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Quality Evaluation of Aloe (Aloe barbadensis Miller) Juice Supplemented *Chapatti*

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Abstract

Aloe vera is long been known for its medicinal and therapeutic properties. Therefore an attempt has been made in the present investigation to study the utilization of aloe juice in whole wheat flour in the form of *chapatti* and to investigate the physico-chemical changes occurring during storage in order to assess acceptability as well as shelf life of aloe supplemented *chapatti. .* The physico-chemical analysis showed that aloe juice was a good source of crude fibre, ash and total phenolic content. Unblanched aloe juice had more crude fibre (0.15%), ash (0.2%) and phenolic content (20 mg, %) as compared to juice prepared from blanched aloe. Optimum supplementation levels of aloe juice in the *chapatti*. were selected on the basis of sensory evaluation. It was found that aloe juice can be supplemented up to 3 per cent level without adversely affecting the overall quality of *chapatti*. . Laminates and high density polyethylene (HDPE) pouches were used for packaging of *chapatti*. s. Storage studies depicted that laminate pouches were better suited for packaging of supplemented products. Negligible effect of treatment, packaging material and storage period on moisture content, water activity, texture and acceptability of supplemented *chapatti*. s was observed during 8 hours storage. Supplemented products prepared and stored at ambient conditions remained in acceptable range throughout the storage period. Thus, aloe juice can be used as a potential source to increase the nutritional quality of *chapatti*. particularly in terms of minerals and fibres.

Keywords: Aloe vera, *chapatti*. , blanching, storage, packaging

Introduction

Aloe vera is traditionally known for promoting well being in humans due to the presence of bioactive components in the gel of the leaves. The Food and Drug Administration of the US refers A. vera as a food, herb or a dietary supplement (Anon 2006). Such information is vital to study the potential utilization of aloe gel in human diet.

Recently, aloe vera has received much attention as a highly potential, functional and valuable ingredient in the food industry that exhibits impressive biological functions of great interest. The predominant medicinal use of the orally ingested aloe gel/ juice is against ulcerous, gastrointestinal, kidney and cardiovascular problems and aids in detoxification. Aloe gel too reduces the serum cholesterol, triglycerides and low density lipoproteins (LDL) in patients with hypercholesterolemia (Valverde et al 2005). Other properties of aloe gel including anti-inflammatory, antibiotic activities and activities against some diseases like diabetes, cancer and severe allergy have been reported (Reynolds and Dweck 1999).

In the food industry aloe vera is being utilized as a functional ingredient for the preparation of health drinks and beverages but not much investigation has been made in the field of aloe vera supplemented products such as biscuits and *chapatti*s. Wheat in the form of unleavened flatbread known as *chapatti* forms an integral part of Indian diet including Pakistan and some parts of Africa (Nurul-Islam and Johansen 1987). More than fifty percent of the total energy intake is derived from wheat flour (OMNI 1996) and about 85% of wheat consumption in India is in the form of *chapatti*s (Kadam et al 21012). Moreover, *chapatti*s being least expensive can be used as potential vehicle for supplementation of aloe vera to improve overall nutritional quality of human diet.

Aim of study

People have become more health conscious and are viewing diet as a component for achieving good health, maintenance and possible body issues such as hypercholesterolemia and diabetes, has led to the development of a larger market for fortified/supplemented food products. Aloe would be among the popular ones for such applications.

Supplementation of wheat flour with inexpensive staples, such as cereals and pulses, to improve the nutritional and therapeutic quality of *chapatti* have been reported but little information is available regarding the supplementation of aloe juice in *chapatti*. Therefore, an attempt has been made to explore the possibility of enhancing nutritional quality of *chapatti* by supplementing aloe juice.

Material and methods

Processing of aloe gel into juice

Fresh Aloe vera leaves were procured from the Department of Agronomy, Punjab Agricultural University, Ludhiana. Top and bottom ends of aloe leaves were trimmed off and the spikes placed along the margins, were removed before slicing the leaves. The epidermis (or skin) was carefully separated from the parenchyma using stainless steel knives. The sticking gel was then scooped and collected with the help of stainless steel scrapper. One lot of aloe gel was blanched for 2 minutes at 80^{0}C temperature while the other lot was kept unblanched. Blanched and unblanched aloe gel was passed through the juicer (Inalsa) to get aloe juice. The aloe juice was further filtered through muslin cloth to get juice free from coarse fibrous material. Sodium benzoate and potassium metabisulphite each was added @ 100 ppm in both the lots. Aloe juice was filled in clean, sterilized glass bottles (capacity 200ml), corked immediately and processed in boiling water for 20 minutes. After processing, bottles were cooled quickly to room temperature and stored for further studies.

Product Preparation

*Chapatti*s were prepared using the method described by Austin and Ram (1971). Whole wheat flour and required quantity of water were mixed manually to obtain dough of suitable consistency. The dough was rounded manually and kept for 30 minutes at 30^{0}C and 85 per cent relative humidity. The dough was divided into two equal parts and sheeted/rolled on smooth surface to circular *chapatti*s of 15.0 cm in diameter. This was then baked on hot flat open. Juice from blanched and unblanched aloe was blended at the levels ranging from 1-5% and was optimized on the basis of product characteristics and sensory evaluation score for different attributes.

Quality evaluation of *chapatti*s

*Chapatti*s were cooled and comparative evaluation was done by observing dough handling properties such as stickiness and puffing along with sensory evaluation. Aloe vera supplemented *chapatti*s were evaluated for sensory attributes (appearance, color, flavour, texture and overall acceptability) through a panel of semi-trained judges using 9- point hedonic scale (Larmond, 1970)**.**

improvement. Recent market analysis reports indicated that demand for
functional foods to provide energy and added nutrition to handle health

Storage stability of *chapatti*s

*Chapatti*s were packed in High density polyethylene (HDPE-200 gauge) and aluminium foil laminates and kept under ambient conditions. *Chapatti*s were then evaluated for shelf life by estimating moisture content, water activity, sensory evaluation and textural quality at 0, 2, 4, 6 and 8 hours interval.

Analytical methods

Proximate composition

Aloe gel and juice were analyzed for moisture, ascorbic acid, total sugars, reducing sugars, ash and crude fibre (AOAC 2000), total carotenoids, titratable acidity (Ranganna 1986) and total phenols (Swain and Hills 1959). Physico-chemical characteristics of whole wheat flour and *chapatti* such as moisture, ash, protein, fat, carbohydrates and crude fibre were determined using AACC (2000) methods.

Water activity

The water activity of *chapatti* was measured by using water activity meter (Rotronic Company).

Texture analysis

The texture of *chapatti* was analyzed by Stable Microsystem Texture Analyzer Model (TA-H di England). The texture analyzer has two basic components-hardware (load cell with sample platform to hold the sample and a moving head for holding the probe) and the software (Texture expert) for recording and interpreting the results for the particular texture parameter. Strips measuring 4 cm × 2 cm were cut from each *chapatti*. One strip at a time was placed on the centre of the sample holder and the blade was allowed to cut the *chapatti* strip. The force (N) required to cut *chapatti* strip into two pieces was recorded. The speed was maintained at 1.70 mm/s.

Table 1. Settings of stable Microsystem Texture Analyzer used to measure the texture of *chapatti*s

Parameter	***Chapatti*s**
Test	Penetration test
Probe	2mm needle probe (P2N) using 25 kg
Pre-test speed	2 mm/s
Test speed	2 mm/s
Post-test speed	10 mm/s
Distance	2 mm
Force	60 g

Statistical analysis

The data regarding the fresh and stored samples were statistically analyzed by ANOVA (Analysis of variance) using factorial design (Gomez and Gomez, 2010).

Results and discussion

Physico-chemical composition of aloe gel and aloe juice

Please see last page (Table 2)

The physico-chemical composition of aloe differs widely depending on the species, season and growing conditions (Briggs 1995 and Shelton 1991).

The data tabulated in Table 2 represents the physico-chemical composition of aloe gel and aloe juice. Total solids of aloe gel comprised mainly of reducing and total sugars, acids, crude fibre and ash. Blanching did not show any effect on crude fibre content, but aloe juice had lower fibre content as compared to aloe gel. This was attributable to filtration and clarification step adopted during juice processing. The results coincide with the findings reported by Femenia et al (1999) and Wang and Strong (1995). Losses of ascorbic acid during processing in fresh as well as processed products are well known. Ascorbic acid is a known reducing agent and is vulnerable to oxidation. Thus, blanched aloe gel had lower ascorbic acid content as compared to unblanched aloe gel (Table 2). Similarly, aloe juice had quite low ascorbic acid content (1.56 mg/100g) as compared to gel (1.90 mg/100g). This might be attributable to the method adopted to prepare aloe juice. Pierce (1983) found similar values for ascorbic acid in aloe extract.

The phenolic compounds are highly volatile and get easily oxidized. Total phenolic content of unblanched and blanched aloe gel were noted as 23.0 and 21.0 mg/100g respectively. Further reduction in total phenolic content was observed when aloe gel was processed into juice. Zheng and Wang (2001) noted similar values for total phenolic content in aloe extract. The carotenoid content of aloe gel and juice recorded in present studies was 0.003 mg/100g.

From the above results, it can be concluded that aloe juice is a potential source of crude fiber, ash and phenolic compounds. Due to richness in phenolic compounds, aloe could be used as a valuable source of natural antioxidants.

Physico-chemical composition of whole wheat flour meal and aloe juice supplemented *chapatti*

The proximate composition of whole wheat flour meal and aloe juice supplemented *chapatti* is represented in Table 3. Whole wheat flour contained 12.09 per cent moisture, 10.21 per cent protein, 1.78 per cent fat, 1.39 per cent ash, 1.83 per cent crude fibre and 74.53 per cent carbohydrates. The results obtained were in accordance with the findings reported by Shaikh et al (2007).

Supplementation of aloe juice resulted in a considerable improvement in ash and crude fibre content of *chapatti*s (Table 3). *Chapatti*s supplemented with aloe juice exhibited an increase in crude fibre content from 1.88 (control) to 1.92 and 1.94 per cent in blanched and unblanched aloe juice supplemented *chapatti*s respectively. The ash content of blanched and unblanched aloe juice supplemented *chapatti*s recorded as 1.68 and 1.69 per cent respectively while control *chapatti*s contained 1.63 per cent ash. An increased ash and crude fibre content of supplemented biscuit seems to be the direct effect of supplementation of wheat flour with aloe juice, which had high ash and fibre content. However, supplemented *chapatti*s did not differ much from control for protein and fat content. Wheat flour *chapatti*s had maximum amount of carbohydrate (55.55 %) than supplemented *chapatti*s (55.49 % and 55.48 % in blanched and unblanched aloe juice supplemented *chapatti*s respectively).

Quality assessment

The quality evaluation of *chapatti*s prepared by different levels of aloe juice from 1 to 5% is mentioned in Table 4. Statistically significant variations were observed for water absorption of aloe juice supplemented *chapatti*. Water absorption of supplemented *chapatti*s decreased as the level of supplementation of aloe juice increased from 1 to 5 per cent, in both blanched and unblanched aloe juice treatments. Water absorption was noted as 64.0 per cent for control *chapatti* whereas 62.2 and 62.1 per cent, at 5 per cent level of supplementation, for blanched and unblanched aloe juice supplemented *chapatti*s respectively. Singh and Singh (2009) supplemented aloe gel in bread and observed that water absorption capacity decreased with increasing level of aloe gel in different formulations of bread. Supplementation of juice from blanched and unblanched aloe up to 4 per cent showed smooth handling of dough, but dough became slightly sticky beyond 4 per cent level of supplementation of aloe juice. No variations were observed regarding puffing, colour, flavour and texture parameters of blanched and unblanched aloe juice supplemented *chapatti* is as compared to wheat flour *chapatti* (control). Full puffing was found in all the supplemented *chapatti*s (1-5%) from both blanched and unblanched aloe juice.

The overall acceptability and flavor scores were significantly affected with the supplementation of aloe juice in *chapatti*s (Table 4). Panelists described the *chapatti*s containing more than 3 per cent of juice from blanched and unblanched aloe as having a bitter after taste. The organoleptic parameters of supplemented *chapatti*s secured highest overall acceptability scores at 3 per cent level for juice from blanched (8.0) and unblanched (8.0) aloe and found optimum and most acceptable.

Storage studies

Moisture Content and water activity

Supplemented *chapatti*s exhibited marginal but significant effect on moisture content (Table 5). The moisture content of blanched and unblanched aloe juice supplemented *chapatti*s was 29.64 and 29.62 per cent respectively. However, control *chapatti* had 29.67 per cent moisture. The moisture content found in the present study is well correlated with the finding reported by Singh and Singh (2009). The authors observed that aloe gel supplemented bread contained slightly lower moisture content (32.1%) as compared to control bread (32.8 %). However, the baking conditions also had pronounced effect on the moisture content of *chapatti*s.

Packaging material was found to have a non-significant effect on moisture content of supplemented *chapatti*s. Venkateswara et al (1986) observed negligible moisture losses in *chapatti*s stored either in polyethylene pouches or plastic containers for three days, whereas, those wrapped in waxed paper showed considerable losses. Storage of supplemented *chapatti*s (packed in either packaging material) at ambient room temperature significantly affected the moisture content. The observations indicated that there was a moisture loss of 1.3 and 1.2 per cent in laminate and 1.5 and 1.4 per cent in HDPE packed blanched and unblanched aloe juice supplemented *chapatti*s respectively (Table 5). Singh and Singh (2009) reported that moisture content of bread decreased with time of storage and the decrease in moisture content of bread was due to storage environment (temperature and relative humidity) as well as the nature of packaging material.

Although the treatment, packaging material and storage exhibited non-significant effect (p≤0.05) on moisture content of aloe juice supplemented *chapatti*s, interactions of treatment and storage, treatment and packaging material as well as packaging material and storage were found to affect the moisture content of aloe juice supplemented *chapatti*s significantly (p≤0.05).

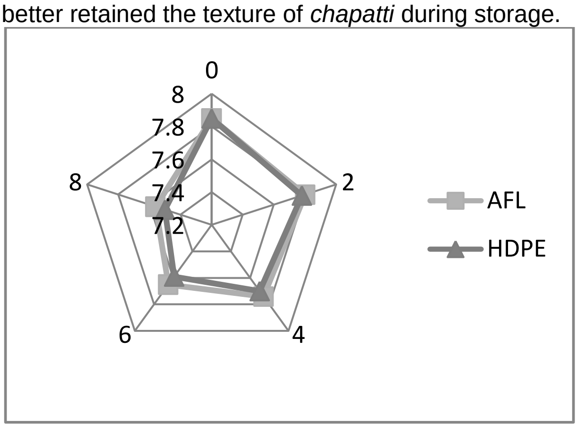
Packaging material represented a non-significant effect on a_w of supplemented *chapatti*s (Table 5). Storage period was observed to have a non-significant effect on a_w of supplemented *chapatti*s. At 0 month, the a_w recorded for both blanched and unblanched aloe juice supplemented *chapatti*s as 0.92, which increased to 0.93, irrespective of packaging material, after 8 hours of storage. Statistical analysis showed non-significant effect (p≤0.05) of treatment, packaging material and storage on a_w of aloe juice supplemented *chapatti*s.

Texture

The effect of treatment, packaging material and storage on the texture of aloe juice supplemented *chapatti*s has been depicted in Table 6. Unblanched aloe juice supplemented *chapatti* required marginal but significantly less force for penetration (0.20 kg) followed by blanched aloe juice supplemented *chapatti* (0.21 kg) and control *chapatti* (0.24 kg). The above observations indicated that supplementation of aloe juice resulted in a considerable improvement in the texture of *chapatti*s as compared to control *chapatti*s. This might be ascribed to the presence of glucomannan in aloe, which is a polysaccharide and was believed to be the active constituent (Singh and Singh 2009). Packaging material found to have a significant effect on the texture of supplemented *chapatti*s. Texture values of the stored supplemented *chapatti*s increased during storage at ambient temperature, indicating the increasing hardness of the *chapatti*s. Force required to penetrate the *chapatti* recorded as 0.21 and 0.20 kg at the initial stage of storage which increased to 0.22 and 0.21 kg in laminate and 0.23 and 0.22 kg in HDPE packed blanched and unblanched aloe juice supplemented *chapatti*s respectively, with progression of storage period. Shaikh et al (2007) reported that the texture of *chapatti*s became progressively harder during storage. The authors noted that fresh *chapatti* had the least value for force required to penetrate the *chapatti* (225.26 g), indicating that it was soft, the *chapatti*s stored for one month at room temperature showed a value of 618.20g. Statistically, treatment, packaging material and storage exhibited significant effect (p≤0.05) on texture values of aloe juice supplemented *chapatti*s.

Overall acceptability

The effect of packaging material and storage on the acceptability scores of aloe juice supplemented *chapatti*s is shown in figure 1. Unblanched aloe juice supplemented *chapatti*s secured significantly higher acceptability compared to control. Packaging material significantly influenced the acceptability scores of supplemented *chapatti*s. Laminate packaged supplemented *chapatti*s showed higher scores for acceptability, whereas HDPE packed *chapatti*s were less preferred. This could have been due to the protective effect of foil laminates which were better barrier to moisture loss than HDPE pouches and thus better retained the texture of *chapatti* during storage.



AFL- Aluminium Foil Laminate, HDPE- High Density Polyethylene

Fig 1. Effect of packaging material and storage on acceptability of aloe juice (3%) supplemented *chapatti*

Significant effect on the liking of supplemented *chapatti* was noticed up to 8 hours of storage. Acceptability score decreased with progression of storage at room temperature. However it was worth appreciating that the supplemented *chapatti*s remained in high acceptability range throughout the storage period. Sharma et al (1999) and Jagannath et al (1998) reported that a gradual decrease in the overall acceptability of bread was due to decrease in moisture content of bread during storage.

It is therefore, concluded that supplemented *chapatti*s can be stored safely in laminates and HDPE pouches at room temperature for 8 hours without any adverse change in the organoleptic traits.

Conclusion

From the present investigation, it was concluded that aloe juice could be supplemented up to 3 per cent level without affecting the overall quality of *chapatti*. Supplementation of aloe juice resulted in considerable improvement in ash, crude fibre and phenolic content of *chapatti*s. Negligible effect of treatment, packaging material and storage period on moisture content, water activity and texture of supplemented *chapatti*s was observed during 8 hours storage. Results showed that laminate pouches were better suited for packaging of supplemented products as compared HDPE pouches.

Suggestions

The *chapatti*s supplemented with unblanched aloe juice were better in all physico-chemical as well as organoleptic attributes. Hence, the product supplemented with juice from unblanched aloe was found superior in all quality parameters though the product supplemented with blanched aloe juice also falls under acceptable range. Future emphasis can be given to extract aloe juice by different methods and to choose one that best preserves bioactive components of aloe vera and to explore new products for aloe vera supplementation.

Reference

1. AACC (2000), Approved Methods, American Association of Cereal Chemist, St. Paul Minnesota, USA.
2. Anon (2006), http://www.naturealternative.com.
3. AOAC (2000), Official Methods of Analysis, Association of Official Analytical Chemists, Gaithersburg, Maryland, USA.
4. Austin, A. and Ram, A. (1971), Studies on chapati making quality of wheat: Tech Bull 31. pp 108. Indian Council of Agricultural Research, New Delhi.
5. Briggs, C. (1995), Herbal Medicine: Aloe, Can Pharma J, Vol. 128, pp 48-50.
6. Femenia, A., Sanchez, E.S., Simal, S. and Roselló, C. (1999), Compositional features of polysaccharides from Aloe vera (Aloe barbadensis Miller) plant tissues, Carbohydrate Polymer, Vol. 39, No. 2, pp 109-117.
7. Gomez, A. K. and Gomez, A. A. (2010), Statistical procedures for Agricultural Research, pp 680 John Wiley and Sons, New York, USA.
8. Jagannath, J.H., Jayaraman, K. S. and Arya, S.S. (1998), Effect of wrappers, temperature, humidity and modified atmosphere on phase transitions during staling of bread, Journal of Food Science and Technology, Vol. 35, pp 132-137.
9. Kadam, M. L., Salve, R.V., Mehrajfatema, Z.M. and More, S.G. (2012), Development and Evaluation of Composite Flour for Missi roti /*chapatti*, Journal of Food Processing Technology, Vol. 3, pp 1.
10. Larmond, E. (1970), Methods of Sensory Evaluation of Food, Can Department of Agriculture.
11. Nurul-Islam, M. D. and Johansen, H.B. (1987), Physical chemical tests-A basis for selecting the size of wheat flour, Journal of Food Science and Technology, Vol. 24, pp 136-138.
12. OMNI (1996), "Mandatory Food Enrichment" Nutriview Supplement, the Roche/USAID Fortification Basics series, and OMNI/ USAID Publication.
13. Pierce, R.F. (1983), Comparison between the nutritional contents of the aloe gel from conventional and hydroponically grown plants, Erde Int, Vol.1, pp 37–38.
14. Ranganna, S. (1986), Handbook of analysis and quality control for fruit and vegetable products, Tata McGraw Hills Publ Co. Ltd. New Delhi.
15. Reynolds, T. and Dweck, A. C. (1999), Aloe vera leaf gel, Journal of Ethnopharmacology, Vol. 68, pp 3-37.
16. Shaikh, I. M., Ghodke, S. K. and Ananthanarayan, L. (2007), Staling of *chapatti* (Indian unleavened flat bread), Food Chemistry, Vol. 101, pp 113–119.
17. Sharma, S., Sekhon, K.S. and Nagi, H.P.S. (1999), Suitability of durum wheat for flat bread production, Journal of Food Science and Technology, Vol. 36, pp 61–62.
18. Shelton, M. (1991), Aloe vera: its chemical and therapeutic properties, International Journal of Dermatology, Vol. 30, pp 679-683.
19. Singh, A. and Singh, A. K. (2009), Optimization of processing variables for the preparation of herb bread using Aloe vera gel, Journal of Food Science and Technology, Vol. 46, No. 4, pp 335-38.
20. Swain, T. and Hillis, E. (1959), The phenolic constituents of Prunus domestica: the quantitative analysis of phenolic constituents, J Sci Food Agric, Vol. 10, pp 63-68.
21. Valverde, J. M., Valero, D., Martinez, R. D., Guillen, F., Castillo, S. and Scrrano, M. (2005), Novel edible coating based on Aloe vera gel to maintain table grape quality and safety, Journal of Agriculture and Food Chemistry, Vol. 53, pp 7807-7813.
22. Venkateswara, R. G., Leelavathi, K., Haridas Rao, P. and Shurpalekar, S. R. (1986), Changes in the quality characteristics of *chapatti* during storage, Cereal Chemistry, Vol. 63, No. 2, pp131-135.
23. Wang, Y. T. and Strong, K. J. (1995), A Two-Year Study Monitoring Several Physical and Chemical Properties of Field-Grown Aloe barbadensis Miller Leaves, Subtrop plant sci, Vol.47, pp 34-38.
24. Zheng, W. and Wang, S.Y. (2001), Antioxidant activity and phenolic compounds in selected herbs, Journal of Agriculture and Food Chemistry, Vol. 49, No.11, pp 5165-5170.

Table 2

Physico-chemical composition of aloe gel and juice

Parameters	Gel		Juice	
	Blanched	Unblanched	Blanched	Unblanched
Moisture (%)	97.10	97.20	97.2	97.24
Titratable acidity (malic acid, %)	0.10	0.11	0.12	0.13
Ascorbic acid (mg/ 100g)	1.75	1.90	1.23	1.56
Reducing sugars (dextrose, %)	0.25	0.25	0.21	0.20
Total sugars (dextrose, %)	0.73	0.71	0.71	0.70
Crude fibre (%)	0.26	0.26	0.13	0.15
Ash (%)	0.26	0.25	0.19	0.20
Total phenolics (mg/100g)	21.0	23.0	18.0	20.0
Total carotenoids (mg/100g)	0.003	0.003	0.003	0.003

Table 3

Proximate composition of whole wheat flour meal and aloe juice (3%) supplemented *chapatti*

	Aloe juice supplemented chapattis			
	Whole heat flour meal	Control	Blanched	Un blanched
Moisture (%)	12.09	29.67	29.64	29.62
Protein (%)	10.21	11.60	11.64	11.65
Ash (%)	1.39	1.63	1.68	1.69
Fat (%)	1.78	1.55	1.55	1.56
Crude fibre (%)	1.83	1.88	1.92	1.94
Carbohydrates (%)	74.53	55.55	55.49	55.48

Table 4

Quality assessment of aloe juice enriched *chapatti*

Treatment	Supplementation levels (%)	Water absorption (%)	Dough handling	Appearance	Colour	Flavour	Texture	Overall accept-ability
Blanched	0	64.0	NS	7.9	7.7	7.8	7.7	7.7
	1	63.8	NS	7.9	7.7	7.8	7.7	7.7
	2	63.4	NS	7.8	7.8	7.9	7.8	7.8
	3	63.0	NS	7.9	7.8	8.1	7.9	8.0
	4	62.6	NS	7.8	7.7	7.5	7.9	7.6
	5	62.2	SS	7.8	7.7	7.3	7.8	7.5
LSD (p≤ 0.05)	**0.3**			**0.1**	**0.1**	**0.4**	**0.1**	**0.4**
Unblanched	0	64.0	NS	7.9	7.7	7.8	7.7	7.7
	1	63.7	NS	7.8	7.7	7.9	7.8	7.8
	2	63.3	NS	7.9	7.8	7.9	7.8	7.9
	3	62.9	NS	7.9	7.8	8.1	7.9	8.0
	4	62.4	NS	7.9	7.8	7.6	7.9	7.7
	5	62.1	SS	7.7	7.7	7.3	7.8	7.4
LSD (p≤ 0.05)	**0.3**			**0.1**	**0.1**	**0.4**	**0.1**	**0.4**

NS: Non sticky, SS: Slightly sticky

Table 5

Effect of treatment, packaging material and storage period on moisture content (%) and Water activity (a_w) of aloe juice (3%) supplemented *chapattis*

Strage period (hrs)	AFL*						HDPE**					
	Control		Blanched		Unblanched		Control		Blanched		Unblanched	
	Moisture	aw	Moisture	aw	Moisture	aw	Moisture	aw	Moisture	aw	Moisture	aw
0	29.67	0.93	29.64	0.92	29.62	0.92	29.67	0.93	29.64	0.92	9.62	0.92
2	29.62	0.93	29.60	0.92	29.57	0.92	29.60	0.93	29.57	0.92	9.56	0.92
4	29.54	0.93	29.51	0.93	29.50	0.92	29.51	0.94	29.46	0.93	9.45	0.93
6	29.42	0.94	29.40	0.93	29.43	0.93	29.38	0.94	29.36	0.93	9.34	0.93
8	29.28	0.94	29.26	0.93	29.25	0.93	29.22	0.94	29.20	0.93	9.21	0.93
LSD (p≤ 0.05)	0.13	0.01	0.13	0.01	0.13	0.01	0.13	0.01	0.13	0.01	0.13	**0.01**

Table 6

Effect of treatment, packaging material and storage period on texture (kg) of aloe juice (3%) supplemented chapattis

Storage period (hours)	AFL*			HDPE**		
	Control	Blanched	Unblanched	Control	Blanched	Unblanched
0	0.24	0.21	0.20	0.24	0.21	0.20
2	0.24	0.21	0.20	0.24	0.21	0.21
4	0.24	0.22	0.20	0.25	0.22	0.21
6	0.25	0.22	0.21	0.26	0.23	0.22
8	0.25	0.22	0.21	0.26	0.23	0.22
LSD (p≤ 0.05)	0.03	0.03	0.03	0.03	0.03	0.03

*AFL: Aluminium foil laminate; **HDPE: High density polyethylene