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The Influence of Aloe Vera Powder on Dough Properties and the Quality of Barbari Bread

M. Jafari [a], ***S. H. Hosseini Ghaboos*** [b*]

[a] *M.Sc. Graduated of the Department of Food Science and Engineering, Azadshahr Branch, Islamic Azad University, Azadshahr, Iran.*
[b] *Assistant Professor of Food Science and Technology Research Center of East Golestan, Azadshahr Branch, Islamic Azad University, Azadshahr, Iran.*

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ABSTRACT: Barbari is traditional flat leavened Iranian bread and one of the most popular breads consumed in Iran. Barbari bread stales quite fast and its shelf life is very short. Therefore, the addition of bread improvers and anti-staling agents, such as aloe vera, is a suitable method for extending the shelf life of the bread. In the present study, the effect of aloe vera powder at 0, 1, 3, 6 and 9% (w/w based on flour) concentration on dough rheological properties, fresh bread quality and bread staling have been investigated. Dough water absorption was increased by the addition of aloe vera and 9% aloe vera had the highest effect. In all the treatments, the extensibility of dough was significantly decreased with an increase in the resting time from 45 to 135 minutes, that is probably due to the water-biding ability of aloe vera ($P<0.05$). The application of aloe vera resulted in increase in dough development time (DDT) but dough stability decreased. Hydrocolloid addition to the bread formulation improved the rheological properties of Barbari bread and retarded the staling process while toughness was changed in the range of 7.87-60.7 mJ.

Keywords: *Aloe Vera, Bread, Dough, Rheology, Texture.*

Introduction

Bread is the main bakery product. Barbari is one of the most popular flat breads widely consumed in the Middle East. The bread is usually 70 to 80 cm long and 25 to 30 cm wide with a thickness of about 3.5 cm. It is produced by mixing all its ingredients to proper consistency and fermenting for two hours. Dough balls are flattened into an oval shape and rested for 20 minutes. Then, a teaspoonful of a concentrated and boiled mixture of flour, water, and oil is poured on the surface to make it shiny and brown after baking. The dough is then docked and grooved with fingers to form five or six one-centimetre deep rows, primarily for decorative purpose. Final proof and baking times are often 15 and 8-12 minutes respectively. The bread weighs about 300-500 g and stales in a few hours (Majzoobi *et al.*, 2011; Maleki *et al.*, 1980).

Because of improper formulation and lack of gluten, the resulting dough cannot raise enough and, therefore, the bread will have a poor volume and texture. In order to obtain a large, open-crumb, good volume flat bread, the cell wall of the dough should be strengthened to retain moisture (Upadhyay *et al.*, 2012). Hydrocolloids are widely used as additives in the food industry because they are useful for modifying the rheology and texture of aqueous suspensions (Dziezak, 1991; Polaki *et al.*, 2010). Hydrocolloids are able to retard the migration of moisture to the bread surface and, thus, retard the staling process during

[*] Corresponding Author: HosseiniGhaboos@yahoo.com

storage (Sciarini *et al.*, 2012). According to Guarda *et al.* (2004), water absorption increases by the addition of hydrocolloids to the bread formulation. Addition of hydrocolloids like alginate, carrageenan, and xanthan increase, while pectin and hydroxypropyl methylcellulose (HPMC) decrease, dough maximum viscosity (Rojas *et al.*, 2001).

Extracts from leaves of aloe vera (*Aloe barbadensis L.*) plant have been used for many years for topical treatment of skin injuries (including wounds and irritations) and as key ingredients in cosmetic formulations. The parenchyma tissue of aloe vera leaves contains over 98% water, with more than 60% of dry matter made up of high molecular weight polysaccharides (Nindo *et al.*, 2010). In commercial processing of shelf-stable ingredients, this large amount of water must be removed with very little disruption to the high molecular weight polysaccharides that contribute to the plant's immune modulating properties. Qiu *et al.* (2000) showed that aloe polysaccharides with molecular weight between 50 to 200 kDa possess significant immunoregulatory activity, while Leung *et al.* (2004) reported that high molecular weight and mannose content are essential for the antitumor potency of aloe vera.

An improvement in wheat dough stability during proofing is obtained by the addition of hydrocolloids such as sodium alginate, carrageenan, xanthan, and HPMC (Rosell *et al.*, 2001). HPMC has an improving effect on the specific volume index, width/ height ratio, and crumb hardness of the fresh bread. In addition, HPMC and alginate show anti-staling effects and retard the crumb hardening (Guarda *et al.*, 2004). Tavakolipour and Kalbasi-Ashtari (2007) investigated the influence of carboxy methyl cellulose (CMC) and HPMC on Lavash bread. According to their results, both gums enhanced significantly the dough quality due to increasing the water absorption and reducing resistances in Extensograph test. However, anti-staling properties of HPMC were better than CMC.

Little data are available on the effect of aloe vera on the dough rheological properties and bread quality in relation to flat breads, especially Barbari bread. Therefore, the aim of this study was to investigate the effect of aloe vera on rheological properties of Barbari dough. Organoleptic properties, textural properties and staling process of the resulting bread were also studied.

Materials and Methods

- Chemical composition of wheat flour

The chemical composition of the flour including moisture content, ash, wet gluten, and protein were determined according to the standard methods of American Association of Cereal Chemists (AACC, methods 44-16A, 08-03, 56-81B and 46-13, respectively, 2000). Commercial wheat flour with extraction rate of 82% containing 14.5% protein, 14.2% moisture, 32% wet gluten, and 0.822% ash was obtained from the local market. Baker’s yeast was obtained from Iranmellas Company (dry instant yeast, Iranmellas company, Iran).

- Barbari dough preparation

Aloe vera powder was purchased from Alavi food science company (Puvanenthiran *et al.* 2014). Barbari dough was prepared according to the following formula: wheat flour (100 g), salt (2 g), dry instant yeast (1 g), water (according to Farinograph water absorption). Aloe vera was added when required at 0, 1, 3, 6 and 9% (w/w based on flour). The complete mixing of the dough samples was performed in a fork-type mixer at 75 rpm within 5 minutes. The dough was fermented at 35°C and a relative humidity of 85% for 45 minutes in a fermentation cabinet, divided into 400 g balls and then the intermediate proofing conducted for 40 minutes. The process was followed by flattening and final proofing for 5 minutes. The baking of Barbari bread was performed for 30 minutes in a traditional oven at 210°C. Baked loaves were then allowed to cool down to room temperature, packed in polypropylene bags and kept at room temperature until required for analysis.

- *Rheological properties of the dough*

Water absorption, dough development time (DDT), and dough stability were determined using a Brabender Farinograph (Germany). Viscoelastic behavior of dough samples was determined by Brabender Extensograph (Germany) according to the standard methods of AACC (Method 54-21 and 54-10) (AACC, 2000). The parameters studied were resistance to extension (R), extensibility (E), ratio figure (R/E), and energy (Area) with resting time of 45, 90, and 135 min.

- *Textural properties*

To determine bread hardness and toughness, the textural properties of Barbari bread sample were performed using a texture analyzer (Stevens, Lefra, UK) with a 7 mm diameter cylindrical probe and 5 mm penetration. Bread samples were then seated on the platform and a cylindrical probe loaded at the speed of 1.0 mm s^{-1} to penetrate the sample (Salehi *et al.*, 2016b). The textural parameters recorded were hardness and toughness averaged from three replications. Staling rate was calculated after 2, 24, 48 and 72 hours of preservation.

- *Sensory Evaluation*

The sensory evaluation of fresh breads was carried out by 10 experienced persons. The hedonic test was used to determine the degree of overall liking for the Barbari bread. For this study, trained consumers were recruited from the students, staff and faculty. All consumers were interested volunteers and were informed that they would be evaluating Barbari bread. For the Barbari bread manufacturing study, 10 consumers received five samples and were asked to rate them based on the degree of liking on a nine-point hedonic scale (1 = dislike extremely, 3 = neither like nor dislike, 5 = like extremely). Samples were placed on plates and identified with random three-digit numbers. Panelists evaluated the samples in a testing area and were instructed to rinse their mouths with water between samples to minimize any residual effect (Salehi *et al.*, 2016a).

- *Statistical analysis*

All the experiments were carried out in triplicate order. The experimental data were subjected to an analysis of variance (ANOVA) for a completely random design using a statistical analysis system (SAS 9.1 Institute, Inc.). Duncan's multiple range tests were used to determine the difference among means at the level of 0.05. $P< 0.05$ was selected as the decision level for significant differences (Ramzi *et al.*, 2015; Zameni *et al.*, 2015).

Results and Discussion

- *Dough rheological properties*

The effect of aloe vera powder addition on Farinograph results is summarized in Table 1. The addition of aloe vera to flour increased its water absorption significantly ($P<0.05$). This property of aloe vera has been attributed to the hydroxyl groups in the structure which allows more water interactions through hydrogen bonding (Guarda *et al.*, 2004). Increased water absorption of the dough may be due to the hydrophilic nature of added aloe vera. They are able to absorb and maintain water and decrease the free water molecules and amylopectin recrystallization (Bárcenas & Rosell, 2007). Water absorption is an important dough property, which, if increased, may result in slower bread staling rate (Pomeranz, 1988). Wheat flour containing 9% aloe vera had higher water absorption than the control sample (P< 0.05). The results is in agreement with those of Friend *et al.* (1993), Rosell *et al.* (2001), Guarda *et al.* (2004) and Smitha *et al.* (2008).

Dough development time (DDT) is the time required for the dough development or time necessary to reach the maximum consistency. DDT is increased with aloe vera powder addition. Generally, stronger dough has higher DDT and there is a positive correlation between dough protein content and DDT (Pomeranz, 1988). Stability of dough, indicating the time the curve remains at 500 BU (Brabender Units, 500 BU= 1.1 Nm) and showing the flour mixing tolerance, had an obvious change by aloe vera powder addition. Dough with proper stability show good gluten network forming (Pomeranz, 1988). The treatments showed a reduction in the stability of dough (P< 0.05) with the addition of aloe vera. Lowest stability was produced by the addition of 9% aloe vera.

Smitha *et al.* (2008) reported that DDT is increased with the addition of xanthan and decreased by the addition of Arabic gum, guar and hydroxy propyl methyl cellulose (HPMC). The latter hydrocolloids also caused a decrease in dough stability. Guarda *et al.* (2004) studied the influence of different hydrocolloids (sodium alginate, κ-carrageenan, xanthan and HPMC) on dough rheology and bread quality. They reported that DDT slightly increased with all hydrocolloids; nevertheless, alginate was the one that promoted the highest effect. They also found that the stability of dough was clearly affected by hydrocolloid concentration tested; obtaining a lower stability at the lowest hydrocolloid concentration, with an exception of κ-carrageenan. Our data was also compatible with that of Tavakolipour and Kalbasi-Ashtari (2007) who found a decrease in stability time by the addition of carboxy methyl cellulose (CMC) or HPMC to the dough formulation. In addition, farinograph quality number (FQN) results showed that with the addition of aloe vera powder on dough, the FQN was decreased from 117.33 to 98.00.

- *Extensograph*

For Extensograph test, each test piece was stretched at 45, 90, and 135 minutes after the end of the mixing. This procedure was designed to simulate the fermentation period in conventional bread baking. The following characteristics of the Extensograph are widely used for determination of dough quality: the extensibility (E), expressed as the length of the curve until the point of rupture; the resistance at a fixed extension, usually corresponding to 50-mm transportation of the chart paper (R_{50}); R_{50}: E ratio (R_{50}/E); the area under the curve which is proportional to the energy that is required to bring about rupture of the test piece along the predetermined path (Dempster *et al.*, 1952). The results of Extensograph analysis

Table 1. The effect of aloe vera powder addition on Farinograph results

Treatment	Water absorption (Min)	Dough development time (Min)	Dough stability (Min)	Dough softness (after 10 min)	Dough softness (after 12 min)	Farinograph quality number (FQN)
Blank	60.7 ^{d}	2.53 ^{b}	8.40 ^{ab}	32.33 ^{ab}	52.33 ^{c}	117.33 ^{a}
1%	61.33 ^{d}	2.33 ^{b}	8.88 ^{a}	23.33 ^{b}	44.00 ^{c}	115.33 ^{a}
3%	62.80 ^{c}	6.43 ^{a}	8.83 ^{bc}	31.33 ^{ab}	83.66 ^{b}	102.00 ^{a}
6%	67.20 ^{b}	6.70 ^{a}	7.33 ^{cd}	27.33 ^{ab}	94.00 ^{b}	103.33 ^{a}
9%	70.73 ^{a}	6.93 ^{a}	6.93 ^{d}	34.66 ^{a}	116.33 ^{a}	98.00 ^{a}

Values are the mean of three replications; different letters in each column indicate significant differences (P≤0.05).

are presented in Tables 2 and 3. The viscoelastic behaviour of the dough was affected by aloe vera addition. In all treatments, the extensibility of dough was significantly decreased with an increase in the resting time from 45 to 135 minutes, probably owing to the water-biding ability of aloe vera (P< 0.05).

The results, also, showed that higher concentration of aloe vera gave significantly shorter extensibility (P< 0.05). The addition of 9% aloe vera to the dough formulation was more effective than in terms of reduction in dough extensibility. The addition of aloe vera into dough formulation can strengthen the dough by forming a strong interaction with the flour protein (Collar *et al.*, 1999; Rosell *et al.*, 2001). Hence, in a multiphase system like bread dough, this bifunctional behaviour allows the dough to retain its uniformity and to protect and maintain the emulsion stability during baking (Bell, 1990).

Table 2 shows the effect of aloe vera on dough resistance (R_{50} value). With an increase in resting time from 45 to 135 minutes, the R_{50} value for both the control and aloe vera added samples was significantly increased (P< 0.05). The R_{50} value was also affected by aloe vera concentration. The application of aloe vera in dough formulation caused a significant increase in R_{50} value of dough samples as compared to the control sample (P< 0.05). The higher the aloe vera concentration (9%), the higher was the R_{50} value (P< 0.05). Pomeranz (1988) reported that by increasing the water content, an increase in extensibility occurs that accompanies a decrease in the resistance. As the R_{50} predicts the dough handling properties and fermentation tolerance and the increased promotion by aloe vera addition suggests a good handling behaviour and a large dough tolerance in the fermentation stage (Rosell *et al.*, 2001). As shown in Table 2, the overall effect of aloe vera resulted in augmented R_{50}/E. As the resting time increased from 45 to 135 minutes, the dough deformation energy value also increased for all the samples (P<0.05, Table 3). The addition of

Table 2. The effect of aloe vera powder on Extensogragh characteristics of flour

Parameters	Extensibility (mm)			Maximum dough resistance (g)			R_{50}: E ratio (R_{50}/E)		
Treatment	**45 min**	**90 min**	**135 min**	**45 min**	**90 min**	**135 min**	**45 min**	**90 min**	**135 min**
Blank	155.33 ^{a}	145.33 ^{a}	143 ^{a}	295 ^{d}	411 ^{d}	394 ^{c}	1.40 ^{c}	2.20 ^{d}	2.23 ^{d}
1%	131 ^{b}	131 ^{b}	122 ^{b}	460 ^{c}	594 ^{c}	547 ^{b}	2.93 ^{b}	3.80 ^{c}	8.30 ^{c}
3%	116 ^{cd}	113 ^{c}	107 ^{c}	318 ^{a}	756 ^{a}	717 ^{a}	4.70 ^{a}	6.20 ^{a}	6.10 ^{a}
6%	125 ^{bc}	113.33 ^{c}	115 ^{bc}	567 ^{ab}	720 ^{a}	704 ^{a}	4.13 ^{a}	5.80 ^{ab}	5.73 ^{a}
9%	111 ^{d}	112.33 ^{c}	112.33 ^{bc}	493 ^{bc}	662 ^{b}	598 ^{b}	4.20 ^{bc}	5.53 ^{b}	5.13 ^{b}

Values are the mean of three replications; different letters in each column indicate significant differences (P≤0.05).

Table 3. The energy required to tear the dough (cm^2)

Treatment	45 min	90 min	135 min
Blank	72.33 ^{a}	81.00 ^{b}	77.00 ^{c}
1%	83.33 ^{a}	94.33 ^{ab}	88.33 ^{abc}
3%	98.00 ^{a}	106.00 ^{a}	98.00 ^{ab}
6%	91.33 ^{a}	105.00 ^{a}	101.33 ^{a}
9%	71.33 ^{a}	97.00 ^{ab}	86.33 ^{bc}

Values are the mean of three replications; different letters in each column indicate significant differences (P≤0.05).

aloe vera to the dough formulation had significant effect on deformation energy. According to Smitha *et al.* (2008) the energy or work output necessary for the deformation at 135 minutes was reduced by the addition of some hydrocolloids (Arabic gum, guar, HPMC and carrageenan), with the exception of xanthan. Rosell *et al.* (2001) also reported that the addition of some hydrocolloids (HPMC, alginate and carrageenan) decreased the energy for the deformation, with the exception of xanthan.

- *Textural properties*

As the staling of bread occurs, its texture becomes stiffer and more extending force is required for cutting (Gujral & Pathak, 2002). The effect of hydrocolloids on Barbari bread textural properties (hardness and toughness) was reported in Table 4. The hardness of Barbari bread increased during storage. Bread samples containing aloe vera at 1% level reduced the staling process ($P<0.05$). The results were in agreement with that of Abu-Ghough *et al.* (2002) and Tavakolipour and Kalbasi-Ashtari (2007), who reported antistaling effect of CMC and HPMC on Arabic flat bread and Lavash (a traditional Iranian bread), respectively. The softening effect of aloe vera may be attributed to their water retention capacity. They likely prevent the amylopectin retrogradation (Collar *et al.*, 1999). Shalini and Laxmi (2007) incorporated various levels of hydrocolloids ranging from 0.25 to 1.0% into whole wheat flour. They showed that the forces required for tearing the fresh Chapatti bread decreased with hydrocolloids addition, and guar addition at 0.75% level gave softest Chapatti, followed by CMC and HPMC at 0.75 and 0.5%, respectively.

According to Guarda *et al.* (2004), the most evident changes during storage of bread are related to moisture content loss and crumb hardening. It was reported that breads containing hydrocolloids showed lower loss of moisture content and thus reduced dehydration rate of crumb during storage. Friend *et al.* (1993) reported that rollability characteristics of Tortilla bread were retained for a longer period with addition of CMC and cellulose-based commercial blends. Staling is a very complex process, which cannot be explained by a single effect and involves amylopectin retrogradation and reorganization of polymers within the amorphous region (Rojas *et al.*, 2001). Biliaderis *et al.* (1997) proposed that the effect of the addition of hydrocolloids results from two opposite phenomenon. First, an increase in the rigidity as a consequence of the decrease in the swelling of the starch granules and amylose, and, secondly, a weakening effect on the starch structure due to the inhibition of the amylose chain associates, although the weight of each effect will be dependent on the specific hydrocolloids.

- *Sensory evaluation*

For measuring product liking and preference, the hedonic scale is a unique scale, providing both reliable and valid results (Stone *et al.*, 2012). The effect of various aloe vera on sensory properties of Barbari bread is shown in Table 5. Each attribute was scored from 1 (lowest) to 5 (highest). Regarding the aroma and taste, bread containing 9% aloe vera received the lowest score. The addition of aloe vera resulted in significantly lower scores regarding the density and porosity, as compared with the control bread. Tavakolipour and Kalbasi-Ashtari (2007) in their investigation about Lavash bread showed that dough samples containing CMC and HPMC at 1% level had significantly better organoleptic attributes (firmness, softness, and chew-ability) than the control breads. Smitha *et al.* (2008) reported that the addition of hydrocolloids improved the shape of Parotta bread. In general, Parottas with hydrocolloids had a soft and pliable handfeel. They concluded that hydrocolloids

Table 4. Characteristics of bread containing aloe vera powder (2, 24, 48 and 72 hours after baking)

Day	Hardness (N)					Toughness (mJ)				
	Blank	**1%**	**3%**	**6%**	**9%**	**Blank**	**1%**	**3%**	**6%**	**9%**
1	13.05 a	4.99 b	5.75 c	10.28 d	24.66 a	24.66 a	11.46 b	7.86 c	20.30 a	60.70 a
2	17.29 a	11.59 a	17.57 b	17.89 c	23.84 a	34.46 a	26.52 ab	38.00 b	39.93 b	44.30 a
3	18.25 a	12.81 a	30.39 a	29.57 b	28.08 a	37.56 a	24.86 ab	56.66 a	49.66 b	59.00 a
4	18.47 a	16.25 a	25.69 a	28.11 a	29.32 a	27.36 a	32.36 a	54.33 ab	85.53 a	68.57 a

Values are the mean of three replications; different letters in each column indicate significant differences (P≤0.05).

Table 5. The average score related to the sensory evaluation of bread

Treatment	Aroma, taste	Shape	Chewiness	Density and porosity	Firmness and softness of texture
Blank	3.7 a	3.7 a	4.1 a	4.1 a	4.2 a
1%	2.9 b	3.3 a	3.1 b	3.3 b	3.1 b
3%	2.1 c	2.7 b	3.1 b	3.0 b	2.8 b
6%	1.8 c	2.4 b	2.5 b	2.5 b	2.2 c
9%	1.7 c	2.6 b	2.7 b	1.7 c	2.0 c

Values are the mean of three replications; different letters in each column indicate significant differences (P≤0.05).

improved the overall quality of Parotta and the highest improvement in the overall quality was brought about by guar, followed in decreasing order by HPMC, xanthan, carrageenan, and Arabic gum.

Conclusion

The present study showed that the addition of aloe vera improved the rheological characteristic of Barbari dough. Dough water absorption, which has a great effect on bread quality and its shelf-life, was increased. DDT increased with all concentration of aloe vera powder. The treatments showed a reduction in the stability of dough (P< 0.05) with the addition of aloe vera. Lowest stability was produced by adding 9% aloe vera. The results showed that higher concentration of aloe vera gave significantly gave shorter extensibility (P<0.05). The addition of 9% aloe vera to the dough formulation was more effective than in terms of reduction in dough extensibility. Sensory analysis revealed that when aloe vera was added to the bread formulation, some sensory indexes of the bread, such as aroma and porosity, were enhanced more pronouncedly than the other indexes.

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