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Effect of Flour Extraction Rate on Flour Composition, Dough Rheological Characteristics and Quality of Flat Bread

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ABSTRACT

The effect of flour extraction rate on flour composition, dough rheological characteristics and the quality of Iranian flat breads (lavash, taftoon and barbari) and their staling rate was investigated. Flours with different extraction rates (70, 75, 80, 83, 86, 88, 90 and 93) were subjected to different tests. Resultes indicated that, by increasing the extraction rate, the amount of protein, fat, fiber, ash, wet gluten, water absorption and the color of the flours all increased but the moisture content, sedimentation value and falling number decreased. Rheological studies of doughs by farinograph showed a reduction in dough stability, whereas the dough mixing tolerance index increased along with the extraction rate. By using an extensigraph it was shown that dough resistance, extensibility and the area under extensigram curves were decreased by increasing the extraction rate. A study of the effects of flours with different extraction rates on bread quality, showed that the overall quality of breads is generally affected by the flour extraction rate. Sensory analysis of breads in respect to overall quality and staling indicated that the desirable rates of extraction for lavash, taftoon and barbari, breads are 88, 90 and 88 respectively.

Keywords: Flat bread quality, Flour extraction rate, Rheological properties, Staling.

INTRODUCTION

Epidemiological studies have shown that the incidence of cardio-vascular disease, gastrointestinal disease and diabets among people living in industrial communities has increased. Studies, however, also indicated that the main reason for these problems could be related to the lack of fiber in their daily diet (Pomeranz *et al*, 1977). Bakery products and particularly bread are the best potential sources of fiber in this regard. The highest percentage of wheat bran that can be used for bread making is seven percent and these kinds of breads compared to others that are produced from white flours have an acceptable quality (Pomeranz *et al*., 1977). Regarding the effect of wheat bran on dough rheological characteristics and bread quality, many investigations have been reported (Haridas Rao and Malini, 1991; Lai *et al*., 1974). Wheat bran has an adverse effect on bread volume. On the other hand, the particle size distribution profile of wheat bran also plays an important role on its effect. Results indicated that when the size of the wheat bran added to flour gets finer, the negative effect of wheat bran on bread volume is lower (Lai *et al*., 1974). Orth and Mander (1974) used flours with different extraction rates or yields and mentioned that special attention should be paid to the effect of the extraction rate on flour properties. Nikolaer and Mityukova (1976) reported that, with respect to any appreciable differences between compounds of wheat bran and wheat endosperm and even endosperm structure, flours with different extraction rates have different qualities. Moto *et al.*

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(1973), Nikolaer and Mityukova (1976), Venkateswara *et al.* (1985), Mansour *et al.* (1988), Qarooni *et al.* (1993), and Qarooni *et al.* (1994) have all investigated the effect of the flour extraction rate on flour composition, dough rheological characteristics, bread quality and rate of staling on their native breads. However, to the best of our knowledge, there is hardly any information on the effect of flour extraction rate on the flour composition, dough rheological characteristics and quality of Iranian flat breads.

MATERIALS AND METHODS

Wheat used in this study was (Khazar1) which is produced at Mazandaran Province. Wheat was milled using Buhler laboratory mill to different extraction rates of (70, 75, 80, 83, 86, 88, 90 and 93) that were used for different experiment. Active dried yeast was obtained from Fariman Co., Khorasan, Iran.

Chemical and Physical Analysis of Flours

Moisture, ash, fiber, fat, wet gluten and sedimentation tests were determined according to AACC standard methods (1983) 44-16 A, 08-07, 32-17, 30-10, 38-11 and 56-11 respectively. Flour color was measured using Kent-Jones colorimeter (Tinsley Co., UK). The falling number was determined using AACC method 56-81 (1983).

Rheological Characteristics

For investigating dough properties, Farinograph and Extensigraph instruments were used, based on methods 54-21 and 54-10 of AACC (1983).

Bread Making

The breads investigated in this study were lavash, taftoon and barbari that are the predominant and the most consumed flat breads in Iran. Production of these breads was performed using a method suggested by Maleki and Parchami (1975) without the addition of any bread improver. Specifications for the bread baking conditions have been presented in Table 1.

Sensory Analysis of Breads

The bread quality was investigated according to Rajabzadeh (1991). Sensory evaluation was performed using 15 expert panelists. The overall quality of the breads was evaluated by considering quality characteristics such as bread shape, crust, upper and lower surface, cavity and porosity, firmness and softness of texture, chewing ability, taste and aroma and the results were reported as scores. The scores ranged from 0 to 5, with 5 being the highest value.

Table 1. Specification of different types of Iranian flat breads.

Character	Bread type		
	Lavash	Taftoon	Barbari
Dough loaf weight (g.)	180	300	400
Dough mixing time (min.)	10	15	20
First fermentation time (min.)	60	60	90
Second fermentation time (min.)	10	10	15
Third fermentation time (min.)	1	1	5
Fermentation temperature (^oC)	30	30	30
Kind of furnace	Curvature[a]	Curvature[a]	Cupola[b]
Baking temperature (^oC)	320	300	250
Baking time (sec.)	40	60	480

[a] A traditional kind of oven that is round and vat shaped made from clay.
[b] A traditional kind of oven that is chamber and dome shaped with a window in front and made from clay.

Bread Staling Evaluation

The staling rate of breads was evaluated using AACC (1983) method 74-30. After cooling, breads were packed in polyethylene bags, stored at room temperature and evaluated after 24, 48 and 72 hours.

Statistical Analysis

The means of results obtained from a sensory evaluation of the staling rate during storage were analyzed using a completely randomized design (CRD) test. For a mean comparison of averages and introducing the best sample, Duncan's new multiple range test was used. Statistical analysis of the data was carried out using SPSS software (Kinnear and Gray, 1999).

RESULTS AND DISCUSSION

Chemical Characteristics of Wheat Flours

The results obtained for the chemical characteristics of wheat flours have been presented in Table 2. This shows that characteristics such as moisture, ash, protein, crude fiber, fat, sedimentation number, wet gluten, falling number and color grade value are all affected by flour extraction rates. With the exception of moisture, falling number and sedimentation number all of which decreased with increasing of flour extraction rate, all other parameters have increased. The reduction in flour moisture with the increase in the flour extraction rate is due to the presence of more wheat bran in flour which has less moisture compared with aleuron particles. This also affects flour water absorption and the storage quality of this flour. Reduction in the falling number shows an increase in alfa-amylase activity of flours with a higher extraction rate, which is due to an increase in wheat germs and bran in flours. By increasing the flour extraction rate, the protein and crude fiber content of flour will increase and this is very important for nutritional issues and the physiological effect of cellulose on the digestive system. Although with increasing the extraction rate of flour the quantity of protein will increase, the sedimentation test shows that the quality of gluten will be reduced and this causes the weaker baking quality of high extraction rate compared to lower extraction rate flour. One of the physical properties that depends on the extraction rate is flour particle size. This property affects the rheological characteristics of dough, such as water absorption and bread baking quality. Coarser particles were obtained from flours with a higher extraction rate which, in turn, can affect the gluten network of dough, starch gelatinization, volume, texture, shelf life and general quality of bread. Nikolaer and Mityukova (1976) reported that flours with different extraction rates are of different quality.

Table 2. Quality characteristics of wheat flours with different extraction rates.

	Extraction rate (%)							
Experiment[a]	70	75	80	83	86	88	90	93
Moisture(%)	12.30	12.02	11.80	11.60	11.09	10.45	10.10	9.88
Ash(%)	0.54	0.57	0.79	0.92	1.06	1.17	1.30	1.51
Protein(%)	10.64	10.67	10.90	11.06	11.20	11.41	11.54	11.77
Crud fiber (%)	0.34	0.43	1.20	1.35	1.74	1.96	2.01	2.24
Fat (%)	1.10	1.16	1.31	1.45	1.70	2.10	4.26	4.70
Sedimentation (ml)	27	25	24	22	19	15	12	11
Wet gluten (%)	24.2	24.8	25.8	26.2	26.1	24.4	25	26.1
Falling no. (sec.)	570	565	551	540	533	525	510	506
Color (K.J)	0.85	1.72	6.30	8.85	10.20	11.30	12.30	13.41

[a]All values except wet gluten are expressed on 14% moisture basis.

Rheological Properties

To study the effects of the flour extraction rate on the rheological properties of dough, farinograph and extensigraph tests have been applied to flours and the results are presented in Tables 3 and 4. As shown in Table 3, water absorption was increased by increasing the flour extraction rate but dough stability and the mixing tolerance index after 10 and 20 minutes were reduced. This shows the negative effect of wheat bran on dough rheological characteristics and the gluten network. The effect of flour extraction rate on extensigram characteristics has been presented in Table 4. This is such that, with increasing the flour extraction rate, resistance to extension, extensibility and the area under the extensigram curves reduced. This negative effect of a higher extraction rate flour on dough rheological characteristics is due to a reduction in the gluten network and quality due to the presence of a larger amount of wheat bran in flour that results in weaker resistance to mechanical shocks. The same result showing the effect of wheat bran on dough rheological characteristics has been reported by Haridas Rao and Malini) (1991) and Lai *et al*., (1974).

Bread Quality

Iranian breads were evaluated for shape, crust, upper and bottom surface, cavity and porosity, firmness and softness of texture, chewing ability, odor, flavor and taste by a team of expert panelists. This sensory analysis of bread is reported in Table 5. As is shown, by increasing the extraction rate of flours, the quality of breads was improved up to a 90 percent extraction rate. The same result has been reported by Lai *et al*. (1974). Statistical analysis shows that, by increasing the extraction rate of flour, bread quality is affected significantly and differences in bread quality averages are meaningful at (P=0.05). Based on the results presented in Table 5 with a higher than 95 percent probability, it can be concluded that the best extraction rate of flour for baking lavash is 88, for taftoon is 90 and for barbari is 86 and 88 percent. There is no difference between an 86 and 88 percent extraction rate for barbari and given the better nutritional and economical characteristics of higher extraction rate flour, it can be concluded that the best extraction rate for barbari is 88 percent.

Table 3. Effect of flour extraction rate on farinograph characteristics.

	Flour extraction rate (%)							
Rheological properties	70	75	80	83	86	88	90	SEM(±)
Water absorption (%)	61.0^{b}	61.0^{b}	61.5^{c}	62.7^{d}	63.9^{f}	56.6^{a}	66.3^{e}	0.26
Dough development time (min.)	2.5^{a}	2.5^{a}	3.0^{b}	3.3^{bc}	3.5^{c}	3.8^{d}	3.3^{bc}	0.23
Dough stability (min.)	8.4^{e}	8.5^{e}	6.0^{d}	4.8^{c}	4.2^{c}	3.5^{b}	2.7^{a}	0.21
Mixing tolerance index after 10 min(BU)	85^{e}	80^{d}	80^{d}	80^{d}	70^{c}	50^{b}	33^{a}	2.61
Mixing tolerance index after 20 min(BU)	140^{e}	140^{e}	140^{e}	135de	130^{d}	100^{c}	70^{b}	2.42
Dough rupture time (min.)	4.5^{a}	4.5^{a}	4.5^{a}	5.5^{b}	6.0^{bc}	7.7^{c}	10.0^{d}	0.41
Valorimeter value (BU)	54^{b}	56^{c}	56^{c}	53^{ab}	54^{b}	56^{c}	52^{a}	1.09

Values in the same row followed by different letter differ significantly.

Table 4. Effect of flour extraction rate on extensigram characteristics.

Extraction rate	Rheological properties					
	Time (min.)	Resistance to extension (BU)	Extensibility (mm)	Ratio R/E	Maximum resistance (BU)	Energy (cm^2)
70	45	243^{c}	156^{f}	1.56^{b}	315^{h}	64^{f}
	90	300^{f}	150^{e}	2.00^{fg}	420^{m}	78^{j}
	135	320^{g}	150^{e}	2.13^{h}	450^{n}	86^{l}
75	45	260^{d}	170^{h}	1.53^{b}	330^{I}	63^{f}
	90	290^{ef}	165^{g}	1.76^{d}	388^{k}	75^{I}
	135	318^{g}	170^{h}	1.87^{e}	420^{m}	82^{k}
80	45	200^{a}	145^{d}	1.38^{a}	260^{f}	47^{bc}
	90	280^{e}	155^{f}	1.80^{de}	330^{I}	72^{h}
	135	320^{g}	155^{f}	2.06^{g}	410^{l}	79^{j}
83	45	200^{a}	138^{c}	1.44^{a}	250^{e}	47^{bc}
	90	280^{e}	135^{c}	2.07^{g}	340^{j}	62^{f}
	135	300^{f}	150^{e}	2.00^{fg}	340^{j}	68^{g}
86	45	250^{cd}	127^{bc}	1.97^{f}	260^{f}	42^{b}
	90	305^{f}	126^{bc}	2.42^{j}	320^{h}	57^{e}
	135	305^{f}	130^{bc}	2.35^{I}	336^{ij}	58^{e}
88	45	220^{b}	127^{bc}	1.73^{d}	222^{c}	41^{b}
	90	262^{d}	133^{c}	1.97^{f}	272^{g}	53^{d}
	135	300^{f}	119^{b}	2.52^{k}	315^{h}	56^{e}
90	45	195^{a}	118^{b}	1.65^{c}	195^{b}	40^{b}
	90	241^{c}	132^{c}	1.83^{e}	250^{e}	49^{c}
	135	260^{d}	120^{b}	2.17^{h}	270^{g}	52^{d}
93	45	190^{a}	110^{a}	1.72^{d}	170^{a}	37^{a}
	90	227^{b}	121^{b}	1.88^{e}	241^{d}	45^{bc}
	135	242^{c}	125^{bc}	1.94^{f}	251^{e}	48^{c}
SEM(±)	-	3.37	2.58	0.03	3.36	2.63

Values in the same column followed by different letter differ significantly.

Evaluation of Staling Rate of Breads

Regarding the effect of the flour extraction rate on the staling rate of breads, it was proved that by increasing the extraction rate of flour for all three type of breads (lavash, taftoon and barbari), the staling rate will be reduced while the quality numbers will increase. However this increase is up to a certain extraction rate for each kind of bread and then that quality value will be reduce again. Venkateswara *et al.* (1985), Mansour *et al*. (1988) and Qarooni *et al*. (1993) investigated the effect of the flour extraction rate on the rate of staling of flat breads and reported the same result. Results of the study of the staling rate of different type of breads after 24, 48 and 72 hours storage are presented in Table 6. These results show that, for lavash and taftoon breads, extraction rates of 86 and 88 are the best and have a significant effect on retarding the staling rate of this kind of bread and there is no difference between a 86 and 88 percent extraction rate at P=0.05. For barbari bread, extraction rates of 83, 86, 88 and 90 can best be used for retarding the staling rate of this type of bread and there are no differences between these extraction rates.

CONCLUSIONS

From a consideration of all parameters such as the physico-chemical properties of flour, rheological characteristics of dough, baking quality of bread and staling rate, it can be concluded that the best extraction rate of flour for baking lavash bread is 88 percent because this sample has the highest

Table 5. Effect of flour extraction rate on overall quality of breads.

Extraction rate	Bread type		
	Lavash	Taftoon	Barbari
70	2.69^{e}	3.06^{f}	3.23^{c}
75	2.77^{e}	3.29^{e}	3.37^{c}
80	3.30^{d}	3.64^{d}	3.90^{b}
83	3.49^{cd}	3.80^{cd}	4.03^{b}
86	3.66^{bc}	4.02^{bc}	4.29^{a}
88	3.89^{a}	4.25^{ab}	4.27^{a}
90	3.87^{ab}	4.30^{a}	3.90^{b}
93	3.61^{c}	4.06^{ab}	3.26^{c}
SEM(±)	0.02	0.04	0.03

Values in the same column followed by a different letter differ significantly.
All scores ranged from 0 to 5 with 5 being the highest value.
Scores are the average of sensory values presented by 15 expert panelists.

Table 6. Staling rate of different types of breads.

	Lavash			Taftoon			Barbari		
Extrac-tion rate	First day	Sec. day	Third day	First day	Sec. Day	Third day	First day	Sec. day	Third day
70	4.00^{b}	2.60^{b}	1.20^{b}	3.33^{a}	2.07^{a}	1.20^{a}	2.97^{a}	1.93^{a}	1.13^{b}
75	4.06^{b}	2.67^{b}	1.33^{bc}	3.60^{b}	2.13^{a}	1.27^{ab}	2.90^{a}	2.00^{a}	1.20^{b}
80	4.17^{c}	3.20^{cd}	1.53^{c}	3.80^{b}	2.27^{a}	1.60^{b}	3.50^{b}	2.33^{b}	1.40^{c}
83	4.13^{bc}	3.17^{c}	1.53^{c}	4.73^{d}	3.00^{c}	1.53^{b}	4.13^{c}	2.40^{bc}	1.47^{c}
86	4.53^{d}	3.37^{d}	1.67^{d}	4.87^{d}	3.40^{d}	1.87^{c}	4.20^{c}	3.30^{d}	1.53^{d}
88	4.93^{e}	3.80^{e}	1.93^{e}	5.33^{e}	3.53^{d}	2.33^{d}	4.47^{d}	3.33^{d}	1.53^{d}
90	4.00^{b}	2.80^{b}	1.27^{b}	4.67^{d}	2.93^{bc}	1.47^{b}	4.33^{cd}	2.67^{c}	1.27^{bc}
93	2.85^{a}	2.27^{a}	0.87^{a}	4.20^{c}	2.73^{b}	1.13^{a}	3.47^{b}	2.27^{b}	1.00^{a}
SEM(±)	0.04	0.02	0.01	0.03	0.02	0.01	0.03	0.02	0.01

Values in the same column followed by a different letter differ significantly.
All scores ranged from 0 to 5 with 5 being the highest value.
Scores are the average of sensory values presented by 15 expert panelists.

rank for quality and retarding the staling rate among all the other samples. For taftoon bread, extraction rates of 88, 90 and 93 had the best quality but an extraction rate of 88 has the greatest effect on retarding the staling rate and this can be the best among all other samples for this type of bread. For barbari bread there is no difference between 83, 86, 88 and 90 percent extraction rates. However, by considering the effect of these samples on bread quality (Table 5) it can be shown that extraction rates of 86 and 88 were the best and, taking account of the economic and nutritional questions, an extraction rate of 88 could be considered as the best sample. The result of this study show that the recommended extraction rates for the preparation of three traditional Iranian breads are higher than those extraction rates that nowadays are in practice used in bakeries.

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تاثیر درجه استخراج روی ترکیبات آرد، خصوصیات رئولوژیک خمیر و کیفیت نانهای مسطح

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چکیده

تاثیر درجه استخراج روی ترکیبات آرد، خصوصیات رئولوژیک خمیر و کیفیت نانهای مسطح (لواش، تافتون و بربری) و شدت بیاتی آنها مورد بررسی قرار گرفت. آرد با درجه استخراجهای (۹۳،۹۰،۸۸،۸۶،۸۳،۸۰،۷۵،۷۰) تهیه و خصوصیات فیزیکی و شیمیایی آنها اندازه گیری شد. بااضافه

شدن درجه استخراج، مقدار پروتئین ، چربی، فیبر، خاکستر، گلوتن مرطوب، جذب آب و رنگ آردها افزایش یافت ولی رطوبت، عدد رسوبی و فالینگ نامبر آنها کاهش پیدا کرد. در بررسی خواص رئولوژیکی با توجه به منحنی فارینوگرام کاهش در مقاومت خمیر و افزایش در اندیس افت مخلوط کردن و در منحنی اکستنسوگرام نیز کاهش در مقاومت به کشش پذیری و سطح زیر منحنی با افزایش درجه استخراج مشاهده شد.درجه استخراج روی خواص حسی و کیفیت کلی نانهای تهیه شده تاثیر معنی داری داشت و آنالیز امتیازات کیفی و بیاتی نانها نشان داد که درجه استخراج مناسب برای نانهای لواش، تافتون و بربری به ترتیب ۸۸، ۹۰ و ۸۸ بوده و نانهای تهیه شده با این درجه استخراجها بهترین کیفیت و طولانی ترین زمان ماندگاری را داشتند.