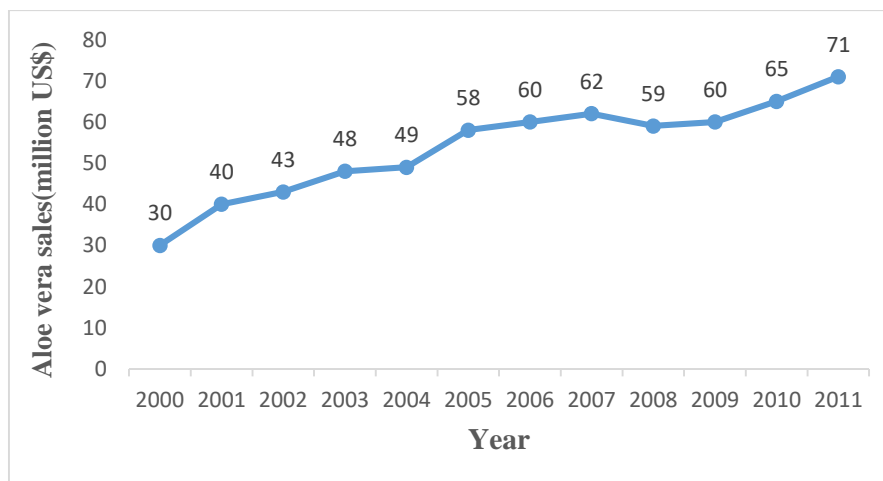


Fig 2. Sales of dietary supplements containing Aloe vera in the USA

(Source: Nutrition Business Journal, 2010, 2012)

Aloe juice and its food applications

The aloe vera juice gets wide application in food products like production of ready to serve drink, health drink, soft drink, laxative drink, aloe vera lemon juice, sherbet, aloe sports drink with electrolyte, diet drink with soluble fiber, hangover drink with B vitamin, amino acids and acetaminophen, healthy vegetable juice mix, tropical fruit juice with aloe vera (Eshun and He, 2004) (Table 3).

The comparison of antimicrobial activity shown different aloe vera based beverages against human pathogen (*E. coli*) is given in Fig.3. Maximum zone of inhibition was shown by pure juice (25.7mm), minimum was shown by squash (12.10 mm) while RTS (Ready to Serve) drink failed to show any zone of inhibition. Prashar et al. recorded 5.00 mm zone of inhibition in ethanolic extract of Aloe vera leaf against *E. coli*, whereas DMSO (Dimethyl sulfoxide) gel extract of Aloe vera exhibited 13 mm zone of inhibition in Aloe vera juice against *E. coli* (Source: Karunyadevi *et al.*, 2009) (Fig 3).



Fig 3. Antimicrobial activity of different Aloe vera based beverage

(Source: Karunyadevi *et al.*, 2009)

In other study, Karunyadevi et al recorded 20mm zone of inhibition in Aloe vera juice against *E. coli* (Karunyadevi *et al.*, 2009). Further, the maximum antioxidant activity was shown by pure aloe vera juice (71.81%) while minimum (7.90%) was shown by RTS drink (Fig 4).

Apparently, both the activities were directly related to the amount of juice used in the product development.

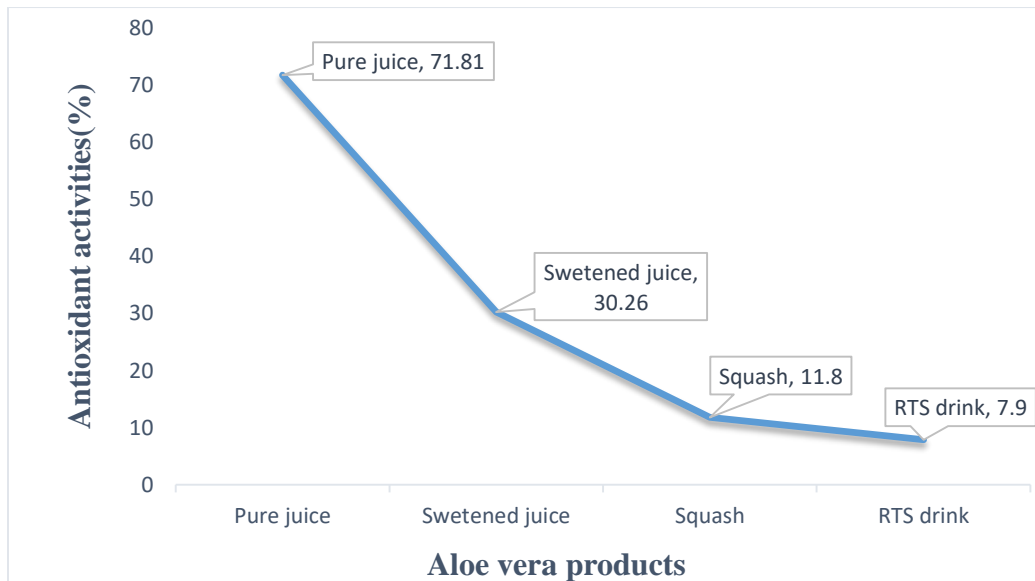


Fig 4. Antioxidant activity of different Aloe vera based beverage

(Source: Karunyadevi *et al.*, 2009)

Aloe powder and its properties

The aloe vera powder from fresh Aloe vera leaves was analyzed in term of the microbiology, water content, density, solubility, pH, colour, appearance and active compounds using LC-MS. The properties of Aloe vera powder obtained from the research for drying air inlet temperature variation was described in Table 1. It was compared with the standard commercial aloe vera powder from Terry Labs. The final sample has met most of the parameters and specifications of commercial aloe vera powder on the market such as water content, pH, appearance, solubility, colour, and microbiology. Table 1 shows that drying air inlet temperature with higher temperatures resulting in aloe vera powder products with microbiology (cfu/g) levels are lower even though the four variables still eligible (<100 cfu/g or colony forming unit/g). The testing methods used packed density. In the drying process (spray dryer), the decreasing of hot air inlet temperature did not affect the increase of water content significantly. In fact, water content tended to be stable of 2-5%. This has a positive effect for the quality of product in which the active component microencapsulated was relatively stable for lower temperature of dryer. A LC-MS method was used to get chromatography analysis. It was described the chromatography analysis of Absorbance at 254 nm for aloe vera gel powder concentrates from evaporation process, the aloe vera powder using 110⁰C, 120⁰C, 130⁰C,

140°C drying air inlet temperature. Based on data, the maximum drying air inlet temperature was 120°C to produce Aloe vera powder which all of phenolic compounds of Aloe vera powder can still be maintained. Microbiology is 96-less than 100(cfu/g), it means it is safe for product uses. The safe limit of microbiology is 30-300cfu/g and pH range was 3.5-5, which was acidic. The density was 0.99-1.00 (g/ml), which was similar to water density and it could easily mixed with water. Solubility for aloe vera Powder 1 (140°C),Aloe vera Powder 1 (130°C),Aloe vera Powder 1 (120°C) ,Aloe vera Powder 1 (110°C) and Aloe vera powder Spray dried gel (Terry Lab`s Product) were 2.26,1.93,2.94,2.94 and 5 minutes respectively. The color was Beige white for all powder. The appearance was fine crystalline powder (Hendrawati, 2015) (Table 1).

Table 1. The properties of aloe vera powder

Compounds	Aloe vera Powder 1 (140°C)	Aloe vera Powder 2 (130°C)	Aloe vera Powder 3 (120°C)	Aloe vera Powder 4 (110°C)	Aloe vera powder Spray dried gel (Terry Lab`s Product)
Water content (% w/w)	2.88	4.04	4.89	4.89	8% max
pH	4.98	4.99	4.97	4.98	3.5 – 5.0
Microbiology (cfu/g)	96	97	97	98	< 100 cfu/g
Density (g/ml)	0.99	0.99	1.00	1.00	0.990 – 1.010
Solubility (minute)	2.26	1.93	2.94	2.94	5 minutes
Color	Beige white	Beige white	Beige white	Beige white	Beige white
Appearance	Fine Crystalline powder	Fine Crystalline powder	Fine Crystalline powder	Fine Crystalline powder	Fine Crystalline powder

(Source: Hendrawati, 2015)

Aloe drug industry

Disease due to the pathogenic bacteria and fungi represent a critical problem of human health and they are the main causes of morbidity and mortality worldwide. Resistance to antibiotics and with the toxicity during prolonged treatment with present day drugs have been the reasons for an extended search for newer drugs to treat opportunistic microbial infections. During this process, the investigation of the efficacy of plant-based drugs in traditional medicine has been paid attention because these drugs elicit few side effects, cheap & easily available.

DMSO (Dimethyl sulfoxide) gel extracts of aloe vera were screened for the antibacterial and antifungal activity against the human pathogens and the results are given in the Table 2. In the DMSO gel extracts of aloe vera against all the specific bacteria with varied activity has been observed antioxidant activity. In the investigation, in vitro antibacterial and anti-fungal activity of the DMSO gel extracts of aloe vera was quantitatively evaluated on the basis of zone of inhibition. All the three concentration of DMSO gel extracts of aloe vera studied in the present investigation exhibited varying degree of inhibitory effect against the selected bacterial and fungal pathogens (Table 1). The present study shown the anti-bacterial and anti-fungal property of DMSO gel extracts of aloe vera against the selected strains of human pathogenic bacteria and fungi and the degree of inhibition varied depending upon the concentration of the extract. Highest concentration of DMSO gel extracts of aloe vera displayed maximum zone of inhibition (Table 2). The three different concentrations (100, 200 and 400 µg/mL) of DMSO gel extracts of aloe vera showed the inhibitory effect on the seven out of eight pathogens with the maximum zone of inhibition in the highest concentration (400 µg/mL). *Bacillus subtilis* had showed highest inhibition zone 10mm in 400 µg/ml & lowest 7mm in 100 µg/ml concentration of DMSO aloe vera gel extract. *Salmonella typhi* & *Aspergillus fumigates* had showed no inhibition zone in any concentration of DMSO aloe vera gel extract. *Escherichia coli* had showed highest inhibition zone 13mm in 400 µg/ml & lowest 10mm in 100 µg/ml concentration of DMSO aloe vera gel extract. *Staphylococcus aureus*, *Proteus vulgaris*, *Candida albicans* & *Penicillium sp.* had showed highest inhibition zone 10.5, 12, 11 & 9 in 400 µg/ml and lowest 8, 10, 8 & 6 in 100 µg/ml concentration of DMSO aloe vera gel extract respectively (Antonisamy *et al.*, 2016) (Table 2).

Table 2: Anti-bacterial and anti-fungal activity of the DMSO aloe vera gel extract

Name of the Pathogen	Conc. of DMSO (Dimethyl sulfoxide) aloe vera gel extract in µg/ml		
	& Zone of Inhibition in mm		
	100 µg/ml	200 µg/ml	400 µg/ml
<i>Bacillus subtilis</i>	7	8	10
<i>Salmonella typhi</i>	Nil	Nil	Nil
<i>Escherichia coli</i>	10	12	13
<i>Staphylococcus aureus</i>	8	9	10.5
<i>Proteus vulgaris</i>	10	11	12
<i>Aspergillus fumigatus</i>	Nil	Nil	Nil
<i>Candida albicans</i>	8	10	11
<i>Penicillium sp.</i>	6	8	9

(Source: Antonisamy *et al.*, 2016)

Aloe vera products & food application

Aloe vera is used as a different product, such as concentration, gel fillet, juice & powder. They are used as different food application. Aloe concentration can be used as a squash, jam, jellies & can be also mixed with tea water or juice. Gel fillet can be used in candies, bar, munch, chewing gum, instant aloe vera tea granules , aloe vera gum for sore or bleeding gums, candy type aloe vitamins, aloe vera fruit smoothies. Juice can be used in ready to serve drink, health drink, soft drink, laxative drink, sherbet, sports drink (with electrolytes), diet drink with soluble fiber, hangover drink with B-vitamins, amino acids and acetaminophen, healthy vegetable juice mix, yoghurts, aloe vera mix for whiskey or other alcohol, white bread with aloe vera and cucumber juice with aloe vera. Powder can be used in yoghurt, curd, lassi, ice-cream and aloe vera laddu etc (Eshun and He, 2004) (Table 3).

Aloe contents of different market products are about 20% (sunburn treatments, creams and ointments), 95% (juices), 50% (beverages), 10% (drinks), and 5-10% (capsules) (Pandey *et al.*, 2016).

Table 3. Food applications of aloe vera products

Aloe vera products	Food applications
Concentrate	Squash, jam, jellies, aloe vera concentrate can also be mixed with tea, water or juice
Gel fillet	Candies, bar, munch, chewing gum, instant aloe vera tea granules, aloe vera gum for sore or bleeding gums, candy type aloe vitamins, aloe vera fruit smoothies
Juice	Ready to serve drink, health drink, soft drink ,laxative drink, sherbet , sports drink (with electrolytes),diet drink with soluble fiber, hangover drink with B-vitamins, amino acids and acetaminophen ,healthy vegetable juice mix, yoghurts, aloe vera mix for whiskey or other alcohol, white bread with aloe vera and cucumber juice with aloe vera
Powder	Yoghurt ,curd, lassi, ice-cream and aloe vera laddu

(Source: Eshun and He, 2004)

3.4 Medicinal efficacy of Aloe vera

Aloe vera is anthelmintic, aperients, carminative, depurative, diuretic and stomachic. Juice is used in skin care medicine, dropsy carbuncles, sciatica, lumbago and flatulence.(Joseph *et al.*, 2010).Health benefits of aloe vera include its application in wound healing, anticancer, antitumor, antifungal, antibacterial, cosmetic & skin protection, antiseptic, anti-fungal reducing blood sugar in diabetics, allergies and improving immune system (Sahu *et al.*, 2013) (Fig 5).

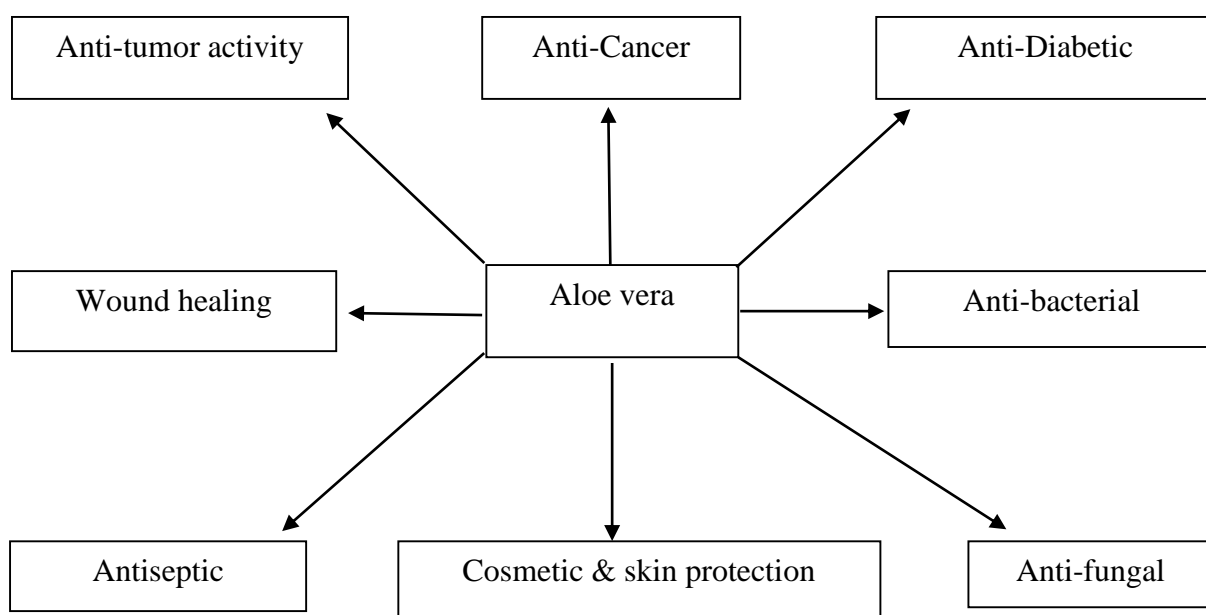


Fig 5. Medicinal utilities of aloe vera

(Source: Sahu *et al.*, 2013)

Aloe vera has several chemical component which has some health benefits, such as acemannan which accelerates wound healing, modulates immune system, antineoplastic & antiviral effect. Alprogen has anti-allergic effect. C-glycosylchromone, bradykinase, magnesium lactate & salicylic acid has anti-inflammatory effect (Sharma and Goel, 2002) (Table 4).

Table 4. Novel components of aloe vera along with their health benefits

Chemical components	Health benefits
Acemannan	Accelerate wound healing, modulate immune system, Antineoplastic & antiviral effect
Alprogen	Anti-allergic
C-glycosylchromone	Anti-inflammatory
Bradykinase	Anti-inflammatory
Magnesium lactate	Anti-inflammatory
Salicylic acid	Analgesic , anti-inflammatory

(Source: Sharma and Goel, 2002)

Aloe vera is natural solution to drug-resistant bacteria, viruses & fungi

In higher concentration (60, 80 and 90 %) whole leaf aloe vera extracts can eliminate dozens of harmful microorganism. The diseases related with these microorganism. Some microorganism causes many diseases which can be eliminated by aloe plant, such as *Streptococcus pyogenes* causes infectious diseases (rheumatic fever & strep throat), *Escherichia coli* causes symptom & fatal malady, *Staphylococcus aureus* causes food poisoning, bacteria genus *Pseudomonas aeruginosa* causes severe & fatal blood or urinary tract infections, *Serratia marcescent* causes endocarditis & respiratory illness, *Candida albicans* causes duct,metastasis & skin infections , *Klebsiella pneumonia* causes pneumonia (Williams, 2000).

Table 5. Bacteria & fungi known to be eliminated by aloe vera

Bacteria	Causes
<i>Streptococcus pyogenes</i>	Rheumatic fever & strep throat
<i>Escherichia coli</i>	Diarrhea & fatal food poisoning
<i>Staphylococcus aureus</i>	Food poisoning & toxic shock syndrome
<i>Pseudomonas aeruginosa</i>	Severe & fatal blood or urinary tract infections
<i>Serratia marcescens</i>	Endocarditis, pneumonia & bacteremia
<i>Candida albicans</i>	Vaginal, respiratory & skin infections, thrush & endocarditis
<i>Klebsiella pneumoniae</i>	Pneumonia

(Source: Williams, 2000)

In fig 6, the foremost effective antibiotic for gram positive is vancomycin showing 80.5% efficacy, then methicillin with 68.0% efficacy, erythromycin with 55.6% efficacy, novobiocin with 54.1% efficacy and bacitracin with 25.0% efficacy. For gram negative bacteria, the most efficient antibiotic is vancomycin displaying 72.2% efficacy, then novobiocin with 63.6% efficacy, methicillin with 60.8% efficacy, bacitracin with 51.4% efficacy and erythromycin with 42.4% efficacy. The susceptibility of gram positive isolates to erythromycin, methicillin and vancomycin was generally high while that to bacitracin and novobiocin was low. This

suggests that the penicillin's-resistant antibacterial agents should be selected as a first choice to treat these infections .The results showed that aloe vera leaf was 0% effective against the entire tested gram positive as well as gram-negative isolates. Aloe vera gel showed 100% activity against gram negative isolates and 75.3% against all tested gram positive isolates. This result could be responsible for the popular use of aloe vera gel and leaf to relieve many types of gastrointestinal irritations (Bashir *et al.*, 2011) (Fig 6).

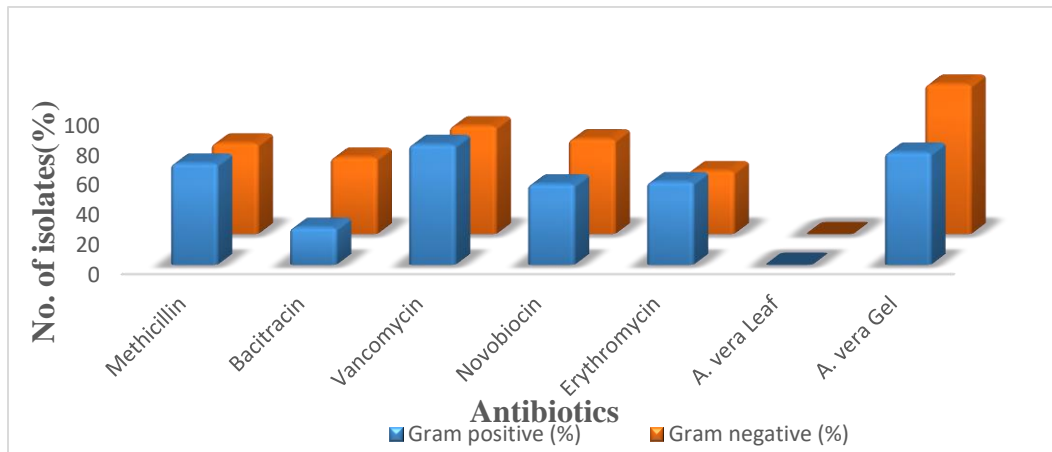


Fig 6. Comparative study of aloe vera leaf and gel with standard antibiotics against clinical skin infection isolates

(Source: Bashir *et al.*, 2011)

Atherosclerosis and Coronary Heart Disease

Coronary heart disease related to the buildup of blood fats (lipids) in the lining of arteries continues to be one among the foremost causes of death within the western world. Many studies in animal models in addition as in human subjects have advised that the body function of aloe gel could have a helpful impact by lowering blood serum cholesterol, serum triglycerides, and serum phospholipids, which, once elevated, appear to accelerate the deposition of fatty materials within the massive and medium-sized arteries, together with the coronary arteries of the heart. In study, albino laboratory rats were fed high cholesterol diets with the experimental group fed the polysaccharide (Glucomannan) from aloe. The group fed aloe and control animals showed:

1. Total cholesterol levels had been decreased by aloe,
2. Triglyceride levels had been decreased by aloe.
3. Phospholipid levels had been decreased by aloe,
4. Non-esterified fatty acid levels had been decreased by aloe,
5. HDL cholesterol (the “good” cholesterol) levels had

been increased by aloe, 6. HDL/Total cholesterol ratios had been markedly increased by aloe (Danhof, 2010). The function of gel, could have a salubrious impact on fat (lipid) metabolism that, if active in human subjects, would tend to decrease the the danger of coronary artery sickness in individuals (Danhof, 2010).

Trion was given to monkey, which increased in blood lipids markedly, were partitioned into two groups. The first was given Aloe, while the second received the drug, clofibrate. Clofibrate was exercised clinically to lower triglyceride levels and lower serum cholesterol level. The figure 6 shows the reduction level in the different parameters compared with the control animals. Compared with clofibrate treated monkey, the group fed the Aloe fraction showed:

1. Decreased total cholesterol levels.
2. Decreased triglyceride levels.
3. Decreased phospholipid levels.
4. Decreased non-esterified fatty acid levels (Danhof, 2010) (Fig 7).

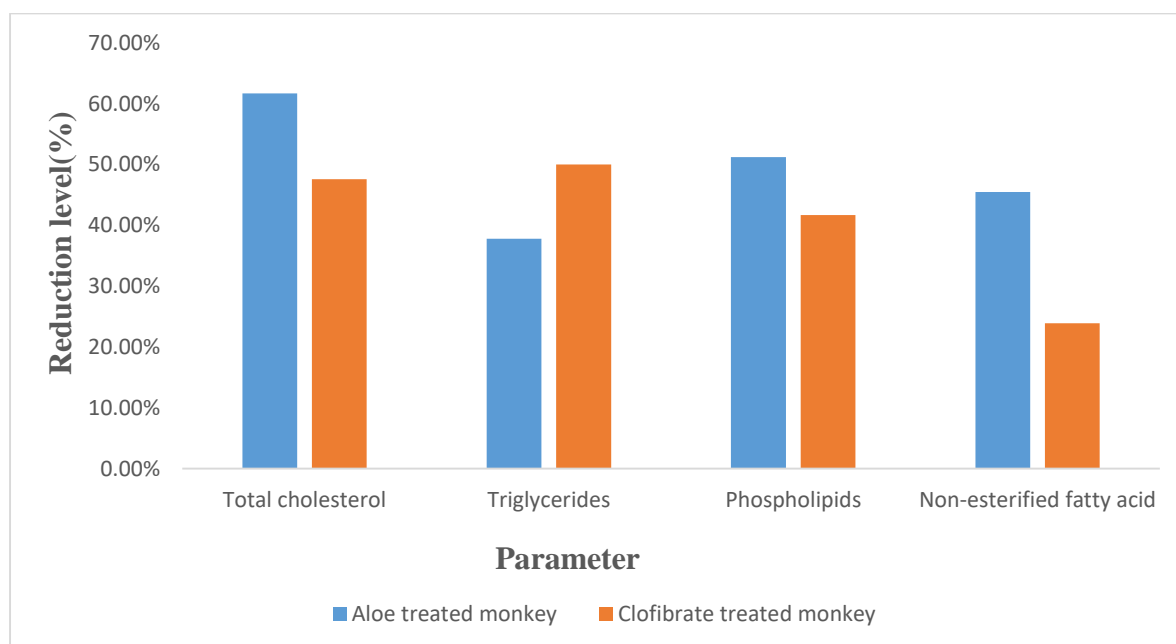


Fig 7. The reduction in the various parameters compared with the aloe treated monkey and clofibrate treated monkey

(Source: Danhof, 2010)

Antitumor activity

In aloe gel, glycoproteins are gift, are enlightened to posse growth and antitumor activity and to extend proliferation of normal human dermal cell (Yagi et al., 2003). In recent studies, a

carbohydrate fraction has been seen to inhibit the binding of benzopyrene to primary rat hepatocytes, thereby pre-empting the formation of doubtless cancer-initiating benzopyrene DNA adducts.

Wound healing and topical activity of aloe vera

The wound healing property of Aloe vera gel has been attributed to Mannose-6-phosphate used for first to second degree burns (Davis *et al.*, 1991). Wound healing is a dynamic process, occurring in 3 phases. The first phase is inflammation, hyperaemia and leukocyte infiltration. The second phase consists of removal of dead tissue. The third phase of proliferation consists of epithelial regeneration and formation of fibrous tissue (Reddy *et al.*, 2011). Glucomannan and plant growth hormone gibberellin interacts with growth factor receptors of fibroblast and stimulate its activity and proliferation for increased collagen synthesis in topical and oral administration of Aloe (Hayes *et al.*, 1999). Aloe vera was effective orally in promoting wound healing. Oral food-grade aloe vera (100 mg/kg/day) improved wound healing compared to the healing of control animals receiving only water (Fig 8). The decrease in wound diameters for the control animals was 3.5 +/- 0.3 mm, whereas the aloe-treated mice had a decrease in wound diameters by as much as 4.8 +/- 0.5 mm. The difference was significant at $p < 0.05$. These findings clearly suggest that aloe vera was a significant factor in the healing of the wounds (Vera, 2011) (Fig 8).

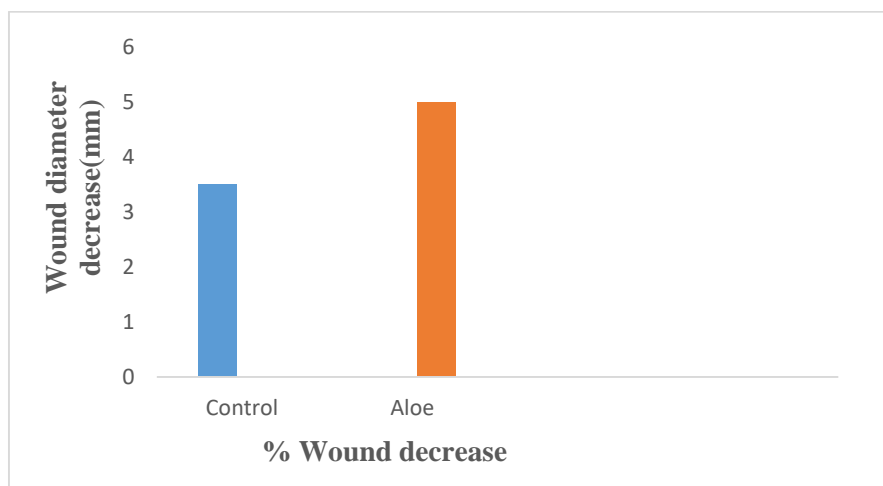


Fig 8. Effect of oral aloe vera on wound healing in mice over a 2-month period

(Source: Vera, 2011)

Moreover, the laboratory found that Aloe vera administered topically also served to improve wound healing. Figure 9 depicts the effect of topical 25% colorized Aloe vera in mice over a period of 7 days. The wounds on the mice that received 25% colorized aloe vera demonstrated

a 5 mm reduction in diameter, as compared to the wound diameter reduction of 2 mm ($p < 0.001$) for the animals that received cream alone. No significant difference was observed between the untreated wounds and the wounds treated with eucerin cream alone ($p > 0.5$). Therefore, the decrease in wound diameters for the non-treatment control group, cream alone and 25% colorized aloe vera group were 3mm, 2mm and 5mm respectively. These findings clearly suggest that 25% colorized aloe vera was a significant factor in the healing of the wounds (Vera, 2011) (Fig 9).

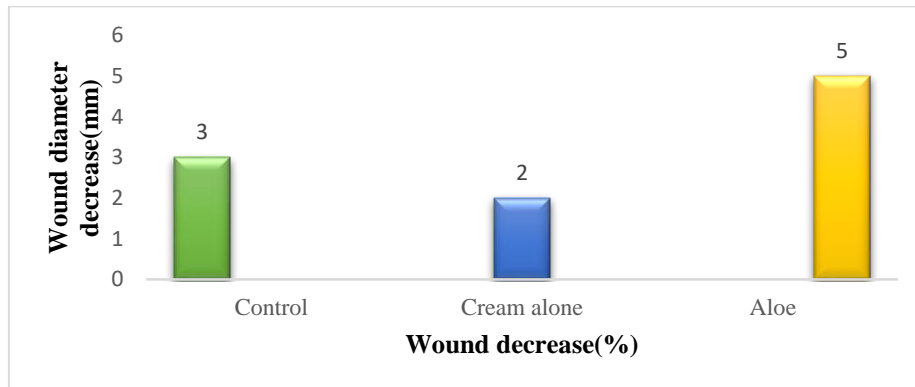


Fig 9. Topical effect of Aloe vera on wound healing in mice over a 7-day period

(Source: Vera, 2011)

Comparison of Aloe Vera gel and Vaseline in Wound Healing

Twenty-seven patients with partial thickness burns were given either Aloe vera or vaseline to improve healing time. Patients treated with Aloe Vera gel healed in an average of 11.89 days, while patients treated with Vaseline healed in an average of 18.19 days (Syed *et al.*, 2009) (Fig 10).

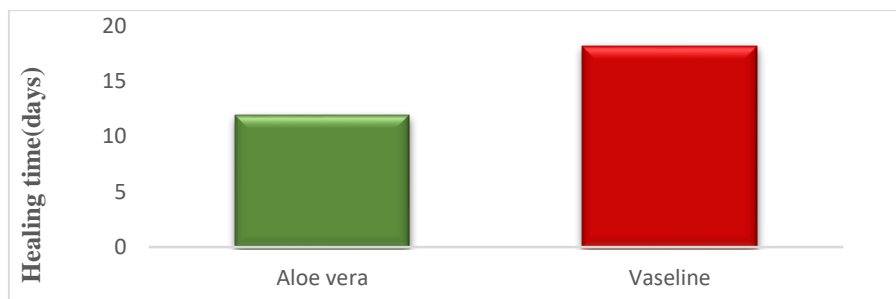


Fig 10. The clinical and histological study showed the effect of Aloe Vera gel to healing of burn wounds (Source: Syed *et al.*, 2009)

Wound bacterial counts were effectively decreased by silver sulfadiazine and aloe vera extract. Aloe vera contains salicylic acid, which inhibits thromboxane production. This can contribute to increased healing time. Four treatment were given to patients and bacterial count was taken. In control and silver sulfadiazine treatment, average healing time was 50 days and bacterial count was standard. In aloe vera gel treatment, average healing time was 30 days that was standard and effective. In salicylic acid cream treatment, average healing time was 50 days and no changes of bacterial count. Salicylic acid cream alone failed to improve healing time, other ingredients in aloe vera must contribute to decreased healing time. (Rodriguez-Bigas *et al.*, 2014) (Table 6).

Table 6. Aloe vera treatment vs. common wound remedies

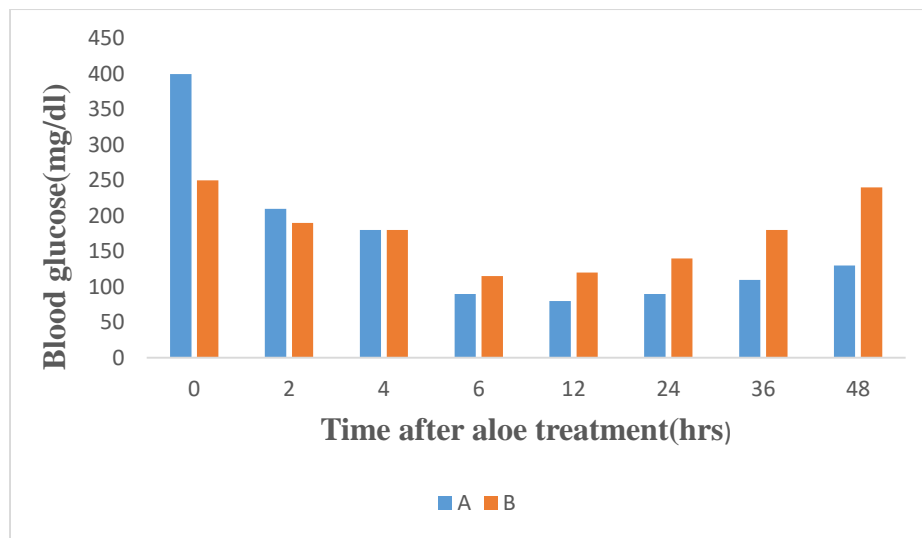
Treatment	Avg. Time to Heal	Bacterial Count
Control	50 days	Standard
Silver sulfadiazine	~50 days	Decrease
Aloe vera Gel	30 days	Standard
Salicylic acid Cream	~50 days	No Change

(Source: Rodriguez-Bigas *et al.*, 2014)

Reduction of blood glucose in obese, middle-aged diabetics

At the present time, people tend to eat excessively and get little exercise, factors that can be attributed to an increasing prevalence of diabetes mellitus. Aloe vera has been shown to be a highly effective treatment for diabetes. The beneficial effects of selective medicinal plant species such as *Allium cepa*, *Allium sativum*, *Aloe vera*, *Azadirachta indica*, *Gymnema sylvestre*, *Syzygium cumini* and *Pterocarpus marsupium*, and emphasize on the role of active bio-molecules which possess anti-diabetic activity. Lophenol, 24-methyl- lophenol, 24-ethyl- lophenol, cycloartanol and 24-methy- lenecycloartanolis the five phytosterols of aloe showed anti-diabetic effects in type-2 diabetic mice (Noor *et al.*, 2008). Figure 11 shows that in both strains of mice, Aloe injection reduced blood glucose level to a normal range (120 mg/dl) 8-12 hours after injection. In this experiment, Aloe was given in two forms: Aloe A (superficial blue-colored portion of Aloe leaf) and Aloe B (the inner red-colored fleshy portion of Aloe leaf). Both Aloe A and Aloe B reduced blood glucose level to a normal range. After 8-10 hours

of aloe treatment blood glucose level become increasing and after 40 hours, it increased up to 200mg/dl in case of Aloe B and up to 100mg/dl in case of Aloe B (Fig 11).



Here, A= Superficial blue-colored portion of Aloe leaf

B= The inner red-colored fleshy portion of Aloe leaf

Fig 11. Normalization of blood glucose level (Blood glucose level normalized in diabetic rats 8-12 hours after Aloe treatment)

(Source: Fujita *et al.*, 2012)

Aloe vera gel in ulcer therapy

Aloe vera is useful clinically in the treatment of ulcer, it is used its emulsion in a group of patients with ulcer as primarily the only medication, aside from the occasional administration of pro-banthine in instance in which overwhelming distress indicated the necessity for the immediate restraint of acid secretion. All patients had recovered fully. This condition seems to be increasing, particularly among the younger. Twelve patients had diagnosed clinically as having ulcer, having clear radiography proof of small intestine cap lesions, were treated with the aloe gel emulsion. Findings were most encouraging. They had improved on aloe vera gel medication and complete clinical recovery had occurred & no recurrence was seen. Except case no 12, the patient (Age: 84) had suffered from duodenal ulcer, on and off, for 20 years. She had improved on aloe vera gel treatment but subsequently died of cardiac failure without, however, ever again suffering from gastric distress (Blitz *et al.*, 2004) (Table 7).

Table 7. Response of patients with duodenal ulcer to aloe vera gel emulsion

Case no	Sex	Age	Result of treatment	
1	Male	24	Clinical recovery; no recurrence	
2	Male	28	Clinical recovery; no recurrence	*The patient had suffered from duodenal ulcer, on and off, for 20 years. She improved on Aloe vera gel medication but subsequently died of cardiac failure without, however, ever again suffering from gastric distress.
3	Male	38	Clinical recovery; no recurrence	
4	Male	40	Clinical recovery; no recurrence	
5	Male	40	Clinical recovery; no recurrence	
6	Male	54	Clinical recovery; no recurrence	
7	Male	67	Clinical recovery; no recurrence	
8	Female	27	Clinical recovery; no recurrence	
9	Female	41	Clinical recovery; no recurrence	
10	Female	56	Clinical recovery; no recurrence	
11	Female	60	Clinical recovery; no recurrence	
12	Female	84	Clinical recovery*	

(Source: Blitz *et al.*, 2004)

Six patients had diagnosed clinically as having duodenal irritability & spasm, were treated with the Aloe vera gel emulsion. Preliminary findings were most encouraging. They had improved on aloe vera gel medication and complete clinical recovery & no recurrence had seen. Although Case 18 is listed as a failure, the even, aloe vera gel emulsion treatment was taken by the patient and, after a few doses, patient stopped to take aloe vera gel emulsion treatment and never again gone to the clinic. Her record is therefore incomplete in files. It is assumed that she did not respond to treatment (Source: Blitz *et al.*, 2004) (Table 8).

Table 8. Response of patients with duodenal irritability & spasm to aloe vera gel emulsion

Case no	Sex	Age	Result of treatment
1	Male	16	Complete recovery
2	Male	22	Complete recovery
3	Female	39	Complete recovery
4	Female	39	Complete recovery
5	Female	40	Complete recovery
6	Female	49	No improvement

(Source: Blitz *et al.*, 2004)

Moisturizing & anti-ageing

Muco-polysaccharides of aloe vera has Agent which help in binding moisture into the skin. The amino acids also soften hardened skin cells and zinc acts as an astringent to tighten pores. In the treatment of dry skin aloe vera gel gloves improved the skin integrity, decrease appearance of acne wrinkle and decrease erythema where its moisturizing effects have been studied (West *et al.*, 2003).

Cosmetic & skin protection application

Aloin and its gel are used as skin tonic against pimples. Aloe vera is also used for soothing the skin, and keeping the skin moist to help avoid flaky scalp and skin in harsh and dry weather. The Aloe sugars are also used in moisturizing preparations (Barcroft *et al.*, 2003) and mixed with selected essential oils, it makes an excellent skin smoothening moisturizer, sun block lotion plus a whole range of beauty products.

Antiseptic

The aloe has six antiseptic agents namely lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulphur. They have inhibitory action on fungi, bacteria and virus (Anjum *et al.*, 2016).

CHAPTER IV

CONCLUSIONS

Aloe vera is a medicinal plant and because of its in depth medicinal, industrial and alternative uses its fancy an excellent demand within the market across the world. Australia, US and the entire Europe are the main markets for aloe vera and its extracts. Given the exponentially growing demand for it in the international market, Aloe vera presents the finest commercial opportunity among the various medicinal plants. Among the few countries, Bangladesh has the unique geographical characteristics which is essential for cultivation of aloe vera plant. Aloe is used against sunburn wounds, eczema, psoriasis, acne, skin irritation, scalds, dermatitis, ulcer, to stimulate cell regeneration. Skin exposure to UV and gamma radiation. Plants have antiulcer, anti-diabetic effects, antibacterial, antioxidant, hypoglycemic, cytotoxic cardiovascular effect on human. Healing properties, anti-inflammatory, antiviral and antitumor, moisturizing, anti-aging effect, antiseptic properties of plant stimulates the immune system, only a few species of aloe have been considered for commercial importance.

The aloe vera finds its usefulness in different industries, such as food, cosmetics, drug & beverage etc. In food industries aloe vera is used in functional food especially in the preparation of healthy food and drinks. In pharmaceutical industry, it is used in gel preparations and available as capsules and tablets. The aloe is used mostly in cosmetic industries where soaps creams, soaps, ointments, beauty lotions, shampoos, sprays and facial cleaners can be found. It needs to be evaluated in scientific manner to isolates principles from aloe vera in future study using various trial models and medicinal experiments to realize its mechanism of action so that more industrial & medicinal efficacy can be extensively investigated.

REFERENCES

- Ahlawat, K. S., & Khatkar, B. S. (2011). Processing, food applications and safety of aloe vera products: a review. *Journal of food science and technology*, 48(5), 525-533.
- Alexander, F. (1967). U.S. Patent No. 3,360,510. Washington, DC: U.S. Patent and Trademark Office.
- Anjum, S., Gupta, A., Sharma, D., Gautam, D., Bhan, S., Sharma, A., & Gupta, B. (2016). Development of novel wound care systems based on nanosilvernanohydrogels of polymethacrylic acid with Aloe vera and curcumin. *Materials Science and Engineering*: 64, 157-166.
- Antonisamy, J. M. A., Beulah, N., Laju, R., & Anupriya, G. (2016). Anti-bacterial and antigungal activity of Aloe vera gel extract. *International Journal of Biomedical and Advance Research*, 3(3), 184-187.
- Barcroft, A., & Myskja, A. (2003). Aloe vera: nature's silent healer. Alasdair Aloe Vera.
- Bashir, A., Saeed, B., Mujahid, T. Y., & Jehan, N. (2011). Comparative study of antimicrobial activities of Aloe vera extracts and antibiotics against isolates from skin infections. *African Journal of Biotechnology*, 10(19), 3835-3840.
- Blitz, J. J., Smith, J. W., & Gerard, J. R. (2004). Aloe vera gel in peptic ulcer therapy; Preliminary report. *Journal AOA*, 62.
- Bozzi, A., Perrin, C., Austin, S., & Vera, F. A. (2007). Quality and authenticity of commercial aloe vera gel powders. *Food Chemistry*, 103(1), 22-30.
- Danhof, I. E. (2010). Internal uses of Aloe vera. Abstract: Aloe used in.
- Davis, R. H., Parker, W. L., Samson, R. T., & Murdoch, D. P. (1991). Isolation of a stimulatory system in an aloe extract. *Journal of the American Podiatric Medical Association*, 81(9), 473-478.
- Eshun, K., & He, Q. (2004). Aloe vera: a valuable ingredient for the food, pharmaceutical and cosmetic industries-a review. *Critical reviews in food science and nutrition*, 44(2), 91-96.
- Fujita, K., BEPPU, H., KAWAI, K., & SHINPO, K. (2012). Whole leaf Aloe vera-Ancient herb in new form delivers proven effects

- Hamman, J. H. (2008). Composition and applications of Aloe vera leaf gel. *Molecules*, 13(8), 1599-1616
- Hayes, S. M. (1999). Lichen planus--report of successful treatment with aloe vera. *General dentistry*, 47(3), 268-272.
- Hendrawati, T. Y. (2015). Aloe Vera Powder Properties Produced from Aloe Chinensis Baker, Pontianak, Indonesia. In *Journal of Engineering Science and Technology Special Issue on SOMCHE 2014 & RSCE 2014 Conference*, Pp. 47-59.
- Joseph, B., & Raj, S. J. (2010). Pharmacognostic and phytochemical properties of Aloe vera: an overview. *International journal of pharmaceutical sciences review and research*, 4(2), 106-110.
- Karunyadevi, S., Arun, N., & Surekha, V. (2009). Screening of phytochemical compounds, antioxidant and antimicrobial activity of Aloe vera and Arkaa. *Advanced Biotech*, 9(06), 34-39.
- Luta, G., & McAnalley, B. (2005). Aloe vera: chemical composition and methods used to determine its presence in commercial products. *GlycoScience & Nutrition*, 6(1), 1-12.
- Noor, A., Gunasekaran, S., Manickam, A. S., & Vijayalakshmi, M. A. (2008). Antidiabetic activity of Aloe vera and histology of organs in streptozotocin-induced diabetic rats. *Current science*, 92(1), 1070-1076.
- Nutrition Business Journal (2010). *NBJ's Supplement Business Report. An analysis of markets, trends, competition and strategy in the U.S. dietary supplement industry*. New York (NY), USA: Penton Media, Inc.
- Nutrition Business Journal (2012). *NBJ's Supplement Business Report. An analysis of markets, trends, competition and strategy in the U.S. dietary supplement industry*. . New York (NY), USA: Penton Media, Inc. Available from: <http://newhope360.com/2012supplement-business-report>; accessed 5 June 2014.
- Pandey, A., & Singh, S. (2016). Aloe Vera: A Systematic Review of its Industrial and Ethno-Medicinal Efficacy. *International Journal of Pharmaceutical Research & Allied Sciences*, 5(1).

- Prashar, P., Gulati, S., Koul, V., Sehgal, S., & Sehgal, S. (2011). In vitro antimicrobial activity of ethanolic extract of Aloe vera against some bacterial and fungal species. *Adv. Biotech*, 11(3), 32-33.
- Reddy, C. U., Reddy, K. S., & Reddy, J. J. (2011). Aloe vera-A wound healer. *Asian Journal of Oral Health & Allied Sciences*, 1(1), 91-92.
- Reynolds, T., & Dweck, A. C. (1999). Aloe vera leaf gel: a review update. *Journal of ethnopharmacology*, 68(1-3), 3-37.
- Rodriguez-Bigas, M., Cruz, N. I., & Suarez, A. (2014). Comparative evaluation of aloe vera in the management of burn wounds in guinea pigs. *Plastic and reconstructive surgery*, 81(3), 386-389.
- Sahu, P. K., Giri, D. D., Singh, R., Pandey, P., Gupta, S., Shrivastava, A. K., & Pandey, K. D. (2013). Therapeutic and medicinal uses of Aloe vera: a review. *Pharmacology & Pharmacy*, 4(08), 599.
- Saito, M., Tanaka, M., Misawa, E., Yao, R., Nabeshima, K., Yamauchi, K., & Furukawa, F. (2016). Oral administration of Aloe vera gel powder prevents UVB-induced decrease in skin elasticity via suppression of overexpression of MMPs in hairless mice. *Bioscience, biotechnology, and biochemistry*, 80(7), 1416-1424.
- Sharma, R., & Goel, M. (2002, December). Utilization of local plants guarpatha (*Aloe barbadensis*) by women residing in Bikaner city (Rajasthan). In *Proceeding of NSI, XXXIII Annual Meeting*.
- Syed, T. A., Ahmad, S. A., Holt, A. H., Ahmad, S. A., Ahmad, S. H., & Afzal, M. (2009). Management of psoriasis with Aloe vera extract in a hydrophilic cream: a placebo-controlled, double-blind study. *Tropical Medicine & International Health*, 1(4), 505-509.
- Vera, A. (2011). Wound healing, oral & topical activity of Aloe vera. *Journal of the American Podiatric Medical Association*, 79, 559-562.
- West, D. P., & Zhu, Y. F. (2003). Evaluation of aloe vera gel gloves in the treatment of dry skin associated with occupational exposure. *American Journal of Infection Control*, 31(1), 40-42.

- Williams, D. (2000). Whole Leaf Aloe Vera A Natural Solution To Drug-Resistant Bacteria, Viruses & Fungi, *Journal of the American Podiatric Medical Association*, 7(3), 123-156.
- Yagi, A., Kabash, A., Mizuno, K., Moustafa, S. M., Khalifa, T. I., & Tsuji, H. (2003). Radical scavenging glycoprotein inhibiting cyclooxygenase-2 and thromboxane A2 synthase from aloe vera gel. *Planta Medica*, 69(03), 269-271.