Effect of temperature on gel extraction process from aloe vera leaves

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Abstract: Aloe vera has drawn attention for its commercial importance in the preparation of nutritional, medicinal and cosmetic products. Temperature is an important criterion for processing of aloe vera to preserve its biological activity. In this investigation the principle of centrifugation was employed for the extraction of gel from aloe vera leaves. The experiment was planned with treatments as three level of centrifuge temperature (50C, 100C and 320C), at varying centrifuge rotating speed and centrifuge duration. The effect of temperature, on gel recovery and quality parameters like viscosity of gel, refractive index of gel, optical density of gel, and TSS content of gel, were studied. It was concluded that the extraction of gel from aloevera should be carried out at 50C temperature for 10000 rpm speed and 30 min duration of centrifuge, so as to obtain higher gel recovery and good quality gel. Higher temperature reduces viscosity which leads decrease in biological activity of aloevera gel.

Keywords: Aloe vera, gel extraction, viscosity, temperature

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1 Introduction

Aloevera is a succulent, belongs to the liliaceae family. There are more than 360 known species of aloe vera.*Aloebarbadensis* Miller is widely used for formulation of cosmetics, functional foods and drugs (Eshun and He 2004; Rodriguez *et al.*, 2010; Ahlawat and Khatkar 2011). Aloe vera gel clear gel is colorless mucilaginous gel obtained from the parenchymatous cells in the fresh leaves of aloe vera *(*Grindlay and Reynolds,1986).Agarwala (1997) studied the pharmaceutical properties of aloes and suggested that aclearsubstance obtained from parenchyma cells, called aloe gel, was colorless and tasteless. Anthraquinonescompound known as aloin is contained in the bitter yellow sap of the middle leaf layer, which exerts a marked laxative effect.

Aloe vera leaves contain biologically active compounds hence their post harvest handling and processing needs great care. The gel contains 98.5% water having pH 4.5 and also contains many polysaccharides such asg*lucomannan,acemannanetc.*, in active form in the leaves of aloe vera. Waller et al. (1978) had worked on sugar analysis of aloe vera gel and reported highest proportion of mannose(0.0394 mmole/kg) which was the main component for biological activity. The polysaccharides containing glucomannans, mannans and pectins of different molecular weights of aloevera are responsible for their biological activities in-vivo, as well as in-vitro (Yaron 1993; Chow *et al.*, 2005).

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Glucomannan is a good moisturizer and mainly used in many cosmetics products (Henry,1979) whereas acemannan, the major carbohydrate fraction in the gel, is a water-soluble long chain mannose polymer which accelerates wound healing, modulates immune function and antiviral effects. It is also reported that polysaccharides of aloevera with specific molecular have different applications (Agarwala, 1997). Utilization of aloevera gel in food product formulations is increased in recent years in products such as health drinks, beverages and yoghurt due to its bioactive components (He *et al.*, 2005). In view of its highly perishable nature, the importance is now being given to increase shelf stability of aloevera gel and to retain its functional properties using appropriate processing technology.

Hand filleting and whole leaf processing, the two types of aloeveragel extraction methods are prevalent. Gel is extracted either cold process or hot process. Combination of hand filleting and the entire whole leaf processing are used to avoid the undesirable elements, while maximizing the desired constituents. Shafi*et al.*, (2000) developed a commercially viable process for preparing a stable and pharmacological active crystalline substance from the fresh whole leaf meal and tested the product on experimental animals and volunteers for wound healing remedy for all kinds of all damaged skin conditions.Yaron(1993) extracted gel from full sized mature leaves and half size young leaves picked from the same shrub. After removal of the 'peel' thecolorless hydro-parenchyma was ground in a blender and centrifuged at 10,000 xg for 30 min at 4^0C to remove the fibers.The gel recovery was found 37.5 % for Aloe vera leaves.

The time, temperature and sanitation are the prime requirements for processing to obtain the aloe vera plant products in active form. The most important factor is how to extract the gel from aloe vera leaf and to preserve it for long duration for its utilization in food, cosmetic and pharmaceutical products. The rheological properties of aloe juice are attributed to high molecular weight polysaccharides containing mannan, and once extracted from plant their viscous characteristics degrade rapidly (Yaron 1991; Yaron 1993; Ni et al., 2004). Hence, care should be taken while processing of aloevera juice and factors such as holding time before processing, concentration and interaction of polysaccharides, dissolved solids and also processing method should be analyzed considering the quality of the aloevera product (Nindo*et al.*,2010). Hence in this study, the effect of temperature on gel extraction was studied as an attributes to the quality of aloe vera gel.

2 Materials and methods

2.1 Sample preparation

The matured aloe vera (*Aloe barbadensis* Miller) leaves were obtained from Department of Botany, College of Agriculture, Junagadh Agricultural University, Junagadh. The freshly harvested leaves of *Aloe barbadensis* variety were cut manually in the early morning for experimentation. To avoid bio-degradation the aloe vera leaf was harvested and pulled carefully from the mother plant so as not to break the rind.Harvested leaves were immediately kept in the icebox at 4^0C to 5^0C to preserve their biological activity and transported to the laboratory. The leaves were thoroughly washed with fresh water. The outer skin and the exudates of the leaves were removed manually with the help of knife to form fillet. The domestic blander (make:Boss, India) was used to ground the fillets to obtain homogenized pulp. The 60 ml pulp on volume basis was centrifuged in cooling type centrifuge for separation of crude gel and fiber. The charcoal was mixed with crude gel for purification in terms of colour and smell. The vacuum filtration method was used to obtain pure gel from crude gelthroughWhatman paper No. 4.The pure gel was collected in the test tubes for further analysis. The experiments were planned for 3 levels of centrifuge temperature (5^0C, 10^0C, and 32^0C)at centrifuge speed of

2000, 5000, and 10,000 rpm, for 10, 20 and 30 minutescentrifuge duration.

2.2 Quality parameters measurement

Aloe vera gel quality is adjudged by the various parameters like viscosity, refractive index, TSS content and optical density.

2.2.1Refractive index determination

The Abbe Refractometer (model: DR 194, make: Double R. Optics & Scientific Works, India) was used for the measurement of refractive index having range of refractive Indices between 1.3000 and 1.7000 with an accuracy of + 0.0002. It was Calibrated with known refractive indices i.e. doubled distilled water (1.3323) at 27^0C $\pm$ 0.2^0C. Two drops of aloe veragel were placed on the refractometer prism surface and was closed carefully. The mirror was adjusted until the reading was sharp. The instrument had been allowed to stand for a few minutes before the reading was taken so that the sample and instrument came to equilibrium. The reading was taken when the blue and yellow shade crossed the cross mark. Refractive index is the physical property of gel which determines the purity of gel as compared to double distilled water. Gel with lowest refractive index, is the best treatment for extraction process. More refractive index indicates the impurities in the extracted gel.

2.2.2Viscosity measurement of aloe vera gel

Viscosity of aloe vera gel was measured by Ostwald type glass viscometer (model: 1421 make: J-SIL, India). The time for a fixed volume of liquid to fall through a capillary into a reservoir under a variable pressure head is a function of the density and viscosity of liquid and the dimensions of viscometer. The liquids of known densities are allowed to flow through its capillary tube between two etched marks and the time of flow of the liquid is measured using a stopwatch. The viscosity of aloe vera gel was obtained relative to that of a reference liquid (water) in the same viscometer by allowing aloe vera gel to flow through the capillary maintaining the same differences of levels in the limbs by following time equation which governs the flow lead to the relation:

$$\frac{\eta_{ag}}{\eta_w} = \frac{d_{ag}}{d_w}\frac{t_{ag}}{t_w} \quad (1)$$

Where, η = Dynamic viscosity, Pa s

t = Time of flow, s

d = Density, kg/ m^3

Subscripts *ag* and *w* represents aloe vera gel and water respectively.

2.2.3Optical density determination

Optical density is the measure of transparency of liquid and also a measure of quality for aloe vera gel. Photo-spectrometer (model: UV-VJS 108, make: Systonic, India) was used for the determination of optical density, which gives the direct reading of absorbance. The filter slot No.6 of the photospectrometer was set on zero transmittance by lower knob and left as such without disturbing lower knob. The filter slot was also set according to wavelength (for aloe gel 400nm) and set 100% transmittance for blank sample or distilled water by side knobs.

2.3 Statistical Analysis

The statistical analysis of experiment was carried out at Statistics Department, College of Agriculture, Junagadh Agricultural University, Junagadh, with completely randomized design. The experimental data were analyzed with the help ofMicrosoft excel programme. The F-test was carried out at 5 % level to determine whether the effect is significant or not. Critical difference and coefficient variation were considered for the interpretation of data.

3 Results and discussion

The effect of centrifuge temperature for gel extraction process was studied and standardized for different centrifuge speed and duration. The effect of temperature on extracted gel from aloe vera leaf for recovery and different quality parameters like viscosity, refractive index, optical density etceterawere recorded.

Temperature is considered, as one of the major factor, which ultimately affects the viscosity, optical density, refractive index and TSS content of gel extracted from aloe vera leaves. Danhof (2000) had reported that the heat exposure and the time of processing of aloe vera leaves should be minimum. The effect of centrifuge temperature on different quality parameters such as crude and pure gel recovery, viscosity, refractive index andoptical density on gel extraction from aloe vera leaf at different temperatures are presented in Table 1 and 2.

3.1 Effect of centrifuge temperatures on aloe vera gel recovery

Crude gel is defined as the gel obtained after the centrifuge operation of aloe vera pulp, while pure gel is the gel obtained after purification of the crude gel. The percentage recovery of crude and pure gel varies from 57.91% to 58.89% and 42.04% to 42.14 % respectively with the variation in temperature. It is seen from the table that the percent recovery of gel is more or less same in both the case with the increase of temperature. This shows that there was no effect of temperature on the recovery of gel either crude or pure. The statistical analysis shows that the combine effect of centrifuge temperature; speed and duration on, crude gel recovery was found to be significant, but for pure gel recovery, it was found to be non significant (Table 1)

Table 1 Combine effect of centrifuge temperature, speed and duration on crude gel recovery

Centrifuge temperature ^{0}C	Centrifuge speed rpm	Centrifuge duration min					
		10	20	30	10	20	30
		Crude gel recovery , %			Pure gel recovery, %		
5	2000	45.33	47.81	54.19	32.11	35.61	38.06
	5000	50.69	58.39	62.94	37.81	42.81	45.17
	10000	63.67	68.25	69.92	46.92	48.81	51.94
10	2000	45.78	48.53	51.61	33.53	34.86	39.11
	5000	53.36	59.42	64.31	38.56	41.61	45.03
	10000	63.97	66.33	69.06	46.06	48.06	51.58
32	2000	46.42	49.86	52.11	33.00	35.50	39.44
	5000	55.11	61.67	62.58	39.00	41.81	44.72
	10000	64.83	66.97	70.47	45.94	48.06	51.11
S.Em.		0.638			0.491		
CD @ 5 %		1.790			1.375		
Test		Sig.			NS		

3.2 Effect of centrifuge temperatures on aloe vera gel quality parameters

The three factors as centrifuge temperature; speed and duration on varying proportions were studied and the resultant effect on various quality parameters was recorded.

3.2.1Viscosity of gel

The results of combine effect of centrifuge temperature; speed and duration on viscosity of gel are presented in Table 1. The statistical analysis shows that the combine effect of centrifuge temperature; speed and duration on, viscosity of gel is found to be significant.

The viscosity of the extracted gel (Table 1) was largely affected with the changes of centrifuge temperature. The maximum viscosity (10.74 mPas) was recorded at 5^0C and minimum (6.74mPas) at 32 ^{0}C (Ambient temperature). Viscosity was recorded 96.69 and 49.13% higher at 5^0C as compared to 32^0C and 10^0C temperatures. This statement is satisfied with the study conducted by ChiouS.J.(2003) that the viscosity of aloe

vera gel decreases with the increase of heating time. It is obvious that higher the value of viscosity of aloe veragelis, better the product will be. It is said that, higher is the viscosity better will be the quality of the product. At the same time the product is considered to be biologically active (Gowda *et al.,*1979). The average values of dynamic viscosity for gel was found 35.33 ± 0.21 and 36.45±0.34 cP respectively which were supported by the findings of Khatkar (2013).

3.2.2Refractive index of gel

Table 2 presents the combine effect of centrifuge temperature, speed and duration on refractive index of gel. The statistical analysis shows that the combine effect of centrifuge temperature; speed and duration on, refractive index of gel, is found to be significant.Therefractive index and TSS increases with the increase of temperature (Table 1). The minimum and maximum refractive index was found to 1.33603 and 1.33610, while TSS was found 1.31^0 and 1.40^0 Brix respectively. The refractive index of the pure gel is found to be closer to distilled water at all the temperatures. It may be said that the temperature has non-significant effect on the purities of the gel.

3.2.3Optical density

It is seen that the optical density of the aloe vera gel increases with the increase of temperature. The maximum value was found to be 0.244 at 32^0C and minimum at 5^0C temperatures. The increase in the value of optical density may be due to enzymatic degradation of aloe vera gel at higher temperatures. From the Table 1 it is seen that the optical density of the aloe vera gel increases with the increase of temperature. The maximum value was found to be 0.244 at 32^0C and minimum at 5^0C temperatures. The increase in the value of optical density may be due to enzymatic degradation of aloe vera gel at higher temperatures. Table 2 presents the combine effect of centrifuge temperature; speed and duration on optical densityof gel. The statistical analysis shows that the combine effect of centrifuge temperature; speed and duration, optical densityof gel, was found to be non-significant.

4 Conclusions

Temperature is important process parameter for gel extraction from aloe vera leaves. Viscosity is the measure of biological activity of extracted gel. It was concluded that 5^0C temperature yield in higher viscosity, lower refractive index and optical density with optimum recovery of gel. It may be suggested that the gel extraction may be carried out by centrifuge at 5^0C temperatures at 10000 rpm centrifuge speed for 30

Table 2 Effect of centrifuge temperatures on quality parameters for aloe vera gel

Centrifuge temperature ^{0}C	Centrifuge speed rpm	Centrifuge duration min								
		10	20	30	10	20	30	10	20	30
			Viscosity mPas			Refractive index			Optical density	
	2000	11.39	10.47	11.23	1.33750	1.33667	1.33638	0.251	0.246	0.241
5	**5000**	10.75	10.25	11.03	1.33630	1.33618	1.33595	0.243	0.238	0.233
	10000	11.38	10.73	10.74	1.33562	1.33543	1.33488	0.233	0.231	0.229
	2000	08.37	08.03	08.36	1.33718	1.33692	1.33683	0.254	0.249	0.248
10	**5000**	08.15	07.87	08.81	1.33605	1.33598	1.33568	0.248	0.242	0.238
	10000	07.76	07.31	09.23	1.33542	1.33537	1.33492	0.239	0.237	0.234
	2000	06.58	06.48	06.41	1.33738	1.33678	1.33632	0.257	0.254	0.252
32	**5000**	06.70	06.29	06.49	1.33602	1.33593	1.33578	0.248	0.245	0.242
	10000	06.89	06.21	06.74	1.33560	1.33535	1.33510	0.237	0.235	0.231
S.Em.			11.066			8.04×10^{-5}			1.05×10^{-5}	
CD @ 5 %			31.051			2.26×10^{-4}			0.003	
Test			Sig.			Sig.			NS	

minutes duration to obtained better quality gel.

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