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Aloe vera: Functional and processing value in food

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Abstract

Aloe vera (*Aloe barbadensis* Miller) a member of a family liacea. Which comprise a more than 360 different species found in arid region of Africa, Asia, Europe and America. The family was named as aloe vera only two species viz *A. barbadensis* Miller and *A. abrenses* are considered the most important one from the processing point of view. Presently the use of *Aloe vera* gained popularity because of natural treatment and alternative therapy for various types of disease. And several studies have subjected the heling, cosmetic, and nutritional benefit of this vegetable. *Aloe vera* extract possess many biological activities such as anti-inflammation, anti-cancer, antioxidant, anti-diabetes and macrophage activity. Because of its high nutritive value aloe vera is used in processing of variety of food products like aloe vera juice, candy, concentrated powder and powder.

Keywords: aloe vera, biological activities, bioactive compounds, processed products

Introduction

Aloe vera is known as *Aloe barbadensis* by taxonomists. The taxonomic genus name “aloe” comes from the Arabic term “alloeh” that means a bright and bitter substance and vera means a true or belongs to plant covered with the sharp edges. Most literature and reference books coated *Aloe barbadensis* Mill as correct species name, and *Aloe vera* (L.) Burm f. as a synonym. However, International Rules of Botanical Nomenclature said *Aloe vera* (L.) Burm f. is the rightful name for this species (Tucker *et al.*, 1989) [79].

Aloe vera is a perennial succulent plant that belongs to the Liliaceae family. This plant grows best in large variety of climate including tropical climate and low-rainfall areas (Manvitha & Bidya, 2014; Sahu *et al.*, 2013) [41, 68]. This plant grows up to 60-100 cm. *Aloe vera* is composed of three different layers. The plant cannot withstand freezing temperatures. Each plant has normally 12 to 16 leaves weighing up to 1.5 kg when mature and with saw-like teeth along their margins (Ahlawat & Khatkar, 2011) [1].

Bioactive compounds of *Aloe vera*

In 2000, Lawless and Allen [36] studied the dry matter content of aloe gel it consists of polysaccharides (55%), sugars (17%), minerals (16%), proteins (7%), lipids (4%) and phenolic compounds (1%). In 2011, Ahlawat and Khatkar [1] reviewed the literature related the phytochemical compound of *Aloe vera* which contain ten main chemical constituents include: amino acids, lignins, monosaccharide, polysaccharides, anthraquinones, enzymes, minerals, vitamins, salicylic acid, saponins, and sterols. He also stated that there are more than 200 bioactive compounds. The *Aloe vera* gel contains many vitamins including the important antioxidant vitamins A, C and E. Vitamin B1 (thiamine), niacin, Vitamin B2 (riboflavin), choline and folic acid are also present. Atherton, 1998 suggest that *Aole vera* also contain cyanocobalamin in trace amounts which is normally available in animal source. *Aloe vera* is rich in antioxidant like vitamin A, C and E, total phenols, flavonoids, and minerals like zinc and selanium). This antioxidant property boost up immune system and neutralize free radicles (Jasso de Rodríguez *et al.*, 2005 and Ozsoy *et al.*, 2009) [28, 56].

The important carbohydrate present in *Aloe vera* is Pure mannan, acetylated mannan, acetylated glucomannan, glucan galactomannan, galactan, galacto galacturan, arabinogalactan, galacto gluco arabino mannan, pectic substance, xylan, cellulose (Ni and Tizard, 2004) [54]. These compound help in accelerating wound healing, modulate immune system, antineoplastic and antiviral effect. *Aloe vera* an essential polysaccharide hold secrete too medicinal value. Fine and Brown, 1938 [23] and Crew, 1939 [13] have attributed to pain relieving property of *Aloe vera*. Some research suggest reported that wound healing capacity of *Aloe* is due to tannic acid. And other polysaccharide. Acemannan, is a polysaccharide in combination with interferon,

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stimulates tumor necrosis factor (Karaca *et al.*, 1995) [33]. Acemannan promotes oral wound healing and hard tissue regeneration (Chantarawarathit *et al.*, 2014) [9]. *Aloe vera* contain plenty of essential and non-essential amino acid are Alanine, arginine, aspartic acid, glutamic acid, lysine, histidine, hydroxyl proline, isoleucine, leucine, lysine, methionine, phenylalanine, proline, threonine, tyrosine, valine (Jyotsana *et al.*, 2008) [30]. These amino acid help to building blocks for repair and regeneration of traumatized tissue (Choi and Chung, 2003) [11].

Lipids act as a principle structural components of living cells. The lipid present in aloe are arachidonic acid, γ -linolenic acid. Campesterol, cholesterol, β -sitosterol and lupenol are the steroids present in *Aloe vera* which has a health benefits like Anti-inflammatory agents, antiseptic and analgesic properties and triglycerides (Ni and Tizard, 2004) [54]. Nandal and Bhardwaj, 2012 [50], has review the literature regarding the lipid content of *Aloe vera*. She said like lipid agents are the source for effectiveness of aloe in treating all kinds of external and internal inflammations including cuts, burns, scrapes, acid indigestion, kidney, colon and pancreas, ulcers and other inflammations of the liver, among others. Additionally, β -sitosterol is a plant sterol has a powerful agent in helping to lower bad cholesterol levels.

Minerals are in organic substance which improve overall health of our bodies and are interactive with the vitamins, co-enzymes and proteolytic enzymes. Calcium, chlorine, chromium, copper, iron, magnesium, manganese, potassium, phosphorous, sodium and zinc these are the essential minerals present in the significant amount. These minerals improve overall health like, Copper help to improve red blood cell, skin and hair pigment, iron involved in oxygen transportation and making of haemoglobin in red blood cells, potassium has a capacity to maintain the fluid balance, phosphorus strengthen the bones and teeth, and also assists in metabolism and maintains body pH and sodium regulates body liquids, helps in nerve and muscle performance, and helps in delivering nutrients to body cells (Zhang and Tizard, 1996) [89]. *Aloe vera* also contains the trace minerals rhodium and iridium used in cancer and tumor research experiments (Zhang and Tizard, 1996) [89].

The *Aloe vera* also contain important enzymes like Alkaline phosphatase, amylase, carboxypeptidase, catalase, cyclooxygenase, cyclooxygenase, lipase, oxidase, Bradykinase, phosphoenol, pyruvate carboxylase and superoxide dismutase which help to improve overall health (Choi and Chung, 2003) [11]. This enzyme has antifungal & antiviral activity but toxic at high concentrations (Jasso de Rodríguez *et al.*, 2005) [28]. Superoxide dismutase significantly reduced the lipid peroxidation products and they concluded that augmented blood sugar leads to amplified oxidative stress (Sultana *et al.*, 2009) [75]. Bradykinase helps to reduce excessive inflammation when applied to the skin topically, while others help in the breakdown of sugars and fats (Surjushe *et al.*, 2008) [76]. He also reported that aloe contain 12 anthraquinones, which phenolic compounds are traditionally known as laxatives. Aloin and emodin act as analgesics, antibacterials and antivirals. *Aloe vera* leaf extract contain anthraquinones, particularly barbalin and isobarbaloin which appear to be responsible for its bitter taste (Boudreau and Beland, 2006) [6].

The ecological relationship of soil with plant, and land cultivation practices, species, processing, age of plant can influence the nutrition variation of plant (Henry, 1979, Ramachandra & Srinivasa, 2008) [24, 60]. In 1999 Femenia *et*

al. [22], made a complete study on different parts of *Aloe vera* plant like, rind, fillet and gel. This *Aloe vera* gel has 99% water content with low calorific value. In fact, one serving of 200 mL it contributes with less of 5 kcal (Rodríguez *et al.*, 2010) [64]. Table 1 summarize the nutrient component of each part of *Aloe vera* plant.

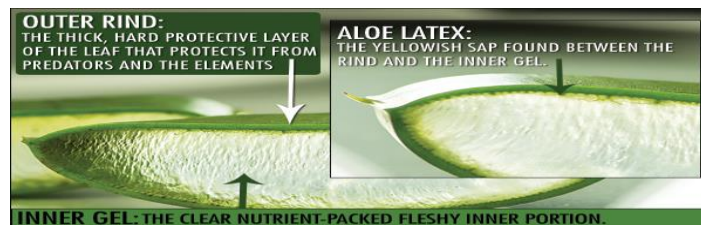
Table 1: Nutrient composition of *Aloe vera*.

Nutrients	Parts of plant			Reference
	Rind	Fillet	Gel	
Water	90%	98%	99%	Femenia <i>et al.</i> , 1999 [22]
Polysaccharide			55%*	Luta and McAralley, 2005 [40]
Dietary fibre	62.3%*	57.6%*	35.5%*	Femenia <i>et al.</i> , 1999 [22]
Ash	13.5%*	15.4%*	23.6%*	Femenia <i>et al.</i> , 1999 [22]
Vitamins			C(127.6mg/100g) E(0.25mg/100g) A,C,E,B1, B3,B2, B12, B9	Miranda <i>et al.</i> , 2009 [45] Ahlawat and Khatkar, 2011 [1]
Soluble sugar	11.2%*	16.5%*	26.8%*	Femenia <i>et al.</i> , 1999 [22]
Total lipid	2.7%*	4.21%*	5.13%*	Femenia <i>et al.</i> , 1999 [22]
C12:0			0.32ppm*	Nejatzadeh-Barandozi, 2013 [51]
C14:0			0.74ppm*	
C16:1			1.32ppm*	
C18:2 n-6			102ppm*	
Protein	6.33%*	7.26%*	8.92%*	Femenia <i>et al.</i> , 1999 [22]
Sterol				
Sitosterol			2.89%	Bawankar <i>et al.</i> , 2013 [4]
Stigmaesterol			2.1%	Femenia <i>et al.</i> , 1999 [22]

*Dry matter content.

Layers of *Aloe vera* leaf.

An inner clear gel contain 99% water and glucomannans, amino acids, lipids, sterols and vitamins. The middle layer called latex, bitter yellow sap having anthraquinones and glycosides. The outer thick layer also called rind which has Protective function and synthesizes Carbohydrates and Proteins (Surjushe, 2008, Eshun and He 2004) [76, 20].



***Aloe vera* has several health benefits like:** Till now many curative evidence are attributed to *Aloe vera*, including Antidiabetics, Aids digestions and enhance the absorption of nutrients Dental and oral hygiene, Anti-carcinogenic, Reduce eye irritation, Building blocks for repair and regeneration of traumatized tissue, Accelerate wound healing, Modulate immune system, Antiviral and Antibacterial effects, Anti-allergic, Anti-inflammatory, Inhibitor of cholesterol synthesis, Antioxidant, Laxative and Pain killer. Some of active compounds which have health benefits are brief in Table 2. (Chantarawarathi *et al.*, 2014 and Bansal *et al.*, 2015) [3]. A

brief review on bioactive compounds of *Aloe vera* coated by Sanchez-machado, 2017^[67].

Table 2: Active compounds of *Aloe vera* (Chantarawarathi *et al.*, 2014, Bansal *et al.*, 2015 and Sanchez-machado, 2017)^[3, 67]

Active compounds	Health benefits
Acemannan	Accelerate wound healing, modulate immune system, Antineoplastic and antiviral effects
Alprogen	Anti-allergic
C-glycosyl chromone	Anti-inflammatory
Bradykinase	Anti-inflammatory
Magnesium lactate	Anti-allergic
Salicylic acid,	anti-inflammatory and Analgesic
Vitamin E and C	inhibitor of cholesterol synthesis and antioxidant
Anthroquinones	pain killer, antibacterial and antiviral agents
Lignin	the capacity to penetrate tissue and carry elements
Saponins	Antiseptic
Lectin	Anti-tumour.
Polysaccerides	Anti-diabetics
Minerals	Overall health of the body and interactive with the vitamins, co-enzymes and proteolytic enzyme.
Vitamins	Maintain health and function as catalysing agent
Amino acids	Building blocks for repair and regeneration of traumatized tissue.
Glycoprotein	Anti-allergic
Steroids (Cholesterol, campesterol, sistosterol)	Anti-inflammatory agents.
Steroids (lupenol)	Antiseptic and analgesic properties
Enzymes	Aids digestion and enhance the nutrition absorption.

***Aloe vera* affect on particular disease**

Nandal and Bhardwaj in 2012^[50] reviewed the research work on health benefits of *Aloe vera*.

***Aloe vera* improves digestive system**

The deposits of un-wanted substances and toxins in our diet keeps on accumulating in intestine and prevent the absorption of essential nutrients. This leads causing nutritional deficiency, lethargy, diarrhea, indigestion, irritable bowel syndrome constipation, and low back ache. Consumption of *Aloe vera* helps to flush out these residues boosting the digestion and gives a greater feeling of good health (Newall *et al.*, 1996)^[52]. In 2014 Kang *et al.*^[32], studied the probiotic originating from *Aloe vera* leaf, particularly lactobacillus brevis has been extracted from naturally fermented aloe gel and have demonstrate to inhibit the growth of harmful enteropathogens without restricting the normal growth of intestinal gut. Suboj *et al.*, 2012^[74] research suggest that isolated aloe-emodin inhibit the colon cancer cell migration by reducing DNA binding activity of nuclear factor K-light-chain-enhancer of activated B cell. Some research showed that Anthraquinones are degraded to metabolites like, aloe-emodin-9-anthrone and aloe-emodin in intestine and that are responsible for its laxative properties; but other therapeutic effects are not still correlated well with a specific components (Radha & Laxmipriya, 2015)^[59].

***Aloe vera* in wound healing**

Natural healer is the best name of *Aloe vera*. Aloe gel has an excellent for healing first degree burns, relieves inflammation

and accelerates healing (Hashemi *et al.*, 2015)^[27]. Wound healing hormones is present in *Aloe vera* which stimulate the cell division. *Aloe vera* gel has anti- bacterial, antifungal, anti-viral and antiseptic properties and helps to heal minor wounds. It reduces painful effects of shingles (caused by Human herpes virus 3), reduces symptoms of psoriasis (grey or silver patches on skin) and eases heartburns and ulcers. This prevents wound desiccation and increases migration of epithelial cells (Mortan, 1961)^[48]. Glycoprotein and lectin are the cell proliferation active compound. *Aloe vera* penetrate in to the skin tissue and act as an wound healing process and increases the activity of biological factor involve in repair process (Tarameshloo *et al.*, 2012)^[78] one of the research showed that acemannan is the major polysaccharide, has been exclusively investigated and proven to stimulate wound healing and hard tissue regeneration by inducing cell proliferation and stimulating vascular endothelial growth factor (chantarawarathi *et al.*, 2014)^[9]. Xing *et al.*, in 2015^[88] reported that, acemannan also stimulate fibroblast present in wound granulation tissue and secretion of collagen.

***Aloe vera* protector of human immune system**

Aloe vera contain trace minerals like rhodium and iridiumin the acemannan which is one of the polysaccharides which dramatically increases the white blood cells or macrophages and T cells. *Aloe vera* extracts when consumed (150 mg/kg) respectively for 5 days, there was a significant increase in the total white blood cell count and macrophages with the engulfed SRBC with increase in concentration. This shows the immunomodulatory property of the extract. In 1992, Pittman says that acemannan has been shown in laboratory study to act as a bridge between foreign protein (virus) and macrophage facilitating phagocytosis (Rabe and Staden, 1997)^[61].

Reynolds and Dweck in 1999^[62] reported that polysaccharides of the aloe gel have a varied immunomodulatory activity. Olantuya *et al.*, 2012^[55] studies shown aloe to increase CD4 count, resulting in an improvement of the immune system.

***Aloe vera* in arthritis**

When *Aloe vera* applied directly to the area of pain, some compounds of *Aloe vera* penetrates in to the skin to soothe the pain. It is a powerful anti-inflammatory agent, analgesic, is able to speed up cell growth, thus it repairs arthritis damaged tissue. Studies have also found that ingestion of *Aloe vera* on a daily basis can help prevent and cause a regression of adjuvant arthritis (Rolf and Zimmerli, 2011 and Davis *et al.*, 1989)^[65, 14]

***Aloe* in cancer**

Aloe vera contain active compounds like anthraquinones, saccharides, vitamin E and C, zinc, enzymes, acemannan, acetyl salicylic radiation protectors and inhibits testicular damage from gamma radiation and reduces cancer. *Aloe vera* leaf contains. Bioactive Compounds origin from *Aloe vera* have been used as an immune stimulant that supportin fighting cancers in cats and dogs (Ferro, 2003)^[21]. *Aloe vera* emodin, an anthraquinone, has the capacity to suppress or inhibit the growth of malignant cancer cells making it to have antineoplastic properties (Urch, 1999)^[81]. Aloe-emodin, found to possess antiproliferation effect on some type of cancer cells, inhibiting N-acetyl transferase activity and gene expression. This activity plays crucial role in aryl amine

carcinogens metabolism, found in human malignant melanoma cells (Lin *et al.*, 2005).

Aloe vera in diabetes

One of the leading cause of death in worldwide is Type II diabetes. And the diabetics individuals have decreased antioxidant defence capability with lower levels of specific antioxidants such as vitamin C and E or reduced activities of antioxidant enzymes (Poul, 2003). *Aloe vera* polysaccharides improve the property of immune cells and are also very effective to eliminate waste and other toxins. *Aloe vera* enhance the action of the drugs or herbal preparations used with insulin for a diabetic (Atherton P, 1997)^[2]. Tanaka *et al.* (2006)^[77] studied five phyosterols of *Aloe vera* which have the property to fight against diabetes.

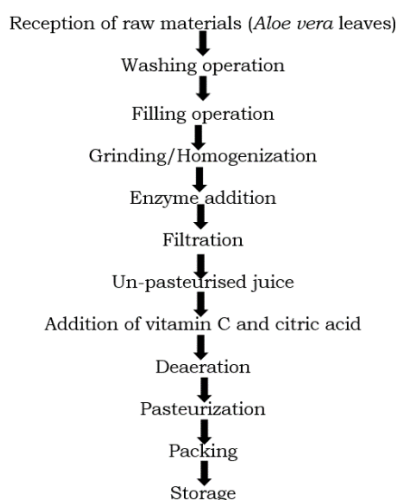
Antimicrobial activity of Aloe vera

Number of research have explicated the contend activity of *Aloe vera* against fungi, virus and bacteria (Sebastian *et al.*, 2010)^[69]. Wang, H 1998^[85] reported that the growth of *Helicobacter pylori* is hindered by the *Aloe vera* in a dose-dependent manner. Thesterol extract of *Aloe vera* showed higher activity against yeast like *Streptomyces. greuseus* and *Candida albicans* as compared toother bacteria and fungi (Bawankar *et al.*, 2013)^[4]. Aloin andaloe-emodin are the two constituent of *Aloe vera* were identified as active principles by their activity against *Colletotrichum gloeosporides* and *Cladosporium cucumerinum*. Sebastian *et al.*, 2010^[69] study showed *A. barbadensis* extracts inhibited viral growth in human cell lines. The MS2 plaque reduction assay was used to detect antiviral activity. The Anti-viral activity and inhibitory mechanism against influenza A virus have been reported because of presence of active compound like anthraquinones (Li *et al.*, 2014)^[38].

Processing of Aloe vera.

Since aloe is abundant source of all healthy compounds, in Food industry it has been used as the source of functional food. The amount of *Aloe vera* application increasing day by day in Food, pharmaceutical industry, and cosmetic industry. Some of the steps of aloe processing involves heating, dehydration and grinding. Because of faulty processing some of the important active compounds may get alter which affect their original structure. So here processing methods are discussed below (Ramachandra and Srinivasa Rao, 2008)^[60]

Flow chart for Aloe vera juice processing (Ramachandra and P. Srinivasa Rao, 2008)^[60]



Reception of raw material

The sound, mature, undamaged, and disease free should be harvested and precool it as soon as possible. The maturity and locality of aloe cultivation influence the keeping quality and flavour of aloe juice. This help to keep all active ingredients in full concentration (Lawless and Allen 2000)^[36]. Because of enzymatic reaction and the presence of bacterial on the surface may deteriorate the gel matrix which significantly effect on end product. Hence pre cooling is very necessary to make a quality end product.

Filleting operation: Because of high enzymatic activity and microbial activity the chances of getting worst of quality ingredients are more. Hence, it is advised to complete the filtering operation within 36 h of harvesting of leaves. The losses of biological activity (Robert 1997)^[63]. The compounds like anthraquinones is an important factor leading to non-enzymatic browning in *Aloe vera* products (He *et al.* 2002)^[25].

Grinding/homogenization/ enzymatic treatment: This is the major step in processing of *Aloe vera* juice. High speed grinder is used for commercial grinding and this operation must be complete within 20 min to avoid the enzymatic browning. Proteolytic enzymatic treatment of *Aloe vera* gel for a long time before processing may cause damage to polysaccharides (Yagi *et al.*, 1982)^[87]. Maughan in 1984^[43] reported that enzymatic treatment at 50 °C for 20 min did not cause a loss in biological active compounds like polysaccharides.

Filtration and fortification: This is the important step in removal of sedimentation and fibrous compounds. Aloe juice contain varies amount of suspended amount matter consisting of broken aloe tissue, skin, gums and varies other substance. This step help in stability of the juice and help to retain cloudy and pulpy appetence to some extent. This unpasteurized *Aloe vera* juice was fortified with citric acid and vitamin C (natural antioxidant) to avoid browning reaction and to improve flavour of the juice (Kennedy *et al.*, 1992; Kacem, *et al.*, 1987)^[34, 31]. The pH of 3.0-3.5 was adjusted by adding citric acid to *Aloe vera* gel juice.

Deaeration: Most of the air as well as other gases are removed by subjecting the fresh juice to a high vacuum. This process is called as deaeration. Here in this step air is removed to prevent the oxidation of ascorbic acid and to improve the stability of the *Aloe vera* juice (Chan *et al.*, 1986)^[8].

Hot processing and flash cooling: This process may affect the taste, appearance, color and biological content as of fruit and vegetable processing. When the *Aloe vera* juice is treated with 65 °C for 15 min prevent the damage of biological active compounds. After heat treatment the juice is suddenly cooled to preserve the biological compounds. Higher temperature and higher time greatly effect on biological active compounds of *Aloe vera*. High temperature short time treatment (at 85–95 °C for 1–2 min) is an effective method to avoid the off flavour and the loss of biological activity of *Aloe vera* gel (Eshun, K., 2003)^[19].

Storage: The two most important parameters that affect the quality are relative humidity and temperature. These two parameters can also affect the amount of the volatile

substances of the juice absorbed by the packaging material and consequently, affect the shelf-life of the product (Sadler and Braddock, 1990)^[66].

Application of *Aloe vera* juice in food products: The wide application of *Aloe vera* juice is gaining more attention in modern day life style because of biological active compound in the *Aloe vera*. The *Aloe vera* is blended in the food products are like production of ready to serve drink, health drink, soft drink, laxative drink, *Aloe vera* lemon juice, diet drink with soluble fiber, hangover drink with B vitamin, sherbet, *Aloe vera* sports drink with electrolyte, amino acids and acetaminophen, healthy vegetable juice mix, tropical fruit juice with *Aloe vera*, *Aloe vera* yoghurts, *Aloe vera* mix for whiskey and white bread, cucumber juice with *Aloe vera* (Eshun and He 2004; Hamman 2008; Singh and Singh 2009)^[20, 26, 71].

Mango nectar prepared from 25% *Aloe vera* gel increases total soluble solid, total acidity, viscosity and vitamin C from 15 to 15.4%, 0.41 to 0.44%, 122 to 151 centipoise and 41.4 to 43.7 mg/100g respectively. However pH decreases from 3.76 to 3.57 and total sugar did not change (Elbandy *et al.*, 2014)^[18]. Blend of *Aloe vera*, sweet lime, amla and ginger (60:5:20:15) are used in RTS preparation. Blend found to be increase in vitamin C content and other nutritional parameters. The physicochemical and sensory quality of RTS blend can be stored for 60 days and free from microbiological spoilage (Lokesh and Danme, 2017)^[39]. Pineapple juice and *Aloe vera* juice was blended and stored for 21 days in glass bottle. Protein and acidity of the juice goes on increases with increase in *aloe vera* juice and pH decreases with increase in *Aloe vera* juice. 30% *Aloe vera* incorporation was best based on sensory evaluation (Sonali *et al.*, 2016)^[73].

The blended nectar prepared from 12% *Aloe vera*, 2% bitter guard, 2% anola and 4% guava pulp having 15°Brix and 0.3% acidity was extremely liked by 9 point hedonic scale and also found best in nutritional value (Jaysukh *et al.*, 2016)^[29]. *Aloe vera* 15% and litchi 85% mixed beverage was processed in high pressure thermal processing of 400-600MPa/ 30-60°C /0-15 min as processing condition. The increase in phenolic and antioxidants was observed for the given pressure and temperature. Pectin Methyltransferase was found to be most boro-resistance enzyme with maximum inactivation upto 54% followed by peroxidase (72%) and polyphenol oxidase (82%) (Nishant *et al.*, 2017)^[53].

***Aloe vera* milk based products**

In 2016, shaik *et al.*,^[72] prepared a *Aloe vera* dahi from 4g/100g milk fat and 10g/100g milk solid not fat and 16g/100g *aloe vera* juice. The result shows that with increasing *aloe vera* juice content pH and water holding capacity of the dahi decreases and consequently syneresis increases. Improvement in probiotic count noticed with increase in *aloe vera* and milk solid not fat this may be due to diverse and increase amount of the nutrient available. *Aloe vera* fortified butter milk was prepared by Deepak *et al.*, in 2016^[15]. The viscosity of buttered milk increased proportionality with increases level of juice fortification. 10% fortified *aloe vera* was most acceptable by the sensory evaluation and improve nutritive value also. Shaik *et al.*, in 2016^[72] did a investigation on oral supplementation off *aloe vera* probiotic lassion *Shigella dysenteriae* infected mice. The results indicate the immuno protective effects of *aloe vera* lassi against on *Shigella dysenteriae* increase infection in mice. Flavoured milk and dahi fortified with *aloe vera* gel has been

prepared and characterised (Jothylinghumb and pugazhenthii, 2013; Ramachandra and srividya, 2014).

***Aloe vera* concentrate and its food applications:** To prevent the excess loss of biological compound the juice is concentrated under 125 mm Hg vacuum at below 50 °C for less than 2 min (Ramachandra and Srinivasa Rao 2008)^[60]. This concentrated *Aloe vera* is applicable in various food products like Squash, jam, jellies, tea, water or juice (Eshun and He 2004; Hamman 2008; Singh and Singh 2009)^[26, 26, 71].

***Aloe vera* powder and its food applications:** Dehydration is the method to removal of moisture from the food products. Desire level of relative humidity and temperature is maintained to get a dehydrated products. In the *Aloe vera* powder preparation pure intact *Aloe vera* gel fillets are washed first to remove traces of aloin. Then the fillets are placed into a humidity chamber where desired level of relative humidity and temperature are maintained (Ramachandra and Srinivasa Rao 2008)^[60]. Another method of powder preparation is hot air is passed over the fillets to dry them. This material is then ground to powder and packed (Ramachandra and Srinivasa Rao, 2008)^[60].

Spray dried *aloe vera* was prepared at the inlet temperature of 156.9°C and maltodextrin concentration of 42% was standardized and the parameter resulted to the power recovery, moisture, solubility, porosity, dispersibility, TSS, color, and wettability of 9.79%, 3.56%, 101.70s, 6.82%, 85.03%, 24.31°Brix, 97.21 (L value) and 415s respectively (preethinder *et al.*, 2017).

To maintain the bioactivity, nutritional, flavour and colour novel Q matrix drying method of dehydration is very necessary. Freeze drying, spray drying, ultra-filtration, reverse osmosis, tray drying, microwave and radio frequency drying are the novel methods using in powder preparation of *Aloe vera*. The food application of *Aloe vera* powder are yoghurt, curd, 'lassi', ice-cream, and *Aloe vera* 'laddu' (Singh and Singh 2009)^[71]. Powder can be apply in bakery products (Mudgil *et al.*, 2012) and processed products (Mudgil *et al.*, 2016)^[15].

***Aloe vera* as bio coating agent**

Aloe arborescens gel in combine with the rosehip oil at 2% delay the softening, color, maturity index on storage and it leads to 2-fold increases in plum storability. Bio active compound accumulation was higher at the end when compare to the control (Domingo *et al.*, 2017)^[17]. Sweet cherry delay the post-harvest quality loss and storage can be extendable. The coating can delay the stem browning and dehydration, maintain the fruit visual aspect with out effect on taste, aroma or flavour (Martínez-Romero *et al.*, 2006)^[42]. In 2016 Vieira *et al.*,^[84] evaluate chitosan based *Aloe vera* as an edible coating in blue berries. He reported the 50% reduce the microbiological loss (*Botrytis cineria*), 42% reduces the water loss. Fresh cut orange was coated with gelatine incorporated *aloe vera* and green and black tea extract. The microbial activity get retarded and shelf life of the product get increases (Mohsen *et al.*, 2016). *Aloe vera* gel (30%) and hot water (45 C) at 25 C can increase the ascorbic acid content, total acidity, fruit firmness, appropriate red color and decrease in fruit decay, juice pH and total soluble solid were observed (Maryam *et al.*, 2016)^[44].

65% sucrose osmotic solution with 10% *aloe vera* gel has attain better physicochemical attributes like loss of moisture and texture, managed respiration rate as well as maturation

progress, delay oxidative browning and reduce microbial propagation in mango (Kiran *et al.*, 2016). *Aloe vera* can be used as the best coating agent, this can increase the shelf life and sensory quality of storage fruits (Benítez *et al.* (2015)^[5]. *Aloe vera* has a excellent quality to extend the postharvest fruit quality of apple slices (Chauhan *et al.*, 2011)^[10], table grapes (Valverde *et al.*, 2005; Serrano *et al.*, 2006)^[83, 70]. 100% *A. vera* + 1% ascorbic and citric acids was coated on the pomegranate aril coatings led to firmness retention and increased levels of total anthocyanins and total phenolics. Furthermore *Aloe vera* treatments led to significantly lower counts for both mesophilic aerobics and yeast and moulds (Domingo *et al.*, 2013)^[16].

Side effect of *Aloe vera*.

Allergy

In 2013 Meena^[46] reviewed the use of *Aloe vera* is not advisable for the allergic individuals. This may cause redness, burning, stinging sensation, and rarely generalized dermatitis in sensitive individuals. Allergic reaction are mostly due to compounds like aloin and barbaloin. It is best advised to apply it to a small area first to test for possible allergic reaction. The use of *Aloe vera* should be avoided in individuals with a known allergy to plant of Liliaceae family, garlic, onions and tulips (Ulbricht *et al.*, 2008)

Oral: Diarrhoea, hepatitis, red urine, abdominal cramps, dependency or worsening of constipation. Prolonged use has been reported to increase the risk of colorectal cancer. Laxative effect may cause electrolyte imbalances (low potassium levels) (Meena, 2013)^[46].

Pregnancy: the use of *Aloe vera* has toxicological effect on embryo and foetus (WHO, 1999).

Loss of minerals: Prolong use of *Aloe vera* has been associated with watery diarrhoea resulting in electrolyte imbalance loss of potassium (WHO, 1999)^[86].

Interaction: Application of *Aloe vera* to skin may increase the absorption of steroid creams such as hydrocortisone. It reduces the effectiveness and may increase the adverse effects of digoxin, due to its potassium lowering effect. Combined use of *Aloe vera* and furosemide may increase the risk of potassium depletion. It decreases the blood sugar levels and thus may interact with oral hypoglycaemic drugs and insulin (Moore TE. 2001)^[47].

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