



Aloe vera and its application in dairy and food products

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ABSTRACT : Now-a-days peoples are health conscious and are looking forward to have products that carry functional and therapeutic values. *Aloe vera* (*Aloe barbadensis* miller) is such a plant that has as many as 200 different types of molecules of health importance. Due to this, it has been used since ancient time for treating various types of disorders. The *Aloe vera* contains 1.0-1.5 per cent TS out of which, polysaccharides occupy 55 per cent, sugars 17 per cent, minerals 16 per cent, proteins 7 per cent, lipids 4 per cent and phenolic compounds 1 per cent on dry basis. It also contains many vitamins A, C and E. Vitamin B1 (thiamine), niacin, Vitamin B2 (riboflavin), vitamins B12 (cyanocobalamin), choline and folic acid including the important antioxidant. Health benefits of *Aloe vera* include wound healing, halts the cancer tumors, prevents kidney stones, lowers high cholesterol, reduces high blood pressure, stabilizes blood sugar and ends constipation. These days researchers are also concentrating to utilize *Aloe vera* as an ingredient in dairy and food formulations. *Aloe vera* gel or juice are used to incorporate in different dairy products like flavoured milk, ice cream, *Dahi*, yoghurt, *Lassi* and also food products like RTS and edible coatings etc.

KEY WORDS : *Aloe vera*, Dairy products, Food products, Ready to serve (RTS), Therapeutic

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INTRODUCTION

Aloe vera has been used for its medicinal value for several thousand years. Its applications have been recorded in ancient cultures of India, Egypt, Greece, Rome and China. In biblical times the Egyptians hailed *Aloe vera* as the plant of immortality. The Chinese called it their *elixir* (magical potion) of youth (Ahlawat and Khatkar, 2011). The name of *Aloe vera* is originated basically from Arabic and Latin Language. “Alloeh” is

the Arabic word which means “shining bitter substance”, from that *Aloe* word is generated, while “Vera” is derived from the Latin meaning “true” (Basmatker *et al.*, 2011). It belongs to the *Asphodelaceae* family and is related to onions and asparagus. *Aloe vera* leaf contains 95-98 per cent of water, 75 nutrients, 200 active compounds, 20 minerals, 18 amino acids, 12 vitamins and 92 enzymes. It can be used as the source of vitamins like A, B₁, B₂, B₆, B₁₂, C, E, folic acid, niacin etc. Owing to its succulent properties, it is a rich source of nutrients and essential minerals. *Aloe* plant is very much prevalent in hot and dry climates. It is among the oldest known medicinal plants gifted by nature; hence, often called ‘miracle plant’.

The common names of *Aloe vera* includes *Aloe*, *aloe capensis*, *aloe spicata*, *Aloe vera*, Barbados aloe, Cape aloe, chirukattali (India), Curacao aloe, Ghaikunwar (India), Ghikumar (India), Indian aloes, Kumari (Sanskrit), giloya (Hindi), kalabandha (Telugu), lolesara (Kannada), kattarvazha (Malayalam), soththukathalai (Tamil), luhui (Chinese), rokai (Japanese), subr (Arabic), Zanzibar aloe

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(Sharrif, 2010; Bhuvana *et al.*, 2014 and Malik and Zarnigar, 2013). There are over 200 types of *Aloe vera* and of these only 4 or 5 are commonly used in medicines and food applications (Manoharan *et al.*, 2012). The most widely used variety of *Aloe vera* is *Barbadensis millar*. *Aloe vera* a member of lily (Liliaceae) family is a spiky, perennial, succulent plant with stiff fresh leaves (Chandegara and Varshney, 2013). It is being cultivated in many parts of the world and also being used as an ayurvedic medicine or as an ingredient of many ayurvedic medicines in India since long (Sudha *et al.*, 2011). *Aloe vera* gel is a clear thin gelatinous material that comes from inside the *Aloe vera* leaves. According to International Aloe Science Council (IASC), the global market for *Aloe vera* products is estimated to be 13.0 billion dollars during 2012-13 (www.nutraingredients.com) currently; there is an increasing interest in the use of *Aloe vera* juice/gel in the dairy and food processing industries. It is, being used as a source of functional and therapeutic ingredients in foods in drinks, beverages, ice creams and yoghurt etc. (Martynez-Romero *et al.*, 2005).

History :

Aloe vera originated in tropical Africa and it is now cultivated in warm climates areas of Asia, Europe and America (Ahlawat and Khatkar, 2011). Ancient Egyptian papyrus and Mesopotamian clay tablets describe aloe as useful in curing infections, treating skin problems and as a laxative. Cleopatra was said to include aloe cream in her beauty regimen. Alexander the Great captured the island of Socotra in the Indian Ocean to secure its aloe supplies to treat his wounded soldiers. During early 1800's in America, until a turning point occurred by mid-1930s where it became successful for the treatment of variety of chronic and server radiation dermatitis diseases. The commercial production of *Aloe vera* was started in the United States of America in middle of the 20th century. It then became very popular for both internal and external uses (Sharrif, 2010).

Physico-chemical properties of *Aloe vera* :

The physico-chemical properties of *Aloe vera* juice/gel is presented in the Table 1 and the chemical composition in percentage in Table 2 (Chandegara and Varshney, 2013).

Table 1 : Physical properties of *Aloe vera* juice/gel

Properties	Values
Appearance	Colourless/or very light yellow or green tinge
Refractive index	1.3340-1.3355
Specific gravity	1.0030-1.0070
pH value	3.5-4.7
Total solids (NLT) % by weight	0.46

Table 2 : Chemical composition of *Aloe vera* juice/gel

Component	Percentage
Water	99.45%
Fat	0.09%
Protein	0.11%
Crude fibre	0.10%
Ash	0.25%

Therapeutic properties of *Aloe vera* :

The following are the wide range of therapeutic properties of *Aloe vera*.

- Lowers high cholesterol.
- Repairs “sludge blood” and reverses “sticky blood”.
- Boosts the oxygenation of your blood.
- Eases inflammation and soothes arthritis pain.
- Protects the body from oxidative stress.
- Prevents kidney stones and protects the body from oxalates in coffee and tea.
- Alkalizes the body, helping to balance overly acidic dietary habits.
- Cures ulcers, IBS, Crohn’s disease and other digestive disorders.
- Reduces high blood pressure natural, by treating the cause, not just the symptoms.
- Nourishes the body with minerals, vitamins, enzymes and glyconutrients.
- Halts colon cancer, heals the intestines and lubricates the digestive tract.
- Ends constipation.
- Stabilizes blood sugar and reduces triglycerides in diabetics.
- Prevents and treats candida infections.
- Protects the kidneys from disease.
- Functions as nature’s own “sports drink” for electrolyte balance, making common sports drinks.
- Boosts cardio-vascular performance and physical endurance.
- Speeds recovery from injury or physical exertion.
- Hydrates the skin, accelerates skin repair.

Therapeutic mechanism of Aloe vera :**Anti-diabetic effects :**

Several pre-clinical (in animals) and clinical (in humans) trials showed a blood glucose lowering effect for *Aloe vera* gel preparations in different forms (e.g. juice or as constituents in bread etc.). In a study on streptozotocin-induced diabetic rats, oral administration of *Aloe vera* gel (alcohol insoluble residue extract) significantly reduced the fasting blood glucose, addition also significantly increased plasma insulin levels (Josias, 2008). The five phytosterols of *Aloe vera*, lophenol, 24-methyl lophenol, 24-ethyl-lophenol, cycloartanol and 24-methylene cycloartanol showed anti-diabetic effects in type-2 diabetic mice. *Aloe vera* contains polysaccharides which increase the insulin level and show hypoglycemic properties (Pankaj *et al.*, 2013).

Wound healing :

The wound healing property of *Aloe vera* gel has been attributed to Mannose-6-phosphate. Actually, glucomannan and plant growth hormone gibberellins interact with growth factor receptors and stimulate its activity and proliferation for increases collagen synthesis. Increased collagen cross linking for wound contraction and improving breaking strength. Acemannan is considered the main functional component of *Aloe vera*, is composed of a long chain of acetylated mannose. This complex carbohydrate accelerates wound healing and reduces radiation induced skin reactions. Direct binding of acemannan to growth factors and their stabilization may lead to promotion of prolong stimulation of granulation tissue (Pankaj *et al.*, 2013).

High blood pressure :

Homocysteine – High levels of homocysteine in the blood causes sticky blood or blood clots, which cannot pass through arteries. Homocysteine levels can be reduced by supplementation of Vitamin B12. *Aloe vera* will decrease the levels of homocysteine, thus, reduce the stickiness or clotting of blood cells. This intern helps blood to deliver life giving oxygen to the cells in the better way.

Antimicrobial activities :

Activity of *Aloe vera* inner gel was against both Gram-positive and Gram-negative bacteria (Habeeb *et al.*, 2007). Anthraquinones isolated from the exudates of

Aloe vera have shown wide antimicrobial activity. The antibacterial activity of emodin against *Escherichia coli* was proposed to be mediated through inhibition of solute transport in membranes. Many Anthraquinones have shown antiviral and/or virucidal effects on enveloped viruses (Alves *et al.*, 2004). The aloe extract was potent against three strains of *Mycobacterium* (*M. fortuitum*, *M. smegmatis* and *M. kansasii*) and a strong anti-mycobacterial activity against *Mycobacterium tuberculosis* as well as antibacterial activity against *Pseudomonas aeruginosa*, *Escherichia coli*, *Streptococcus pyogenes*, *Streptococcus faecalis*, *Staphylococcus aureus* and *Staphylococcus typhi* (Pankaj *et al.*, 2013).

Effect on HIV :

In a case series of 14 HIV+ve patients who were prescribed 800 mg/day of acemannan, there was a significant increase in the number of circulating monocyte and macrophages which mirrored clinical improvements. A pilot study in HIV-infected person's acemannan increased the number of white blood cells and improved symptoms (Sharrif, 2010).

Anti-oxidant activity :

Different fractions of *Aloe vera* as well as unfractionated whole gel have anti-oxidant effects. Glutathione peroxidase activity, superoxide dismutase enzymes and a phenolic anti-oxidant were found to be present in *Aloe vera* gel, which may be responsible for these anti-oxidant effects due to scavenging of both superoxide and peroxy radicals (Langmead *et al.*, 2004). A 3 years old plant extract exhibits the strongest free radical scavenging activity of 72.19 per cent, which is significantly higher than that of BHT (butylated hydroxy toluene) having 70.52 per cent and α -tocopherol with 65.65 per cent (Hu *et al.*, 2003).

Antitumor activity :

A number of glycoprotein's present in *Aloe vera* gel have been reported to have antitumor and antiulcer effects and to increase proliferation of normal human dermal cells. In recent studies, a polysaccharide fraction has shown to inhibit the binding of benzopyrene to primary rat hepatocytes, thereby preventing the formation of potentially cancer-initiating benzopyrene-DNA. An induction of glutathione S-transferase and an inhibition

of the tumor-promoting effects of phorbolmyristic acetate has also been reported which suggest a possible benefit of using aloe gel in cancer chemoprevention (Pankaj *et al.*, 2013).

Anti-inflammatory action :

The anti-inflammatory activity of *Aloe vera* gel has been revealed by a number of *in vitro* and *in vivo* studies through bradykinase activity. The peptidase bradykinase was isolated from aloe and shown to break down the bradykinin, an inflammatory substance that induces pain. The *Aloe* sterols are anti-inflammatory in nature, helps in reducing the inflammation pain and act as a natural analgesic. Other aspirin-like compound present in *Aloe* is responsible for anti-inflammatory and antimicrobial properties (Pankaj *et al.*, 2013).

Arthritis :

Aloe vera should be taken both orally and topically in such cases as rheumatoid and osteoarthritis; which will benefit from the anti-inflammatory properties of *Aloe vera* – Topically *Aloe vera* can be applied directly to the affected joints to reduce pain. In osteoarthritis *Aloe vera* stimulates collagen formation – Collagen makes up cartilage will help to repair the joints where the cartilage has worn away.

Laxative effects :

Anthraquinones present in latex are a potent laxative; it's stimulating mucus secretion, increase intestinal water content and intestinal peristalsis. After oral administration aloin A and B, which are not absorbed in the upper intestine, are hydrolysed in the colon by intestinal bacteria and then reduced to the active metabolites (the main active metabolite is aloe-emodin- 9-anthrone), which like senna acts as a stimulant and irritant to the gastrointestinal tract. Aloe latex is known for its laxative properties (Pankaj *et al.*, 2013).

Antiseptic :

The antiseptic property of *Aloe vera* is due to presence of six antiseptic agents namely lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulphur. These compounds have inhibitory action on fungi, bacteria and viruses. Though most of these uses are interesting controlled trials are essential to determine its effectiveness in all diseases (Pankaj *et al.*, 2013).

Gastro protective properties :

Aloe vera juice protects the mucus membrane of the stomach especially when irritated or damaged. *Aloe vera* juice is considered helpful for relieving many types of gastrointestinal irritation. It has been claimed that *Aloe vera* gel has the ability to cure gastric ulcers or protect against its formation in both animals and humans. The antiulcer activity of *Aloe vera* has been attributed to several possible mechanisms including its anti-inflammatory properties, healing effects, mucus stimulatory effects and regulation of gastric secretion. It was suggested that the *Aloe vera* extract possess cytoprotection activity at this low concentration, therefore, protection against mucosal injury by means of a mechanism different from gastric acid inhibition and neutralization (Priya, 2014).

Stress relieving :

Aloe vera is an excellent example of a functional food that plays a significant role in protection from oxidative stress It reduces cell-damaging process during stress condition and minimizes biochemical and physiological changes in the body. Some antioxidants are part of the body's natural regulating machinery while other dietary antioxidants are derived from diet sources. (Pankaj *et al.*, 2013).

Coronary heart disease :

The studies suggest that the ingestion of *Aloe vera* gel may have a beneficial effect to the accumulation of blood fat lipids associated with the disease. Test groups given *Aloe vera* showed a decrease in total cholesterol, triglyceride, phospholipid and non-esterified fatty acid levels (Kumar *et al.*, 2010).

***Aloe vera* applications in dairy products :**

The tremendous health benefits of *Aloe vera* have increased its application in food industries. Pugazhenti and Jothylingam (2013) prepared low calorie herbal flavoured milk for analysis of physico-chemical properties by incorporating *Aloe vera* pulp extract at different concentrations (3%, 5% and 7%) and artificial sweeteners like aspartame and sucralose at different levels of sugar replacement and stored at 5°C/ 5 days. They reported based on the sensory evaluation, dietetic herbal flavoured milk 5 per cent *Aloe vera* pulp extract, upto 75 per cent replacement of aspartame and 100 per cent replacement

of sucralose were found to be the best. The physico-chemical properties of dietetic herbal flavoured milk 5 per cent *Aloe vera* pulp extract, upto 75 per cent replacement of aspartame is pH was 6.73, titrable acidity was 0.15, specific gravity was 1.048, viscosity was 260.83 Centipoise. Dietetic herbal flavoured milk 5 per cent *Aloe vera* pulp extract, upto 100 per cent replacement of sucralose pH was 6.74, titrable acidity was 0.15, specific gravity was 1.042 and viscosity was 254.66 Centipoise. Manoharan *et al.* (2012) made herbal ice cream with different inclusion levels of *Aloe vera* pulp for organoleptic evaluation. They finally concluded The inclusion of *Aloe vera* pulp at 20 per cent level had maximum score of 92.89. Manoharan and Ramasamy (2013) prepared ice cream with different levels of *Aloe vera* pulp, natural colouring with beetroot, natural strawberry flavour and different artificial sweeteners *i.e.* sucralose, levulose, aspartame for sensory analysis. They concluded ice cream made with 20 per cent *Aloe vera* pulp, 4 per cent beetroot juice and 50 per cent sucralose was scored 95.15 per cent followed by the aspartame and levulose, respectively.

Tajendra *et al.* (2011) developed *Lassi* containing *Aloe vera* juice and studied its quality characteristics. Mixed culture of lactic acid bacteria @2% was used to prepare *Lassi* from standardized cow milk containing 3 per cent (medium) and 0.5 per cent (low) fat and different levels of *Aloe vera* juice. They concluded that medium and low fat *Lassi* gave desired results with 15 per cent *Aloe vera* juice. Parmjit and Shinde (2012) made *Aloe vera* fortified probiotic yoghurt and studied the effect of storage on syneresis, pH, *Lactobacillus acidophilus* count, *Bifidobacterium bifidum* count. *Aloe vera* fortified probiotic yoghurt showed that syneresis was increased from 4.7 to 8.3 per cent (v/w), pH decreased from 4.03 to 3.91, *Lactobacillus acidophilus* count decreased from 39.7×10^9 cfu/ml to 32.1×10^9 cfu/ml and *Bifidobacterium bifidum* count decreased from 16.9×10^9 cfu/ml to 7.3×10^9 cfu/ml and had shown sharp decrease after 21 day and shown good viability for 21 days. The study was conducted on anti-diabetic activity of *Aloe vera* fortified *Dhai* and concluded that *Aloe vera* gel (0.15%) supplementation in the form of curd gave satisfactory results. It further indicates the potential of using *Aloe vera* gel as a hypo glycaemic ingredient in dairy product (Pushkala and Nagarajan, 2014).

***Aloe vera* applications in food products :**

Boghani *et al.* (2012) conducted experiment to study the feasibility of blending papaya and *Aloe vera* juice in different ratios (0, 95:5, 90:10, 85:15, 80:20) for preparation of Ready-To-Serve (RTS) beverage and assess their storage life at ambient temperature. Among different blended ratio for RTS beverage sample with 5 per cent and 10 per cent of *Aloe vera* juice reached the highest hedonic scores (8.1 and 8.2). The storage studies revealed that blended papaya *Aloe vera* gel could be successfully stored for the period of 3 months without significant changes in chemical and organoleptic qualities. Sasi *et al.* (2013) prepared a therapeutic RTS made from blending of different proportions of *Aloe vera*, *Aonla* and ginger (50:25:25, 60:20:20, 70:15:15, 80:10:10). They concluded that sensory quality profile upto the 70:15:15 are acceptable (8.4) and it could be stored successfully for the period of 4 months without significant changes in chemical and sensory qualities. Yadav *et al.* (2013) prepared *Aloe vera* pulp into a RTS beverage supplemented with mint and ginger in the ratio of 80:10:10 and RTS was prepared using variable proportions of juice per cent and sugar in the beverage formulation 10 per cent, 12 per cent, 14 per cent, 16 per cent, respectively. They reported that 14 per cent juice content and 14 per cent TSS had better sensory characteristics (8.40) and also better shelf-life. The developed RTS can be preserved at refrigeration temperature without adding chemical preservatives desirable consumer acceptability for upto 60 days. Trivedi *et al.* (2012 and 2015) produce a functional fermented *Aloe vera* based herbal wine. The *Aloe vera* gel supplemented with cane sugar, $(\text{NH}_4)_2\text{SO}_4$, MgSO_4 and KH_2PO_4 . They concluded the wine was found to be similar to any other wine in terms of its composition and sensory qualities. The wine exhibited bactericidal activity against common food borne pathogens (*Staphylococcus typhimurium*, *Staphylococcus aureus*, *Escherichia coli*). Interestingly, the wine was not inhibitory to the selected probiotic strains and no significant difference in the viable count of lactobacilli was found.

***Aloe vera* applications in edible coatings for extension of shelf-life :**

The use of *Aloe vera* as edible coating has shown to increase the shelf-life of various perishable fruits. Martynez *et al.* (2005) reported a novel edible coating

based on *Aloe vera* gel has been used as a post-harvest treatment to maintain sweet cherry quality and safety during cold storage. During storage, uncoated fruit showed increased losses than *Aloe vera* gel coated sweet cherries at storage at 1°C for 16 days+1 day at 20°C *i.e.* Respiration rate is 2004±112 mmol/kg h and 1024±23 mmol/kg h, Weight loss is 6.20±0.15 per cent and 3.82±0.29 per cent, colour changes is 16.94±0.12 and 13.83±0.13, firmness is 1.02±0.03 N/mm and 1.38±0.05 N/mm and TSS/TA ratio is 24.15±1.68 and 20.75±1.22, total mesophilic aerobic is 4.7 log cfu/g and 2.0 log cfu/g, Yeast and mould is 3.1 log cfu/g and 1.2 log cfu/g. Arowora *et al.* (2013) studied effects of *Aloe vera* coatings on quality characteristics of oranges stored under cold storage. During storage, uncoated fruit showed increased losses than *Aloe vera* gel coated oranges *i.e.* the firmness was 1531.25 ± 185.53 N and 1781.25 ± 118.30 N. The pH was gradually increasing during the course of storage in the two treatments, whereas vitamin C was found to be decreasing in storage, TSS was 9.34 ± 0.06 per cent and 9.79 ± 1.14 per cent, weight loss was 53.30 ± 1.17 per cent and 29.20 ± 0.55 per cent, sugar/acid ratio was 8.90 ± 0.87 per cent and 7.43 ± 0.34 per cent. The *Aloe vera* based edible coating was used for extension of tomato shelf-life. During storage, uncoated tomatoes showed increased losses than *Aloe vera* gel coated tomatoes. The firmness of control fruit on the 20th day was 31.65 N, whereas for the coated fruit on the same day it was 46.79 N (Athmaselvi *et al.*, 2012).

Conclusion :

As an essential part of the herbal medicine, *Aloe vera* has enjoyed a very prominent position in the medicinal practice. Since *Aloe vera* has many therapeutic properties, it is very well suited for incorporation in the formulation of health based dairy and food products including drinks and beverages. Varieties of *Aloe vera* incorporated foods/ dairy products have large market throughout the world. Research attempts are still required to validate the integrity of therapeutic properties of *Aloe vera* components incorporated during processing of dairy and food product processing.

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