Effect of Shortenings on Qualitative Properties of Typical Iranian Flour and Dough

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Abstract: In the present study, the effect of treating Star, Branless and Whole Wheat flours by different shortenings including FRYINGOL, MARGARIN, BUTTER, HYDROOL and OLIVEOL in different levels (0, 0.25, 0.5, 0.75 and 1%) on qualitative and rheological properties of the obtained dough were investigated. The results indicate that shortenings led to strengthening gluten formation. Shortenings in low amounts increased STABT, ARVT and PROT in all flour treatments. MARGARIN was found as the only one increased GLUTINDX. FRYINGOL and MARGARIN led to WA increase in all flour treatments. Strengthening gluten network and consequently increasing DGLUT, WGLUT, PROT, MAXR, EXT, E, PT and STABT by adding BUTTER and MARGARIN, resulted to find them as the best suitable shortenings for the Star, Branless and Whole Wheat commercial flours.
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1. Introduction

In bakery foods, shortenings impart tenderness, give a moister mouthfeel, contribute structure, lubricate, incorporate air and transfer heat. Shortenings include fats and oils which improve baking process and final product properties (Stauffer, 2005). Besides improving physical functionality, shortenings are supposed to support nutritional requirements for human beings. Potentially harmful hydrogenated fats common ingredients, for instance, are required for products consistency, whilst oleic acid must also be included as a health enhancing one. Shortenings facilitate dough mixing process (Ghotra et al., 2002).

2. Methods and Materials

Three kinds of flour including *Whole Wheat Flour (WWA)* (Ash= 1.45 %), *Branless Flour* (Ash= 1.2 %) and *Star Flour* (Ash= 0.75 %) were obtained from Governmental Trading Corporation, Iran Grain Organization. Different shortenings (FRYINGOL, MARGARIN, BUTTER HYDROOL and OLIVEOL) in different levels (0, 0.25, 0.5, 0.75 and 1%) were used. Wet gluten was determined using Glumatic 2200 Perten (Perten Instruments, Huddinge, Sweden) following the corresponding ICC Method No. 159 (NIR) (ICC, 1995). Gluten Centrifuge No. 2128, Centrifuge 2015, (Falling Number, Huddinge, Sweden was applied to wet gluten dehydration. Dried gluten was measured by Gluten Drier Device (Falling Glutork 2020 No. 1007 number, Huddinge, Sweden) and gluten index was measured according to ICC No. 155 (ICC, 1994). Flours rheological properties were measured by Farinograph and Extensograph (both from Brabender. Duisburg, Germany) following the Standard ICC Method No. 115.1 and 114.1, respectively(ICC, 1992). In order to measuring Falling Number, the apparatus Falling Number 1600, No.1020 (Falling Number, Huddinge, Sweden) according to ICC standard Method No. 107.1 (ICC, 1995) was used. Protein content measured by Inframatic 8600 NIR analyzer (Perten Instrument, Hamburg, Germany) according to ICC standard No. 105.2.The abbreviations used in this study are as follows: PROT: Protein; WGLUT: Wet Gluten; DGLUT: Dry Gluten; GLUTINDX: Gluten Index; FN: Falling Number; WA: Water Absorption. Farinograph (ARVT: Arrival Time; PT: Peak Time; STABT: Stability Time). Extensograph (EXT45: Extensibility after 45 min; MAXR45: Maximum Resistance after 45 min; E45: Dough Energy after 45 min; EXT90: Extensibility after 90 min; MAXR90: Maximum Resistance after 90 min; E90: Dough Energy after 90 min; EXT135: Extensibility after 135 min; MAXR135: Maximum Resistance after 135 min; E135: Dough Energy after 135 min). Factorial Experiments in Completely Randomized Design (CRD) had been used for statistical analysis.

3. Results

The effect of adding different shortenings in different levels on the obtained dough from branless flour are illustrated in table 1. The most pronounced amounts of PROT were found in dough treatments with 0 to 0.5% shortenings. Using 0.25 to 1% levels of shortenings led to increase WGLUT. The most amount of DGLUT was acquired by 0.5 to 1% levels. Adding FRYINGOL caused FN increase. All shortenings led to PROT and WGLUT enhancement. DGLUT increased caused to MARGARIN, HYDROOL, FRYINGOL and

BUTTER using. ARVT showed enhancement in 0 to 0.75% amounts of shortenings. HYDROOL, FRYINGOL and OLIVEOL led to ARVT increase. Branless STABT of 0 and 0.25% of all shortenings resulted in the highest amount. All the shortenings in 0 to 0.75% levels led to PT increasing. FRYINGOL and MARGARIN increased WA. The highest pronounced amounts of MAXR, EXT and E, referred to control branless flour, MARGARIN and BUTTER saline, 280µl of the suspension prepared for AST-GN (Antibiotic Susceptibility Test-Gram Negative) was then transferred. The tube was then placed in the cassette with the susceptibility card. The identification GN is based on 43 biochemical tests measured carbon source utilization, enzymatic activities and resistance. The identification results were available in approximately eight hours.

Table 1: Effect of adding different shortenings on quality characteristics of Branless flour

Flour	Treatment	Level	FN (s)	PROT (%)	WGLUT (%)	DGLUT (%)	GLUTINDX	ARVT (min)	STABT (min)	**PT (min)**
BRANLESS FLOUR	SHORTENING	0	580a*	11.56a	29.33b	9.90C	57.00a	1.67a	6.00a	3.50a
		0.25	577ab	11.52a	29.36ab	9.97b	54.00b	1.66a	5.60ab	3.54a
		0.5	574b	11.44a	29.58ab	9.99ab	52.00c	1.64a	5.34bc	3.55a
		0.75	576ab	11.30b	29.59a	10.00a	50.00d	1.65a	5.31bc	3.38ab
		1	577ab	10.86C	29.74ab	10,00a	47.00e	1.53b	4.90c	3.23b
		BUTTER	577b	11.346a	29.41a	10.00a	52.23bc	1.59c	5.83a	3.42a
		FRYINGOL	584a	11.278a	29.41a	10.00a	50.18c	1.66ab	5.35a	3.38a
		HYDROOL	575b	11.338b	29.49a	10.00ab	53.08b	1.62abc	5.28a	3.55a
		MARGARIN	571c	11.376a	29.41a	10.00ab	55.30a	1.61bc	5.31a	3.53a
		OLIVEOL	579b	11.373a	29.63a	10.00b	51.54bc	1.67a	5.40a	3.34a

Continued from Table 1

WA (%)	E45 (cm^2)	E90 (cm^2)	E135 (cm^2)	EXT45 (min)	EXT90 (min)	EXT135 (min)	MAXR45 (BU)	MAXR90 (BU)	MAXR135 (BU)
0.64a	108.30a	120.00a	125.00a	150.00a	140.00a	135.00a	218.00a	265.00a	320.00a
0.63b	104.40b	115.00b	120.00b	144.00b	134.00b	130.00b	210.00b	255.00b	308.00b
0.62c	100.40c	111.00c	115.00c	139.00c	129.00c	125.00c	202.00c	245.00c	296.00c
0.61d	97.42cd	107.00cd	112.00bc	134.00cd	125.00cd	121.00cd	196.00cd	238.00cd	287.OOcd
0.60e	94.02d	104.00d	108.00d	130.00d	121.00d	117.00d	189.00d	229.00d	277.00d
0.62bc	103.46ab	114.60ab	119.37ab	143.25ab	133.70ab	128.92ab	208.51 ab	253.08ab	305.60ab
0.63a	96.83c	107.26c	111.73c	134.08c	125.14c	120.66c	195.16c	236.87c	286.03c
0.61c	98.41c	109.00c	113.55c	136.26c	127.18c	122.63c	198.33c	240.73c	290.68c
0.62a	105.76a	117.15a	122.03a	146.45a	136.68a	131.80a	213.16a	258.72a	312.41a
0.62b	100.14bc	110.93bc	115.55bc	138.66bc	129.42bc	124.79bc	201.83bc	244.97bc	295.82bc

* [a, b, c, d, e] Values are mean of three independent determinations. In each column, means with the same letter are not significantly different (P>0.05).

The effect of adding different shortenings in different levels on the obtained dough from Star flour results are given in table 2. All of obtained results for star flour were similar to those of branless flour.

Table 2: Effect of adding different shortenings on quality characteristics of Star flour

Flour	Treatment	Level	FN (s)	PROT (%)	WGLUT (%)	DGLUT (%)	GLUTINDX	ARVT (min)	STABT (min)	PT (min)
STAR	SHORTENINGS	0	625a*	11.40a	31.00a	9.97C	67.00a	2.33a	7.50a	4.50a
		0.25	622ab	11.36a	31.00a	10.04b	64.40b	2.25ab	6.93ab	4.56a
		0.5	619b	11.28a	31.00a	10.07ab	61.60c	2.25ab	6.65bc	4.48a
		0.75	621ab	11.13b	31.00a	10.08a	59.00d	2.21b	6.61bc	4.35ab
		1	623ab	10.70c	31.00a	10.08a	56.40e	2.07c	6.10c	4.16b
		BUTTER	621b	11.19a	31.00a	10.06a	61.40bc	2.15c	7.25a	4.40a
		FRYINGOL	629a	11.11a	31.00a	10.06a	59.00c	2.30a	6.61a	4.32a
		HYDROOL	620b	11.18a	31.00a	10.04ab	62.40b	2.23ab	6.57a	4.53a
		MARGARIN	615c	11.21a	31.00a	10.05ab	65.00a	2.16bc	6.63a	4.52a
		OLIVEOL	624b	11.20a	31.00a	10.02b	60.60bc	2.28a	6.73a	4.30a

Continued from table 2

WA (%)	E45 (cm^2)	E90 (cm^2)	E135 (cm^2)	EXT45 (min)	EXT90 (min)	EXT135 (min)	MAXR45 (BU)	MAXR90 (BU)	MAXR135 (BU)
0.62a	120.00a	125.00a	130.00a	140.00a	135.00a	130.00a	220.00a	275.00a	350.00a
0.61b	115.68b	120.50b	125.32b	134.96b	130.14b	125.32.b	212.08b	265.10b	337.40b
0.60c	111.21c	115.85c	120.48c	129.75c	125.12c	120.48c	203.89c	254.87c	324.37c
0.59d	107.9cd	112.40cd	116.90cd	125.90cd	121.41cd	116.90cd	197.80cd	247.31cd	314.76cd
0.58e	104.15d	108.49d	112.80d	121.50d	117.17d	112.83d	190.94d	238.67d	303.76d
0.6bc	114.60ab	119.37ab	124.15ab	133.70ab	128.92ab	124.15ab	210.10ab	262.63ab	334.26ab
0.61a	107.26c	111.73c	116.20c	125.13c	120.67c	116.20c	196.65c	245.81c	312.85c
0.59c	109.01c	113.55c	118.09c	127.17c	122.63c	118.09c	199.85c	249.81c	317.94c
0.60a	117.16a	122.03a	126.92a	136.68a	131.80a	126.91a	214.79a	268.48a	341.70a
0.60b	110.9bc	115.55bc	120.17bc	129.42bc	124.79bc	120.17bc	203.37bc	254.22bc	323.55bc

* [a, b, c, d, e] Values are mean of three independent determinations. In each column, means with the same letter are not significantly different (P>0.05).

Table 3 shows the effect of adding different shortenings in different levels on the obtained dough from Whole Wheat flour. All of the obtained results for whole wheat flour were similar to those of branless and star flours except PT and ARVT. ARVT was increased by using FRYINGOL and OLIVEOL. Treating the dough by HYDROOL, FRYINGOL, MARGARIN and BUTTER led to increase in PT.

Table 3: Effect of adding different shortenings on quality characteristics of Whole Wheat flour

Flour	Treatment	Level	FN (s)	PROT (%)	WGLUT (%)	DGLUT (%)	GLUTINDX	ARVT (min)	STABT (min)	PT (min)
WHOLE WHEAT FLOUR	SHORTENING	0	499a*	11.56a	29.00a	9.47c	51.00a	1.33a	5.00a	3.00ab
		0.25	497ab	11.55a	29.03a	9.53b	49.01b	1.30ab	4.67ab	3.03ab
		0.5	495b	11.46a	29.24a	9.57a	46.88c	1.31ab	4.47bc	3.10a
		0.75	496ab	11.32b	29.25a	9.58a	44.89d	1.27b	4.44bc	2.90bc
		1	497ab	10.88c	29.13a	9.58a	42.91e	1.17c	4.09c	2.76c
		BUTTER	496b	11.37a	29.07a	9.56a	46.72bc	1.22d	4.87a	2.92ab
		FRYINGOL	503a	11.30a	29.07a	9.56a	44.89c	1.31ab	4.48a	2.91ab
		HYDROOL	495b	11.36a	29.14a	9.55ab	47.49b	1.27bc	4.40a	3.06a
		MARGARIN	491c	11.39a	29.07a	9.54ab	49.47a	1.26cd	4.42a	3.03ab
		OLIVEOL	499b	11.37a	29.29a	9.52b	46.11bc	1.32a	4.50a	2.86b

Continued from table 3

WA (%)	E45 (cm^2)	E90 (cm^2)	E135 (cm^2)	EXT45 (min)	EXT90 (min)	EXT135 (min)	MAXR45 (BU)	MAXR90 (BU)	MAXR135 (BU)
0.67a	105.00a	110.00a	115.00a	155.00a	145.00a	140.00a	208.33a	230.00a	300.00a
0.66b	101.22b	106.04b	110.86b	149.42b	139.78b	134.96b	200.83b	221.72b	289.20b
0.65c	97.31c	101.95c	106.58c	143.65c	134.38c	129.75c	193.08c	213.16c	278.03c
0.64d	94.43cd	98.93cd	103.42cd	139.40c	130.40cd	125.90cd	187.36cd	206.84cd	269.80cd
0.63e	91.13d	95.47d	99.81d	134.52d	125.84d	121.504d	180.81d	199.62d	260.36d
0.64bc	100.2ab	105.0ab	109.82ab	148.02ab	138.47ab	133.70ab	198.96ab	219.65ab	286.50ab
0.66a	93.85c	98.32c	102.79c	138.55c	129.61c	125.14c	186.22c	205.58c	268.15c
0.64c	95.38c	99.92c	104.47c	140.80c	131.72c	127.18c	189.25c	208.93c	272.52c
0.65a	102.51a	107.39a	112.27a	151.33a	141.56a	136.68a	203.39a	224.55a	292.88a
0.65b	97.07bc	101.68bc	106.31bc	143.28bc	134.04bc	129.42bc	192.59bc	212.62bc	277.33bc

* [a, b, c, d, e] Values are mean of three independent determinations. In each column, means with the same letter are not significantly different (P>0.05).

Correlation Coefficients of the treated branless, star and Whole Wheat flours with different kinds and amounts of shortenings are illustrated in tables 4, 5 and 6, respectively. The results indicate that there is a significant correlation among level and MAXR, EXT, E, WA, ARVT and GLUTINDX in all flours ($p<0.01$). A significant correlation also observed among material and MAXR, EXT, E, WA and GLUTINDX in all of flours ($p<0.01$).

Table 4: Correlation coefficients among quality characteristics of Branless flour treated by different shortenings

Flour	Treatment	Source	df	GLUTINDX	ARVT (min)	STABT (min)	PT (min)	WA (%)	E45 (cm^2)
BRANLESS	SHORTENI	LEVEL	4	192.833**	0.044**	2.446**	0.285*	0.004**	477.591**
BRANLESS	SHORTENI	MATERIAL	4	54.413**	0.016*	0.751ns	0.128ns	0.0005**	200.785**
BRANLESS	SHORTENI	MATLVL	16	7.052ns	0.004ns	0.51ns	0.063ns	0.00004ns	20.896ns
BRANLESS	SHORTENI	ERROR	50	5.371	0.27	0.866	0.119	0.00003	50.828

Continued from Table 4

E90 (cm^2)	E135 (cm^2)	EXT45 (min)	EXT90 (min)	EXT135 (min)	MAXR45 (BU)	MAXR90 (BU)	MAXR135 (BU)
585.988**	635.838**	915.619**	797.605**	741.652**	1939.867**	2857.729**	4167.069**
246.363**	267.317**	384.929**	335.317**	311.795**	815.531**	1201.406**	1751.864**
25.64ns	27.82ns	40.06ns	34.897ns	32.449ns	84.873**	125.032**	182.319**
21.784	21.783	21.784	21.784	21.784	7.261	21.783	21.784

*, ** and ns refer to $p<0.05$, $p<0.01$ and "not significant," respectively.

A considerable Correlation Coefficients were obtained between material and ARVT in star and whole wheat flours ($p<0.01$). A significant Correlation Coefficients obtained between level and PT in star and branless flours ($p<0.05$). A significant Correlation Coefficients obtained among MATLVL, MAXR 135 and MAXR90 in all flours ($p<0.01$) in which the lowest and highest values of MAXR90 and MAXR135 referred to FRYINGOL 1% and MARGARIN 0.25%, respectively. Also a significant Correlation Coefficients ($p<0.01$) obtained among MATLVL and MAXR45 in branless flour and whole wheat flour EXT45 in which the lowest and highest values of both flour treatments referred to FRYINGOL 1% and MARGARIN 0.25%, respectively.

Table 5: Correlation coefficients among quality characteristics of star flour treated by different shortenings

Flour	Treatment	Source	DF	GLUTINDX	ARVT (min)	STABT (min)	PT (min)	WA (%)	E45 (cm^2)
STAR	SHORTENI	LEVEL	4	265.38**	0.145**	3.928**	0.375*	0.003**	585.988**
STAR	SHORTENI	MATERIAL	4	74.88**	0.071**	1.172ns	0.173ns	0.0005**	246.363**
STAR	SHORTENI	MATLVL	16	9.705ns	0.01ns	0.675ns	0.098ns	0.00004ns	25.64ns
STAR	SHORTENI	ERROR	50	7	0.077	0.747	0.153	0.0002	21.784

Continued from table 5

E90 (cm^2)	E135 (cm^2)	EXT45 (min)	EXT90 (min)	EXT135 (min)	MAXR45 (BU)	MAXR90 (BU)	MAXR135 (BU)
635.838**	687.725**	797.605**	741.652**	687.725**	1969.591**	3077.48**	4985.015**
267.317**	289.128**	335.317**	311.795**	289.128**	828.033**	1293.802**	2095.751**
27.82ns	30.09ns	34.897ns	32.449ns	30.09ns	86.175ns	134.649**	218.109**
21.783	21.783	21.784	21.784	21.783	2766.511	21.784	21.783

*, ** and ns refer to $p<0.05$, $p<0.01$ and "not significant," respectively.

Table 6: Correlation coefficients among quality characteristics of Whole Wheat flour treated by different shortenings

Flour	Treatment	Source	DF	GLUTINDX	ARVT (min)	STABT (min)	PT (min)	WA (%)	E45 (cm^2)
	SHORTENI	LEVEL	4	43.664**	0.023**	0.545*	0.111**	0.004**	188.616**
WHOLE	SHORTENI	MATERIAL	4	154.751**	0.064**	1.682ns	0.259ns	0.0006**	448.65**
WHEAT	SHORTENI	MATLVL	16	5.66ns	0.003ns	0.364ns	0.051ns	0.00004ns	19.629ns
FLOUR	SHORTENI	ERROR	50	35.563	0.044	0.667	0.114	0.0002	21.783

Continued from table 6

E90 (cm^2)	E135 (cm^2)	EXT45 (min)	EXT90 (min)	EXT135 (min)	MAXR45 (BU)	MAXR90 (BU)	MAXR135 (BU)
207.011**	226.258**	411.013**	359.699**	335.322**	742.544**	905.017**	1539.719**
492.4**	538.178**	977.678**	855.597**	797.61**	1766.22**	2152.714**	3662.465**
21.544ns	23.547ns	42.774**	37.435ns	34.898ns	77.278ns	94.187**	160.241**
21.783	21.784	0	21.784	87.134	50.829	21.784	21.783

*, ** and ns refer to $p<0.05$, $p<0.01$ and "not significant," respectively.

4. Discussion

Shortenings in low amounts increased PROT in all flour treatments. Higher amounts of shortenings led to DGLUT enhancement in all flour treatments. MARGARIN was found as the only one increased GLUTINDX. The results indicate that shortenings led to strengthening gluten formation. Generally using shortenings in low amounts increased ARVT. All kinds of shortenings while used in 0.25% level increased STABT in all flours. PT obtained results for star and branless flours were the same. FRYINGOL and MARGARIN led to WA increase in all flour treatments. The highest values of all flours MAXR, EXT and E referred to control treatments, MARGARIN and BUTTER. In other word, MARGARIN and BUTTER improved and strengthened extensographic properties of wheat dough. The most significant Correlation Coefficients ($p<0.01$) obtained among MATLVL, MAXR135 and MAXR45 by adding MARGARIN 0.25% in all flours. In the other word, the dough treated by MARGARIN 0.25% showed more resistance against elasticity and strain. Watanabe et al. (2002) studied the effect of lard and corn oil on rheological properties of gluten-starch and wheat flour doughs. The results from rheological measurements of gluten-starch dough indicated that dough with the higher starch content had less resistance to strain against those with lower starch content which had a rubber-like structure (Watanabe et al., 2002). The results from rheological measurements of fat-containing dough indicated that adding fat to dough provided the higher tolerance to strain. They also announced that the fat uniformly distributed gluten and starch in dough.

5. Conclusion

The results obtained from the present study indicate that shortenings led to strengthening gluten formation. Shortenings in low amounts increased STABT, ARVT and PROT in all flour treatments. MARGARIN was found as the only one increased GLUTINDX. FRYINGOL and MARGARIN led to WA increase in all flour treatments. Strengthening gluten network and consequently increasing PT, STABT, DGLUT, WGLUT, PROT, MAXR, EXT and E by adding BUTTER and MARGARIN, resulted to find them as the best suitable shortenings for the Star, branless and Whole Wheat commercial flours.

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