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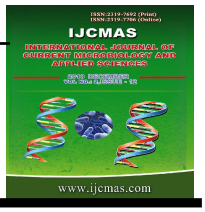

Original Research Article

The effect of dairy powders on the Gluten-free *voluminous* breads

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Keywords

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dry mil with fat;
sodium *caseinate;*
Dough Rheology
Celiac.

A B S T R A C T

Celiac disease (CD) is intolerance to grains prolamins. *Prolamins* in wheat which are known as gliadins, in barley as hordeins, in rye as secalins, and in oats as avenins are main triggering factor in celiac disease. One of the methods of controlling the effects of the disease is gluten-free diet all a person life. The present study aimed to evaluate the effect of 4 diary powders *on* rheological properties and bread specifications. To do this, the dairy powders were added into the formulation at 2, 4%. The results of the study on the breads showed that the sodium caseinate treatment 4% had the highest water absorption compared to the other treatments and the dough yield was more than the other treatments. The sodium caseinate treatment had low tissue hardness and high tissue elasticity. Sodium caseinate 2% treatment had the best crumb color and sodium caseinate *4%* treatment had the best crust color. Adding the dairy powders increased the tissue hardness except the cheese water powder 4% and sodium caseinate 2% reducing the hardness of the crumb tissue compared to the control and the sample with dry milk with fat powder (18%) at level 2% had the highest hardness of bread tissue.

Introduction

Gluten is the main constituent protein of the current structure in wheat flour and due to the viscoelastic specifications for dough, the good capability for holding gas and presenting a good structure for the bread crumb plays an important role in baking from wheat flour (Gallagher *et al*., 2004 a ; Moore *et al*., 2004). Although Gluten is necessary for bread baking, this protein causes some problems for some people including Celiac patients. Due to the performance characteristics of gluten, finding a replacement similar to these characteristics in bread baking is a technological challenge. In the second century Aretaeus explained a gastric system disease similar to the symptoms of celiac. 17 centuries later, the relation

between some specific grains and symptoms of gastric system in celiac was proved. Celiac is a hidden diseases and it is not recognized mostly. This disease is diagnosed at adulthood. Celiac is a kind of self-immune gastric disease due to digesting gluten in people genetically susceptible. Gluten –free diet is the only effective treatment for celiac**.** Gluten's absence in bread formulation often results in a liquid batter rather than pre-baking dough and resulting textures are crumbly, with poor color and other post-baking quality defects. Gluten-free breads get stale rapidly and it is due to the high amount 100% of flour to starch in their formulation. Due to the absence of gluten, more water is accessible and it increases the softness of crumb and crust. As celiac is highly prevalent and gluten-free bread is rare in the market and most of the gluten-free breads in the market are low quality, with bad taste and flavor and as wheat flour is removed and other kinds of flour are used, the nutritional value is reduced. The preparation of these diet breads is most important in this case.

Materials and Methods

Maize starch was provided from Mahshad Starch Company, the rice flour from Fereidunkenar (Iran) with moisture 9.74%, fat 0.72% and ash 0.56% and soy four was provided from Soy Sun company. The formulation of Gluten free bread with sodium caseinate (Iran *sodium* caseinate), fat-free whey powder (Poyan milk, Iran), When with fat 18% (Poyan milk, Iran), guar (Rama, India), Inolin, Sensus, Netherland *(*transglutaminase Ajinomoto), Germany (yeast), Fariman yeast (Datem), Danisko, Denmark (Xanthan, Provisco), Switzerland (Carboxymethyl cellulose, Sunrose), Japan (Guar, Rama), India.

Bread formulation

Gluten-free bread formulation was including rice flour (240gr), maize starch (300 gr), soy flour (48 gr), transglutaminase enzyme (3 gr), Alpha amylase (0.15 gr), Lipase (0.15 gr), guar gum (12gr), Xanthan (5 gr), Carboxymethyl cellulose (5 gr), yeast (60 gr), inulin (10gr), Pregelatinized starch (39 gr), oil (20 gr), Sugar (27 gr), salt (15 gr), Datem (10gr) being improved by the researchers of the present study.

The control formulation was without dairy powder and in the formulations, the dairy powder was added in 2, 4% levels. The related signs are shown briefly in Table 1.

Gluten-free voluminous bread baking method

To provide the gluten free bread, at first all the dry compound was sieved after being weighted to be mixed well. Then dry yeast suspension with sucrose was added and the rest of water was added. The water applied was varied depending upon the applied ingredients and based on the empirical evaluation, the good firmness of the dough for molding was determined. The required dough was provided in the small mixer and all the compounds were mixed at 60rpm for 5min. Then the dough as 500gr was weighted and was put into the moulder 4.5*9*20 mm with greased wall and was put into the fermentation box at 30° and moisture of 85% for 35 min. The baking was done at 250°C for 20 min. After being baked, the breads were taken out of the moulder and were kept at room temperature to be cooled. After that each of the specimen were packed in polyethylene bags to evaluate the quality and quantity characteristics.

The chemical tests, Farinograph test, dough and bread yield, specific volume, colorimeter and porosity were performed.

The chemical tests were as following:

Moisture test: In accordance with AACC method, NO. 16-44, A15-44 and ash test: In accordance with AACC method No. 01-08, 17-08 and protein test: In accordance with AACC No. 12-46 were performed and correction coefficient 6.25 was used to convert azoth to protein. PH test: In accordance with AACC method No. 02-52, the bread volume was measured by rapeseed displacement method and divided by weight(gr) to calculate specific volume of the breads in mL/gr.

To measure the dough yield is the dough gram amount of 100 gram raw materials, the weight of flour compounds/bread weight=100*bread yield (%), the weight loss of bread (%)= (lump)*100/bread weight –lump weight. Bread crumb softness was evaluated by tissue meter Rochdael (088MTCl model) and the bread hardness in 24, 48 and 72 hour after baking was evaluated to test the staling and the increase of force during three days of measurement showed more staling. In this test, the specimens were compressed by cylinder probe with diameter 40mm and speed 100mm/min to 50% of their height. The test was done on two slices of bread loaf center.

Measuring the color and bread porosity

The image processing to extract color parameters was done in Lab color space. Image J software was used to process the bread images. To measure these indices, a slice of bread was provided (Figure a) by scanner (Hp Scanjet G3010) with resolution 300 pixel then the images were evaluated by Image J software. By making the LAB space active in Plugins, L,a,b values were computed. To evaluate the crumb porosity, image processing technique was used. To do this, a slice of crumb was provided and was imaged by scanner (Hp Scanjet G3010), resolution 300 pixel (Figure a). The provided image was given to Image J software. By activating 8 byte section, the grey level image was created.

Results and Discussion

As the only way to cure CD is permanent use of gluten-free diet (Mezaize *et al*., 2009), bread is the dominant food of the population in the world (Anoton, 2007). Replacing Gluten in production of this grain product without Gluten is an important issue for the technologists (Rezentti *et al*., 2007). The dairy powders are used to imitate and present the visco-elastic characteristics of Gluten and improving the quality of this product (Anton, 2007). The present study evaluated the effects of four dairy powders on quality properties of the dough and Gluten-free breads and presented a good formulation to produce gluten-free bread with high quality. As it is observed, among the dairy powders sodium caseinate 4% had the best efficiency in presenting the good properties in terms of Farinograph and other tests In the sensory evaluation on the treatments, treatment 6,9 had the highest scores among the existing treatments. Treatment 7 had the highest sensory score and then treatment 6,9 had the highest score in sensory test. As it was said, the treatment including *sodium* caseinate 4% led into the increase of water absorption of flour compound of the formulations compared to the control treatment without any significant difference. The result of this issue was

Table.1 The treatment of gluten-free bread of dairy powder

Treatment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**8**
	Control	**SM_2**	**SM_4**	**WP_2**	**WP_4**	**FM_2**	**FM_4**	**CS_4**	**CS_2**
Fat-free dry milk powder	-	2	4	-	-	-	-	-	-
Whey powder	-	-	-	2	4	-	-	-	-
Dry milk powder with fat	-	-	-	-	-	2	4	-	-
sodium ***caseinate***	-	-	-	-	-	-	-	4	2

Table.1a Rheological parameters of Farinograph test in various treatments

Treatment No.	**Treatment**	**Extensibility(Min)**	**Water absorption percent**
1	Control	^{a}05/0±8/2	^{a5}/0±59
2	Sm2	2/0±7/2^{ac}	^{g}46/0±4/45
3	sm4	3/0±4/2^{ce}	42/0±93/49^{c}
4	Wp2	1/0±6/2^{a}	34/0±6/49^{c}
5	Wp4	3/0±7/2^{a}	35/0±63/50^{c}
6	Fm2	15/0±25/2^{e}	25/0±2/52^{e}
7	Fm4	2/0±40/2^{e}	4/0±93/51de
8	Cs2	05/0±1/2^{e}	65/0±51^{cd}
9	Cs4	18/0±05/3^{ad}	2/0±62^{b}

Table.2 The effect of dairy powders on chemical analyses of produced Gluten-free breads

Treatment No.	**Treatment**	**% Moisture, 24 hours after the production**	**Ash**	**Protein**	**pH**
1	Control	^{bc}01/0±4/43	^{cd}03/0±72/1	^{a}16/0±1/6	^{ab}01/0±15/6
2	Sm2	^{a}4/0±9/36	^{d}05/0±85/1	^{ab}02/0±7	^{f}05/0±48/6
3	Sm4	^{c}06/0±3/44	^{c}04/0±60/1	^{ab}05/0±1/7	^{f}01/0±5/6
4	Wp2	^{bc}5/0±7/48	^{cd}2/0±72/1	^{a}07/0±43/6	^{ab}21/0±15/6
5	Wp4	^{c}3/0±2/44	^{cd}1/0±70/1	^{a}15/0±45/6	^{ab}07/0±1/6
6	Fm2	^{de}04/0±2/48	^{a}1/0±95/0	^{a}1/0±50/6	^{a}02/0±05/6
7	Fm4	^{d}08/0±52/46	^{b}1/0±15/1	^{a}05/0±1/7	^{f}01/0±45/6
8	Cs2	^{b}1/0±1/42	^{cd}02/0±73/1	^{ab}01/0±34/7	^{bcde}14/0±25/6
9	Cs4	^{de}03/0±8/48	^{a}08/0±02/1	^{b}15/0±65/7	^{de}3/0±3/6

Table.3 The effect of dairy powders on the hardness of the baked breads

Treatment	Tissue hardness (Newton) 24h	Tissue hardness (Newton) 48h	Tissue hardness (Newton) 72h
1 control	25/7	02/8	89/24
Sm2	31/29	95/36	97/36
Sm4	21/9	05/10	35/10
Wp2	73/13	12/14	46/16
Wp4	93/7	50/4	40/4
Fm2	96/9	93/24	52/30
Fm4	39/22	97/36	62/40
Cs2	34/7	77/7	22/8
Cs4	84/6	89/9	25/10

Table.4 The effect of dairy powders on the sensory characteristics of the breads in various treatments

Treatment No.	Treatment	Total score	Taste and flavor	Chewing	Smell and aroma	Crumb tissue	Crumb colour	Crust	Form
1	**Control**	93/33	67/19	7/83	12	12/33	10/33	2/50	10/67
2	**Sm2**	96/17	13/50	13/17	11/17	19/50	22/33	13/67	2/83
3	**Sm4**	85/66	18/50	9	11/83	23/83	5/33	12	5/17
4	**Wp2**	56	6/33	3	4/83	7/67	15/50	9/17	9/50
5	**Wp4**	33/64	11/33	4/50	2/67	3/5	17/50	14	10/83
6	**Fm2**	67/98	22	17/17	15/50	15/17	6/33	10/33	12/17
7	**Fm4**	56/99	13/23	25/17	14/83	18/17	11/33	5/83	11
8	**Cs2**	33/72	5/67	12/50	16	8/33	3/50	15	11/33

Table.5 The effect of dairy powders on dough and bread yield and bread weight loss

Treatment No.	Treatment	Bread yield	Bread weight loss	Dough yield
1	1 control	$^{c}1800$	$^{e}11.8$	214^{cd}
2	Sm2	158^{a}	$^{a}8.5$	$^{a}173$
3	sm4	164^{a}	$^{b}7.6$	$^{b}189$
4	Wp2	170^{b}	$^{a}7$	$^{a}178$
5	Wp4	173^{b}	9.52^{c}	$^{b}191$
6	Fm2	180^{c}	8.7^{a}	$^{c}210$
7	Fm4	194^{d}	10^{d}	$^{bc}200$
8	Cs2	183^{c}	9.45^{c}	$^{bc}200$
9	Cs4	185^{c}	6.9^{a}	$^{cd}218$

The different alphabets showed the significant difference at level 5%.

Table.6 The evaluation of the porosity of bread tissue

Treatment No.	Treatment	Tissue porosity
1	Control	[bc]86/75
2	Sm2	[c]76/79
3	sm4	[c]94/78
4	Wp2	[a]9/69
5	Wp4	[a]2/70
6	Fm2	[b]92/73
7	Fm4	[b]253/74
8	Cs2	[a]8/69
9	Cs4	[a]5/69

Table. 7 The effect of dairy powders on the crust and crumb colour in various treatments

Treatment	Tissue			Crust		
	b	a	L	b	a	L
1 control	0.046 [a]± 24.186	0.026[a]±0.673	0.147 [a]± 71.75	0.217 [a] ±22.168	0.007 [a] ±10.120	0.25 [a]± 40.11
Sm2	0.048 [e]± 22.987	0.041 [a] ±0.477	0.6 [b]± 73.80	0.066 [b]± 24.43	0.133 [b] ±11.367	0.17 [b]± 42.644
Sm4	0.043 [d]± 21.773	0.0184 [b] ±1.354	0.287 [c] ±67.613	0.33 [b]± 24.28	0.12 [d]± 9.88	0.21 [c]± 45.03
Wp2	0.040 [b]± 20.42	0.021 [c] ±0.213	0.336 [d] ±70.363	0.24 [c]± 25.420	0.185 [c] ±11.720	0.08 [b]± 42.069
Wp4	0.176 [b]± 20.82	0.006 [c] ±0.051	0.107 [d]± 70.64	0.27 [c]± 25.2	0.11 3 [e] ±9.097	0.62 [bc]± 44.64
Fm2	0.099 [c]± 22.55	0.022 [be]± 1.13	0.173 [c]± 67.83	0.175 [a]± 22.82	0.0151 [e]± 9.25	0.17 [c]± 46.105
Fm4	0.119 [c]± 22.395	0.028 [be] ±1.403	0.63 [d]± 70.06	0.117 [bc] ±24.83	0.125 [c] ±11.467	0.095 [b] ±42.405
Cs2	0.395 [b]± 20.52	0.25 [b]± 1.69	0.41 [e]± 74.48	0.1 [c]± 25.25	0. 103 [a]± 10.08	0.115 [d] ±51.335
Cs4	0.167 [b]± 20.52	0.3 1 [b]± 1.055	0.142 [f] ±66.671	0.076 [bc] ±25.03	0.27 [d]± 9.59	0.102 [e] ±52.512

Table.8 Measurement of specific volume, density and height of bread

Treatment	Bread Volume	Specific volume of bread(cm^3/gr)	gr/cm^3) Density	Bread height(cm)
1 (control)	5±920	0.018 [a]± 2.08	0.003±0.48	0.15 [a]± 7.25
Sm2	4.36±650	0.016 [b]± 1.42	0.01±0.7	[b]00.026±6.13
sm4	4.6±950	0.0082 [a]± 2.05	0.01±0.49	0.08 [a]± 7.12
Wp2	4.36±710	0.02 [c]± 1.53	0.0059±0.65	0.08 [b]± 6.22
Wp4	4±990	0.016 [f]± 2.21	0.0032±0.45	0.1 [a]± 7.10
Fm2	2.65±1050	0.007 [a]± 2.09	0.031±0.48	0.07 [c]± 7.43
Fm4	4.3±680	0.017 [c]± 1.50	0.065±0.66	0.03 [b]± 6.10
Cs2	2.83±1000	0.004 [d]± 2	0.001±0.5	0.026 [a]± 7.14
Cs4	3.46±1020	0.01 [e]± 2.24	0.01±0.45	0.1 [c]± 7.40

consistent with the results of dough yield in this section. The increase of the water content of dough increased the amount of dough. The highest dough yield in dairy powder treatments was achieved by *sodium* caseinate 4% treatment and the lowest amount was obtained by dry milk powder (low fat) 2% and they showed that highest and lowest water absorption in Farinograph test. With the increase of dairy powders in formulation, the bread quality loss is lowered and by the increase of whey powder 2%, the bread loss was reduced significantly. By the increase of *sodium* caseinate, moisture content is increased in bread and it is due to its capability in keeping moisture and reduction of bread loss. The lowest loss was dedicated to *sodium* caseinate 4% treatment and the highest loss was dedicated to control. The highest specific volume was dedicated to sodium caseinate 4% and the lowest specific volume was dedicated to dry milk powder treatment (fat free) 2%. Among the treatments, the highest lightness of crumb was dedicated to sodium caseinate 2% treatment and the lowest value was dedicated to treatment 9 as sodium caseinate 4%. Regarding the redness index, as it was said in the existing charts, the highest was dedicated to sodium caseinate 2% treatment and the lowest value was dedicated to whey powder 4%. By comparing the treatments, the control treatment was yellowier than the rest of the treatments. The low fat dry milk 2% treatment had the highest porosity and treatment 9 with *sodium* caseinate 4% had the lowest porosity.

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