The effect of applying apple pomace and sodium stearoyl -2-lactylate on rheological properties and shelf life of Taftoon bread

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Abstract: This study was designed to investigate the effect of applied apple fiber and Sodium Stearoyl Lactylate on improve the rheological properties and staling of traditional Taftoon bread. The rheological properties of dough were evaluated using farinograph and extensograph. Bread staling test was applied by sensory evaluation during 1, 2, and 3 days. For this purpose, three different amounts of apple fiber (7%, 9%, and 13%) were dried in a cabinet dryer at 58$^{\circ C}$ as a powder as well as Sodium Stearoyl Lactylate (SSL) at 0.75%, and 1.0% (w/w) were added to the flour. A full factorial design used to arrange treatments. The results of farinograph indicated that, samples D1 (7% apple fiber and 0.75% SSL) and D3 (13% apple fiber and 0.75% SSL) had the highest water absorption capacity respectively and Sample D2 had lower degree of softening, and higher quality properties compared to control and also the other samples. The results of extensograph in the sample containing 13% apple fiber and 0.75% SSL indicated lower ratio and high energy for all three time ranges (45, 90, 135 min) as compared with other experimental samples. The results of the panelists indicated that the enriched breads containing 13% apple fiber and 0.75% SSL obtained highest bread score for overall acceptability. The results of this study demonstrated that the combination of high level of apple fiber and SSL in the Taftoon bread significantly retard staling on it and improved its rheological properties.

Key words: Apple pomace, Bread staling, sodium stearoyl -2-lactylate, Rheological properties

Introduction:

Wheat and its products, especially bread, constitute the main food source in many countries and provide daily main source of energy, protein, and minerals for people. Flat bread such as lavash, Taftoon, Barbari and Sangak are considered the most traditional bread in the Middle East, also consumed worldwide. However, their quality is lower than that of non-flat bread. Retarding staleness is an important issue in bakery industry and has also economic importance. In Iran, bread wastes caused by staling are much significant as estimated by 20-25% (Payan,2001) . Based on literature breads contained high fiber has longer shelf life than the control sample because fiber may bond to water preventing from moisture loss or may react with starch retarding starch retrogradation. Fibers are cell walls of plants which are not broken down by digestive enzymes. They include cellulose, hemicelluloses, lignin, pectin, gums, and mucilage which may be used to reduce calories and also disease such as high cholesterol, diabetes, and constipation (Mandala et al., 2007). Apple fiber is a byproduct of apples squeeze (sudha et al., 2007). Apples may be used as a good source of dietary fiber (Mckee and Lather., 2000). Fibers derived from fruits and vegetables contain high amount of soluble fiber while fibers originated from grains consisted of insoluble cellulose and hemicellulose. Vegetable fibers show practical properties including water holding capacity, swell capacity, increased viscosity or gelation, ability to bond to biliary acids and cationic exchange capacity which all have significant role in physiological functions (Gallaher and Schneeman., 2001). These are due to their porous network structure formed by polysaccharide chains which may hold high amount of water through hydrogen bond (Kethireddipalli et al., 2002), or water may be hold in capillary structures of fibers through surface absorbption (Lopez et al., 1996). Fibers usually are divided into soluble dietary fibers and insoluble dietary fibers (Gorinstein et al., 2001). Fibers originating from grains are frequently used by bakery industry, while fruit fibers are highly soluble, have higher total fiber (TDF) and also have high water holding capacity and are fermentable in intestines are of higher quality and contain lower phytic acid. Thus it seems necessary to develop the processes of fruit fibers production because of their health benefits (having bioactive compounds such as flavonoids, polyphenols, and carotenes). The previous studies showed that applying fibers singly is not sufficient to improve bread volum because of an interaction between fiber and gluten leading to reduced gas holding capacity of bread. Therefore, some additives such as emulsifiers must be applied to eliminate the unwanted effects of fiber addition on kneading properties of dough and bread volum decrease sodium stearueal lactilate (SSL) is obtained through combining lactic acid and stearic acid. It may react with sodium hydroxide producing sodium salt. Sodium stearueal lactilate is an emulsifier used by bakery industries to keep bread soft texture and prevent recrystalization of starch amylase by gelatinizing. The effect of applying different concentrations of SSL (0.25% , 0.5%, 0.75%) as an improver on the properties of dough and Taftoon bread was investigated in 2006. Previous researchers Masoodi and Chauhan (1998) were added apple fiber as a source of dietary fiber at 2, 5, 8 and 11% to wheat flour and they observed that the apple fiber significantly increased water binding capacity. They reported that when the fiber concentrations increased, the volume of dough decreased. In another study Masoodi et al (2002) investigated the application of apple fiber as a dietary fiber on cakes. Dried powdered apple fiber at 5, 10, and 15% with different sizes mixed with wheat flour of the cakes. They

observed that increased apple fiber and reduced particle size resulted in increased viscosity. Also specific gravity and pH value of bread dough reduced as a result of increased apple fiber. They also noticed that fiber particle size had significant effect on cake volume as fine particles of fiber made more voluminous cakes compared to coarse particles. Chen et al (1988) were added apple fiber and cellulose to wheat flour and investigated water holding capacity of different mixtures. They observed that apple fiber is a suitable water binder and increased water holding capacity of bread. The aim of this study was to investigate the effect of (SSL) and apple fiber on rheological properties of Taftoon bread dough and staling of bread.

Materials and Methods

Red variety apple was purchased from a farms located in Damavand. At first, the apples were squeezed, then dried at 58-60^{oC} in a cabinet dryer for 2 days. Dried apple fiber was grinded by Tecator mill and then analyzed Sodium Stearoyl Lactylate (SSL) was purchased from Danisco (Denmark) and dry active yeast obtained from Fariman (Iran, Mashhad).

Physicochemical analysis

Flour and apple fiber physicochemical characterizations were: The Moisture content by the AACC method No. 16-44, the ashes content according to AACC No: 01-08, the fat content by AACC No. 10-30, the pH value by AACC No. 02-52, and protein content was determined according to AACC No. 12-46. The particle size and sugar content were determined by national standard methods No. 103 and No. 4781 respectively. Soluble and insoluble fiber were measured with fibertech, Acid Detergent Fibre **(**ADF**)** and Neutral Detergent Fiber (NDF) were measured using Van Soest method. The wet gluten and precipitation of flour were determined according to AACC methods No. 11-33 and No. 116 respectively. The Farinograph test, was conducted using Brabender (Germany) according to the standard method AACC No. 21-54, and dough elasticity was determined as ICC standard methods No. 114.

Sensory evaluation

The sensory and organoleptic assessment of the traditional Iranian bread was carried out by using 15 trained panelists on overall acceptability and staling of bread by using a hedonic scale. The coded samples in plastic bags were examined by the panel and scored. The highest scores were 6 for the desirable bread with lowest staling and 0 for unacceptable bread with highest staling. The panelists evaluated and scored overall acceptability of bread samples after 72 hour (h) storage by considering characteristics including: aroma, taste and flavor, upper and lower surfaces properties, form and shape, chew ability. The sensory evaluations of bread staling of all experimental breads were performed at 24, 48 and 72 h storage in proper packages at room temperature.

Taftoon bread manufacture

Dough of taftoon bread was prepared using direct method. The basic formula for control sample included 100 g of flour, 60-65 g of water, 1 g of yeast, 0.5 g of sugar, 1.5 g salt,1g shortening and different amounts of apple fiber and SSl as powder on a flour replacement basis. The ingredients of each samples were mixed by mixer (Ziafat, Iran) to make a desirable firmness (5 min), then loaves of dough then loaves of dough were prepared followed by primary fermentation for 15 min at 30^{oC} and 75-85% relative humidity, the loaves of dough left for 10 min, followed by secondary fermentation in an incubator at 60-75^{o}C for 2 min, finally bread was baked at 300^{o}C for 60-80 second .

Experimental design and statistical analysis

In this study a completely randomized design (CRD) was used to arrange treatments and in order to investigate the effect of different amounts of apple fiber (7%, 9%, and 13%) and sodium stearoyl -2-lactylate (0.75% and 1.0% w/w) on rheological properties of taftoon bread dough and staling of bread and compare them with control sample (prepared by basic formula and without apple fiber and SSL). Therefore as shown in Table 1, ten treatments were designed in triplicates using mechanical methods and five replicates using sensory methods. The data obtained from the measurements were subjected to one-way analysis of variance (ANOVA) to determine the significant differences among the treatments.All statistical analysis was performed using the Minitab v. 14 statistical package (Minitab Inc., State College, PA, USA).

Table 1. Levels of the independent variable established according to the completely randomized design.

Symbol	Apple fiber (%w/w)	SSL(%w/w)
A (control)	0	0
B1	7	0
B2	9	0
B3	13	0
D1	7	0.75
D2	9	0.75
D3	13	0.75
D4	7	1.0
D5	9	1.0
D6	13	1.0

Results and Discussion

Physicochemical analysis

Results of Physicochemical test of apple fiber and wheat flour, chemical properties of wheat flour and apple fiber are shown in Table 2. The results indicated that the wheat flour used was suitable for the production of Taftoon bread in

terms of the measured parameters including: moisture, ash, protein, wet, gluten, sedimentation unit and pH.

Table 2. Chemical properties of apple pomace and wheat flour

Physicochemical analysis	wheat flour	Apple pomace
Wet (%)	13.7	4.5
Ash (%)	0.7	1.1
Protein (%)	12.4	1.8
Wet Gluten (%)	3.6	---
Falling Number (sec)	612	---
Sedimentation unit (ml)	28-30	---
Fat (%)	2.6	2.5

Discussions

Increased apple fiber content increases water absorption as a result of network structure of fibers consisted of polysaccharide chains holding high amount of water by hydrogen bonds (kethireddipalli et al., 2002) or water may be held in capillary structures of fibers through surface absorption (lopez et al., 1996). Since apple fiber contains high amount of fibers, these results are predictable. Masoodi and chauhan. (1998) obtained similar results. In addition, water absorption of all samples containing apple fiber with gums is higher than the control sample without fiber. This increase in water absorption may be due to hydrophilic structure of gums and higher content of fiber. Hydroxyl groups of hydrocolloids are bound to water molecules through hydrogen bond and increasing water absorption (Tavakol pour & Ashtari, 2006). There is a direct relationship between apple fiber percentage and dough development time so that addition of fiber to the mixture may reduce water absorption rate and gluten development type and amount of fiber have significant effect on water absorption and expansion of dough. A fiber with potential to absorb high amount of water may prolong dough development time. Interactions between fibers and gluten of wheat flour may explain different effects of various fibers on dough development time. The obtained results are consistent with the results obtained by sudha et al. (2007). It may be noted that all samples contained gums showed increased dough development time compared to control sample. In general, it may say that applying higher percentages of apple fiber and SSL to taftoon dough may increase dough development time compared to control sample.The results of dough resistance time of samples are consistent with results obtained by sudha et al. (2007). They reported that, increase the level of apple fiber resulted in reduced dough resistance time. The addition of SSL at all concentrations significantly increased the amount of energy for all three time ranges. The results reveal that bread becomes firm over time while these forces increase. However, adding apple fiber and SSL results in a soft texture and reduced forces as compared with control sample. The results of shear test show that after 0, 24, 48 and 72 h of storage, the required shearing forces significantly reduced as compared with control sample. For sensory properties, treatment D2 had higher score for bread shape, under surface, chew ability, firmness and softness of bread texture showing a significant difference from control sample. For bread crust and porosity, treatment D2 had higher score but it was not significantly different. The addition of apple fiber and SSL also had a significant effect on improving aroma, taste and flavor of bread in treatment D2 showing a significant difference from control sample. Karimi and Azizi (2007) findings also revealed that adding SSL singly to Taftoon bread dough shortened dough expansion time. In the samples containing SSL dough stability time increased and it was possible to make stronger dough via adding an emulsifier to flour sample. The results of the study conducted by Karimi and Azizi (2007) who investigated the effect of different concentrations of SSL on rheological properties of dough and quality of Taftoon bread showed an increase in dough resistance. Adding SSL and apple fiber significantly reduced softening degree of dough. Thus addition of SSL to flour containing apple fiber increased flour strength and decreased softening degree of results are in agreement with Karimi and Azizi (2007) findings showing that dough softening degree reduced after 10 and 20 min. As showing Table 5, adding different amounts of SSL increased farinograph quality degree, consistent with Karimi and Azizi (2007) findings who reported that valorimetry value, representing total quality of dough, increased. Treatments containing higher content of SSL and treatment containing apple fiber showed the highest and the lowest quality degrees, respectively, because different contents of apple fiber weakend gluten network. In general the applied emulsifiers could strengthen control dough and the dough containing apple fiber. Karimi and Azizi obtained similar results showing that SSL reduced elasticity while increased energy and resistance to elasticity. Also their findings agree with Abd-Hady et.al., (1999) and Kenny et.al., (1999) findings who reported similar results for SSL effect on rheological quality and baking of frozen dough of wheat bread. In other words, adding SSL resulted in firmer dough for this time range. The results of sensory evaluation of the produced bread revealed that all sensory properties showing no significant difference from control sample. Thus treatment D2 had higher score and was significantly different control sample. Adding apple fiber and SSL to Taftoon bread flour may improve the quality of the produced bread. The results of shear test show that the required shear force for treatment bread significantly increased compared with that of control sample after 0, 24, 48, 72h of storage. Instron results revealed that there were no significant differences between the treatment and control sample for applied shear force at baking day, while at following days shear force for control sample was significantly higher than that of treatment sample. These findings are in agreement with Karimi et.al., (2006) results showing the addition of 0.5% of SSL to Taftoon bread dough could improve rheological properties and slow down staling, while retaining sensory properties. The addition of apple fiber to wheat flour may improve water absorption

capacity of flour there by slow down bread staling through systematic method while making the bakery dough firmer and undermining its quality. The higher apple fiber percentage, the lower dough fermentability. Adding SLL to the dough could prolong dough stability time, improve dough fermentability and organoleptical properties and reduce bread staleness. Generally, the addition of fruit fibers and proper emulsifiers to traditional flat bread may give good results.

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Table 3. Comparison of results Farinography test on Taftoon dough containing Apple pomace and Sodium Stearoyl Lactylate (SSL)

Treatment	Water absorption%	Dough development time (min)	Dough stability time (min)	Doug softening after 10 minutes (B.U)	Doug softening after 12 minutes (B.U)	Farinograph quality
A	54.70±1.5^{a}	5.50±0.15^{a}	9.00±0.0^{a}	30.5±0.0^{b}	65.0±0.0^{b}	100.0±0.0 ^{c}
B1	57.20±1.6^{ab}	5.75±0.15^{b}	7.55±0.7^{b}	38.5±0.0^{e}	86.0 ±0.0^{e}	89.0±0.0^{b}
B2	58.50±1.6^{ab}	7.00±0.18^{e}	7.05±0.3^{c}	43.0±0.0^{f}	107.0±0.0^{f}	89.0±0.0^{b}
B3	62.00±1.6^{ab}	5.85±0.18^{d}	7.05±0.0^{c}	50.5±0.5^{g}	121.5±0.0^{h}	87.0±0.0^{a}
D1	62.35±1.9^{c}	6.22±0.31^{h}	11.05±0.0^{c}	11.0±0.5^{g}	24.5 ± 0.0^{c}	164.0 ±0.7^{f}
D2	59.15±1.7^{b}	6.90±0.17^{e}	17.50±0.0^{cd}	7.50±0.0^{b}	20.5±0.0 ^{e}	155.5.0±0.0^{d}
D3	62.50±1.7^{b}	13.10±0.19^{g}	14.05±0.0^{d}	4.0±0.0^{a}	0.2±0.0 ^{h}	200.0±0.0^{g}
D4	59.95±1.6^{ab}	6.20±0.17^{f}	17.30±0.0^{bc}	18.5±0.0^{c}	16.5±0.0 ^{b}	155.5.0±0.0^{d}
D5	60.10±1.7^{ab}	6.40±0.18^{d}	14.50±0.0^{b}	15.5±0.0^{d}	0.4± 0.0^{d}	155.5.0±0.0^{d}
D6	62.50±1.7^{ab}	11.00±0.17^{c}	8.00±0.4^{bc}	8.50±0.0^{e}	0.5±0.0^{g}	155.5.0±0.0^{d}

The values reported are mean ± SD.
Different letters in each column are indicate statistical difference at 5% level

Table 4. Comparison of results Extansography test on dough containing Apple pomace and Sodium Stearoyl Lactylate during fermentation time of 45 min

Treatment	Energy (cm2)	Resistance to stretch (B.U)	Ability to stretch (mm)	(Resistance stretch /Ability to stretch)
A	94.0±0.07^{ab}	330.25±2.1^{a}	162.5±11.46^{d}	2.05±0.14^{a}
B1	103.5±14.85^{bcd}	515.50±36.4^{bc}	128.0±9.05^{abcd}	4.05 ±0.28^{cd}
B2	91.0±9.90^{ab}	511.50±36.2^{bc}	117.5±8.20^{ab}	4.35±0.29^{d}
B3	84.5±7.70^{ab}	602.00±42.6^{de}	96.5±6.82^{a}	6.25±0.43^{e}
D1	128.5±7.70^{ab}	601.50±41.7^{de}	134.5±6.82^{a}	4.45±0.17^{ab}
D2	116.5±0.71^{ed}	484.00±35.2^{bc}	142.0± 9.69^{bcd}	3.40±0.25 ^{bcd}
D3	127.0±4.5 ^{a}	148.5±10.28 ^{cd}	507.50±29.3^{ab}	3.40±0.22^{abcd}
D4	81.5±18.38^{e}	536.50±27.9^{ab}	104.5±11.06^{d}	5.10±0.19^{abc}
D5	84.0±11.31^{abc}	568.50±33.1^{abc}	102.0±9.05^{abcd}	5.60±0.29^{d}
D6	93.0±7.78^{e}	626.50±47.0^{e}	101.0±7.52 ^{ab}	6.20±0.43^{e}

The values reported are mean ± SD.
Different letters in each column are indicate statistical difference at 5% level

Table 5. Comparison of results Extansography test on dough containing Apple pomace and Sodium Stearoyl Lactylate during fermentation time of 90 min

Treatment	Energy (cm2)	Resistance to stretch (B.U)	Ability to stretch (mm)	(Resistance stretch /Ability to stretch)
A	64.7±4.57 ^{a}	284.50±20.0^{a}	139.2±12.85^{a}	2.25±0.15^{a}
B1	104.5±6.68 ^{bcd}	662.0± 46.8^{bcd}	108.0±7.64^{ab}	5.95±0.41^{b}
B2	129..0±7.03^{ab}	764.5±54.1^{de}	114.0±8.06^{a}	6.8±0.48^{b}
B3	144.0 ±6.46 ^{ab}	982.0±69.5^{e}	108.5±7.67^{c}	9.1±0.63^{c}
D1	106.5±9.08^{de}	394.5±27.9^{ab}	154.5±10.92^{bc}	2.55±0.17^{a}
D2	120.0±2.05^{cde}	565.0±40.0^{bc}	147.5±10.42^{abc}	3.50±0.24 ^{a}
D3	132.0±7.99^{bcd}	621.0±34.90^{bc}	120.5±14.85 ^{abc}	4.10±0.28^{def}
D4	111.5±10.18^{d}	606.0±42.90^{bcd}	125.5±17.68^{abc}	4.90±0.33^{b}
D5	116.0.±7.85^{bcd}	768.50±42.50^{bcd}	122.0±14.14^{abc}	5. 0±0.35^{b}
D6	114.5±7.64^{bcd}	866.50±63.00^{e}	105.5±7.54 ^{a}	8.45± 0.66^{c}

The values reported are mean ± SD.
Different letters in each column are indicate statistical difference at 5% level

Table 6. Comparison of results Extansography test on dough containing Apple pomace and Sodium Stearoyl Lactylate during fermentation time of 135 min

Treatment	Energy (cm2)	Resistance to stretch (B.U)	Ability to stretch (mm)	(Resistance stretch /Ability to stretch)
A	65.5±4.62[a]	274.0± 19.40[ab]	150.0±10.61[ab]	1.85±0.12[a]
B1	115.0± 8.13[bc]	687.0± 48.60[b]	120.5±8.50[ab]	5.7±0.39[b]
B2	114.0±8.06[bc]	858.5±60.70[c]	108.0±7.64[ab]	8.35±0.58[b]
B3	94.0±6.65[b]	995.5±70.40[c]	93.0±8. 0[ab]	10.7±0.75[b]
D1	121.5±8.58[bc]	453.5±31.90[a]	133.5±9.08[ab]	3.4±0.21[c]
D2	125.5±9.22[c]	565.0±40.10[b]	136.0±9.62[ab]	4.20±0.29[bc]
D3	129.5±9.15[c]	610.5±43.10[b]	142.0±10.04[ab]	4.6± 0.32[bc]
D4	97.5±6.89[b]	478.5±33.80[a]	130.0±9.48[ab]	3.75±0.25[c]
D5	110.0±7.78[bc]	641.5±45.30[b]	117.5±8.66[ab]	5.5±0.38[bc]
D6	118.0±8.34[bc]	937.5±66.30[c]	95.0±6.72[ab]	9.85±0.69[bc]

The values reported are mean ± SD.
Different letters in each column are indicate statistical difference at 5% level

Table7. Mean scores of sensory evaluation treatments when coefficients applied and Sensory evaluation

Treatment	Overall acceptability of Bread after 72 h storage[a]	Bread staling score[a]		
		24 hours	48 hours	72 hours
A	3.20±0.22[a]	5.40±0.38[a]	3.60±0.25 [a]	2.0±0.14 [a]
B1	4.0±0.28[ab]	5.60±0.39[a]	5. 0±0.35 [ab]	4.15±0.28 [b]
B2	4.21±0.29[ab]	5.80±0.41 [a]	5.20±0.36[b]	4.50±0.34[b]
B3	4.60±0.32[b]	5.80±0.41[a]	5.40±0.38 [b]	4.80±0.33[b]
D1	4.20±0 .29[ab]	5.60±0.39 [a]	5.20±0.36[b]	4.0±0.28[b]
D2	4.40±0.45[ab]	5.60±0.39[a]	5.40±0.38[b]	4.20±0.29[b]
D3	4.95±0.33[b]	6.00.42 [a]	5.80± 0.41[b]	5.20±0.36[b]
D4	4.15±0.28[ab]	5.60±0.39[a]	5.20±0.33[ab]	4.20±0.29[b]
D5	4.55 ±0.31 [b]	5.80±0.41[a]	5.40±0.38 [b]	4.0±0.28[a]
D6	4.75±0.32[b]	6.0±0.42 [a]	5.60±.0.39[b]	4.80±0.33[b]

[a]:The highest scores were 6 for the acceptable bread with lowest staling and 0 for unacceptable bread with highest staling
The values reported are mean ± SD.
Different letters in each column are indicate statistical difference at 5% level