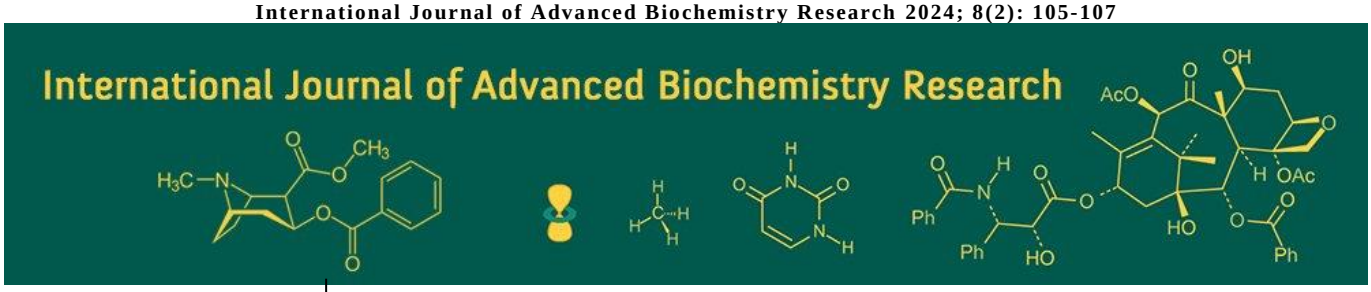

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Effect of chemical treatments on shelf life and quality of *Aloe vera* L. leaves

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Abstract
Aloe vera gel, a commercial product obtained from the leaves of *Aloe barbadensis*, belongs to the plant family Liliaceae. The mesophyll of the leaves is the major constitute of the gel and this has to be stored at proper conditions to get the commercial value. During storage the syneresis of the gel and activity of the microbial organisms deteriorates the shelf life of the gel and hence an attempt made to increase the storage life of the gel with the use of chemicals under 7 ºC. In the study it revealed that treatment of the leaves with 2% Calcium chloride performed best in specific gravity, gel recovery percentage and ascorbic acid content in the gel and the same treatment gave best results in sensory parameters like colour, texture and overall acceptability according to 9 point hedonic scale.

Keywords: *Aloe vera*, calcium chloride, specific gravity, ascorbic acid

Introduction
Aloe vera, scientifically known as *Aloe barbadensis* Miller, is a perennial plant belonging to the Liliaceae family which historically has been used for a variety of medicinal purposes (Tiwari *et al.*, 2018) [14]. It has fleshy green leaves that are arranged in a rosette pattern around the stem. The leaves of *Aloe vera* are comprised of a hard outer coat, covered by a protective cuticle (Maan *et al*., 2018) [7]. Beneath this layer lies the mesophyll, which can be further divided into chlorenchyma cells and thinner-walled parenchyma cells. These cells contain a clear mucilaginous substance known as *Aloe vera* gel. It is a useful ingredient in the food industry, used to make functional food and health drinks (Chand *et al*., 2019) [3]. Additionally, it plays a significant role in the pharmaceutical sector, contributing to the production of topical ointments, gel formulations, tablets, and capsules. Furthermore, the cosmetic industries utilize *Aloe vera* gel as a basic ingredient for making creams, lotions, soaps, shampoos, and facial cleansers (Saleem *et al*., 2022) [10]. Because of its high water content, *Aloe vera* gel has a tendency to be unstable and making it prone to both discoloration and microbial contamination (Suriati, 2018) [12]. To increase its shelf life and maintain its nutritional value, chemical treatments must be applied. Post-harvest application of calcium salts treatments represents safe and effective method for improving quality and prolong the shelf life of produce (Hussain *et al*., 2012) [6]. Calcium plays a crucial role in preserving the integrity of fruit cell walls through its interaction with pectic acid, resulting in the formation of calcium pectate. Additionally, calcium prolongs storage life by lowering the risk of post-harvest diseases and internal deterioration (Pal *et al*., 1997) [9].
During storage, the quality of the produce deteriorates due to the physiological activities such as increased rate of respiration and loss of moisture. Post harvest treatments coupled with cold storage can enhance the shelf life of commodity. Several post harvest treatments with chemicals have been trued to extend the shelf life and minimize the losses due to microbial spoilage by fungi and bacteria. Thus, the losses can be minimized by proper post harvest treatments. Chemicals such as sodium benzoate with citric acid, sodium benzoate with ascorbic acid, calcium chloride and acetic acid treatment were found to enhance the shelf life and quality in various fruit and vegetable crops (Vyas *et al*., 2016) [15]. Hence, the present investigation was undertaken to study the "Effect of chemical treatments on shelf life and quality of *Aloe vera* L. leaves".

Materials and Methods

The experiment was performed in the Laboratory of Centre of Excellence on Post Harvest Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India. The experiment was laid out in completely randomized design with (CRD) with three replications. Fresh, fully mature, uniform sized and injury/infection free leaves were harvested manually, leaves were washed with water and brought immediately to the laboratory in plastic crates for further experimentation. Seven kg of leaves per treatment were weighed, kept separately and immersed in the different chemical solutions for 15 minutes. *i e*., T_1 - 0.1% Sodium benzoate + 0.1% ascorbic acid, T_2 - 0.1% Sodium benzoate + 0.1% citric acid, T_3 - Calcium chloride (1%), T_4 - Calcium chloride (2%), T_5 - Acetic acid (0.1%), T_6 - Control (without any treatment). The solution was drained and leaves were kept in plastic crates and stored under cold storage at 7 ºC. The initial observations were recorded immediately after giving treatments to the leaves. During storage, changes in physico-chemical parameters were recorded in terms of physiological loss in weight (%), specific gravity, gel recovery (%), and ascorbic acid (mg/100g), while the sensory parameters in terms of colour, texture and overall acceptability at the 30th day of storage.

Physiological loss in weight was determined on initial and final weight basis using laboratory level weighing balance and expressed as percentage. For specific gravity, the weight of randomly selected leaves was recorded and were placed in a glass jar full of water and the volume of displaced water was measured with the help of measuring cylinder. To calculate gel recovery, weight of the leaves before gel extraction was taken and weight of the gel extracted from the leaves were measured using an electronic balance. Sensory evaluation of treated leaves was conducted during storage to assess the consumer's acceptance for the products. The samples were evaluated for sensory qualities on the basis of colour, texture and overall acceptability on a 9 point Hedonic scale (Amerine *et al*., 1965) [2].

Results and Discussion

Physico-chemical parameters

The leaves stored under 7 ºC after treating with - 0.1% Sodium benzoate and 0.1% ascorbic acid resulted minimum physiological loss in weight (5.67%) while the maximum physiological weight loss was observed in control leaves (9.67%). In general, the bacterial, yeast and molds growth causes the degradation of the stored plant tissues and as a result there will be a loss in the physiological weight (Oladoye *et al*., 2016) [8]. With the use of Sodium benzoate the activity of the said organisms was reduced and inhibits the physiological weight loss. Ascorbic acid prevents the enzymatic oxidation of phenolic compounds of plant tissues and maintains the quality and colour of the gel (Altunkaya *et al*., 2009) [1].

The maximum specific gravity was recorded in the leaves treated with 2% calcium chloride (1.017) and the minimum was noticed in the leaves preserved with 0.1% sodium benzoate + 0.1% citric acid and 0.1% acetic acid (1.000). Water content can influence the specific gravity of the gel and presence of calcium chloride impacts the water content and thereby maintains the specific gravity of the gel (Tang *et al*., 2011) [13]. It also interacts with polysaccharides of the gel and maintains the density of the gel and the ions of calcium and chloride interact with other ions of the gel, makes changes in electrochemical properties of the gel (Duceac *et al*., 2022) [4].

The maximum percentage of gel recovery (53.33%) was obtained in 2% calcium chloride treated leaves, while the minimum was resulted in 0.1% Acetic acid and control leaves (47.67%). The calcium ions provided by Calcium chloride helps in stabilizing the chains of polysaccharides and also coagulates the pectin molecules present in the *Aloe vera* gel to maintain the texture and structure of the gel resulting high recovery percentage (Zhang *et al*., 2022) [17].

Maximum Ascorbic acid (207.76 mg / 100g) content was found in the leaves stored at 7^{o}C after treating with 2% calcium chloride and the minimum ascorbic acid content was observed in 0.1% Sodium benzoate + 0.1% citric acid (193.90 mg / 100g). The addition of calcium ions protects the oxidation of ascorbic acid and also inhibits enzymatic browning that degrades the ascorbic acid content of the gel. Ascorbic is highly sensitive to pH and calcium chloride maintains the ascorbic acid content of the gel by stabilizing the pH of the gel (Hajebi Seyed *et al*., 2021) [5].

Sensory quality parameters

The data pertaining to colour, texture and overall acceptability of *Aloe vera* leaves as significantly affected by different chemical treatments at 7 ºC. The effect of chemical treatment on colour on the initial day of storage was found non-significant. Highest score for colour (7.32) was obtained in leaves treated with 2% $CaCl_2$ (T_4). This could be attributed to the calcium that maintained greater green life, firmness and minimized the rate of respiration, protein breakdown and rotting incidence. Lowest score (6.33) was recorded in control. It is due to, on 30th day of storage discoloration was noticed with control treatment where the leaves became light yellowish in colour (Sigge *et al*., 2007) [11].

Loss of texture is one of the main factor limiting quality and post-harvest shelf life of commodity. Highest score for texture (6.86) was obtained in leaves treated with 2% $CaCl_2$ (T_4) and lowest score (6.11) was found in control. The retention in firmness or texture in calcium treated fruits might be due to its accumulation in the cell leading to facilitation in the cross linking of the pectic polymers which increased cell wall strength and cell cohesion (White and Broadley, 2003) [16]. Softening might have occurred considerably during the ripening as a result of degradation of the middle lamella of the cell wall of cortical parenchyma cells. It might also be because of change in cell wall structure and their composition mainly due to combined action of enzymes

The overall acceptability of *Aloe vera* leaves was judged by based on the perception of colour and texture. Leaves treated with 2% $CaCl_2$ (T_4) shows highest score (7.09) and lowest score (6.22) was found in control on 30th day of storage. This might be due to retention of firmness and freshness due to low temperature and high relative humidity resulting in reduced transpiration losses.

Tables

Table 1: Effect of different chemical treatments on Physico-chemical parameters of *Aloe vera* leaves stored under 7 ºC

Treatment	Physiological loss in weight (%) on 30th Day	Specific gravity		Gel recovery (%)		Ascorbic acid (mg/100 g)	
		Initial	30th Day	Initial	30th Day	Initial	30th Day
T_1	5.67	1.083	1.017	58.42	48.33	262.44	199.99
T_2	7.33	1.095	1.000	59.00	48.50	259.07	193.90
T_3	6.67	1.105	1.020	59.25	50.50	254.30	207.31
T_4	7.00	1.105	1.047	59.58	53.33	271.64	207.76
T_5	7.67	1.087	1.000	56.67	47.67	245.79	207.73
T_6	9.67	1.088	1.020	57.83	47.67	259.11	199.89
S.Em.±	0.48	0.007	0.003	1.21	0.59	4.81	1.42
C.D. at 5%	1.40	NS	0.008	NS	1.73	14.80	NS

Table 2: Effect of different chemical treatments on sensory quality parameters (as per 9-point hedonic scale) of *Aloe vera* leaves stored under 7 ºC

Treatment	Colour		Texture		Overall acceptability	
	Initial	30th Day	Initial	30th Day	Initial	30th Day
T_1	8.13	6.75	8.02	6.52	8.08	6.64
T_2	7.94	6.83	8.06	6.57	8.00	6.70
T_3	8.09	7.27	8.13	6.36	8.11	7.04
T_4	8.22	7.32	8.29	6.86	8.25	7.09
T_5	8.05	6.73	8.07	6.13	8.06	6.43
T_6	8.07	6.33	8.11	6.11	8.09	6.22
S.Em.±	0.07	0.02	0.08	0.03	0.05	0.03
C.D. at 5%	NS	0.05	NS	0.07	NS	0.10

Conclusion

From the present study it can be concluded that post-harvest treatment of leaves with 2% calcium chloride for 15 minutes and subsequent storage of leaves under 7 ºC upto 30 days resulted best interms of Physico-chemical and sensory characteristics. Hence this practice helps to provide the best quality *Aloe vera* gel with least spoilage.

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