EFFECT OF WET GLUTEN ADDITION ON STALIN CHARATERISICS OF BARLEY BREAD

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ABSTRACT

Vital wheat gluten was extracted from broken wheat (Triticum aestivum) and durum wheat (Triticum durum) flour and used to improve the rheological and staling characteristics of bread made using flour from two varieties of barley (IPA 99, IPA 265) which were obtained from the Ministry of Agriculture / Agricultural Research Center. The recent study included seven treatments being, Wheat flour was used as control treatment in bread making (T1), and barley class IPA99 flour (T2) , IPA 265 flour (T3), IPA99 flour with durum wheat gluten (T4), , class IPA 265, flour with durum wheat gluten (T5), IPA99 flour with broken wheat gluten(T6), IPA 265 flour with broken wheat gluten(T7). The bread samples were prepared according to straight dough AACC method No. 10-10 B and the final products were stored for 72 h. (20°C). The obtained results indicated that gradual increase in the bread crust moisture content coincided with a gradual decrease in the moisture content of the bread crumb during the storage period for all treatments. It has been noticed a significant difference ($p \leq 0.05$) among the crumb swelling power values for all treatments, meanwhile all treatments were showed gradual decrease in the swelling power as storage time proceeded ,no significant differences ($p \leq 0.05$) in the crumb swelling power between T4 and T5 as compared to the control treatment, for all storage periods. A gradual decrease in the barley bread crumb aqueous suspension sediments amount were observed as the storage period proceeded, both T4 and T5 treatments showed significant differences ($p \leq 0.05$) in sediments amount as compared to the control treatment at all storage periods, this means that T4 and T5 were more resistant to the staling phenomena as compared to other treatments .Therefore, the durum wheat gluten was more effective in improving barley bread resistance to staling phenomena as compared to the broken wheat gluten.

***Keywords: Durum wheat- broken wheat - Loaf - Recrystallization of starch.**
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تأثير اضافة الكلوتين الرطب على صفات التجلد لخبز الشعير

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المستخلص

تم استخلاص الكلوتين الحيوي من نوعين من الدقيق هما كسرة القمح وقمح الديورم واستعمل في تحسين نوعية الخبز المصنع من دقيق صنفين من الشعير (إباء 99، إباء 265) الذي تم الحصول عليها من دائرة البحوث الزراعية– وزارة الزراعة. تضمنت الدراسة الحالية سبعة معاملات وكالاتي، استعمل دقيق الحنطة كعينة سيطرة (T1)، ودقيق الشعير صنف إباء 99(T2) ودقيق شعير صنف إباء 265 (T3)، ودقيق الشعير صنف إباء 99 مع كلوتين قمح الديورم، وكانت T5 تتضمن شعير إباء 265 مع كلوتين القمح القاسي، أما T6 دقيق شعير صنف إباء 99 مع كلوتين كسرة القمح(T4)، ودقيق الشعير صنف إباء 265 مع كلوتين كسرة القمح (T7). تم تصنيع نماذج الخبز بأتباع الطريقة المباشرة لرابطة كيميائي الحبوب الأمريكية المرقمة 10-10 خُزن الخبز المنتج لمدة 72 ساعة(20°م). أشارت النتائج المستحصلة الى ظهور زيادة تدريجية في المحتوى الرطوبي لقشرة الخبز مع انخفاض تدريجي في رطوبة لب الخبز مع تقدم مدة الخزن ولجميع المعاملات، وأظهرت نتائج التحليل الإحصائي فروقات معنوية ($p \leq 0.05$) في قوة التشرب المعاملات T4,T5 مقارنة بمعاملة السيطرة ولجميع أوقات الخزن . وانخفض حجم الراسب في عالق اللب المائي لخبز الشعير كلما طالت مدد الخزن ولجميع المعاملات ، وأظهرت المعاملات T4,T5 فروقات معنوية ($p \leq 0.05$) في حجم الراسب مقارنة بمعاملة السيطرة ولجميع مدد الخزن ، وعليه فأن المعاملات T4,T5 كانت أكثر مقاومة لظاهرة التجلد مقارنة بالمعاملات الأخرى، اي ان كلوتين قمح الديورم كان أكثر فاعلية في تطوير المقاومة للتجلد بالمقارنة مع كلوتين كسرة القمح.

الكلمات المفتاحية: حنطة الديورم – كسرة الحنطة – لوف – اعادة بلورة النشا.
جزء من رسالة الماجستير للباحث الاول.

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INTRODUCTION

Barley is one of an ancient cereal crops grown in the world today. Archeological evidence suggests that barley was exist in Egypt along the Nile river around 17,000 years ago (32). It is one of the top most cultivated crops in the world (12% of total cultivated cereal), standing fourth among cereal grains after (wheat, rice, and maize) (28). It is more economical to cultivate in comparison to other cereal due to its winter-hardy, early maturing nature and drought- resistant (10). Only 2% of world total products is used for human consumption, 33% for malting and 65% for animal feed (31). The total production for Iraq at 2014 was about I million tons (2). Many studies focused on beneficial feature of diet fiber and the roles of these beneficial aspects in lowering cholesterol that associated with preventing against coronary heart disease, and hypoglycemic effects that associated with lower risk of type -2 diabetes (9). FAD suggested the regular consumption for beta glucan (associated health benefits) due to its ability in health beneficial mentioned above (13). In addition, Ames & Rhymer (3) proposed to add 0.75 g of beta-glucan per serving. Barley-derived β-glucan beneficially affect total cholesterol, LDL-cholesterol, and triglycerides. β-glucan progress insulin sensitivity and positively control metabolic syndrome. The increased viscosity extends gastric transition time, prolongs satiety and reduces the hunger pangs thus preventing obesity (16). The reason behind decreased use barley as a human food is lack of gluten, that lead to reduced barley bread and all other human food. Barley flour was used with wheat flour at 15-20 % to improve overall flavor, texture and appearance (4). Higher level of barley flour caused a decrease in loaf volume, dull brown color and hard crumb texture (12). This study relied on the use of barley flour to produce bread that can be accepted by the consumer. On other hand, bread staling has been studied for more than a century and has not been overcome and it is responsible for huge economic losses to both the baking industry and the consumer as well (14) . Staling results in un desirable characteristics such as flavor and texture, and it is an outcome of a group of several physical–chemical changes occurring during bread storage that lead mainly to an increase of crumb firmness and loss of freshness (14). Because the barley has several health benefits and available in large quantities, the recent study aimed to improve barley bread characteristic using gluten extracted from broken wheat and from durum wheat, and investigation of bread stalling through 1, 24, 48, 72 hours storage at 20 °C.

MATERIAILS AND METHODS

Barley flour preparation: The barley varieties (IPA 99, IPA 265) were obtained from the Ministry of Agriculture / Agricultural Research Center, they were grown in north Baghdad – Iraq, on 2017. Barley samples were grinding with Brabender Laboratory mill after conditioning to 14 % moisture (17), and the flour was passing through (150 Micron). The extraction rate of barley flour was 72%.

Gluten preparation

The wet gluten was extracted from two types of flour, broken wheat (*Triticum aestivum)* and durum wheat (*Triticum durum),* both types were also conditioned to 14 % moisture before milling. AACC method No. 10-38 (1) was used for gluten estimation and extraction from flour

Chemical analysis:

Proximate compositions of all flours and breads were studied using AOAC methods (7). Total carbohydrate was calculated by difference.

Bread(loaf) preparation

The bread making performances of the flours (control and blends) were determined using the straight dough AACC method No. 10-10 B (1) with a slight modification. The bread formula for each loaf included 80 g barley flour, wet gluten contains 20 g dry gluten, yeast, salt, sugar, fat and an adequate amount of water to obtain dough of optimum consistency. The bread making procedure included mixing , at low speed for 2 min followed by a 9 min rapid mixing using spiral arm mixer, and a proving time of 50 min at 36°C and 70% relative humidity (r.h.) and baking for 23 min at 180°C. in a convection oven. The specific volume was (3.8, 1.35, 1.5, 2.2, 2.6, 3.3, 3.34) for treatments(T1, T2, T3, T4, T5, T6, T7) respectively. Baked loaves were cooled down at room temperature for 60 min, wrapped in a plastic film and then stored at room temperature (20° C). The ingredients of experiments treatments were as listed in following Table 1.

Table 1. The Ingredients of experiment treatments (g)

Treatments	Barley flour (g)	Wheat flour(g)	Dry gluten (g)	Yeast (g)	Salt (g)	Sugar (g)	Fat (g)
T1	-	100	-	2	1.5	4	3
T2	100 IPA 99	-	-	2	1.5	4	3
T3	100 IPA265	-	-	2	1.5	4	3
T4	80 IPA 99	-	20 from wheat durum	2	1.5	4	3
T5	80 IPA265	-	20 from wheat durum	2	1.5	4	3
T6	80 IPA 99	-	20 from broken wheat	2	1.5	4	3
T7	80 IPA265	-	20 from broken wheat	2	1.5	4	3

Bread staling tests

Determination of the moisture content of bread crumb and crust Crumb and crust moisture was measured adapting AACC (44-19) (1) by taking 3gm from bread crust and crumb individually, both were dried under 130° C until constant weight.

Determination of crumb swelling power(SP):

SP of the crumb was measured according to the Prench, Schoch method(24), as described by Al-jellaoy(5), two gm of bread crumb mixed with 10 ml distilled water (d.w.) for 30 min., then placed in test tube for centrifugation at (3000× g / 5 min), the strength of swelling power determined according to the following equation:

The strength of swelling power (SP) = D-(A+B) / B

A= centrifuge tube weigh. B = Sample weigh. D= residual tube weigh.

Determination of crumb sediment volume in aqueous suspension (CVS)

CVS was evaluated according to Prench, Schoch method (27), which described by Al-jillaoy(5), 5 gm of bread crumb was mixed with 50 ml d.w. for 15 min, then placed in graduate cylinder and left for 2.5 hours until crumb portions settled and leachate become clear, the CVS recorded in cm^3.

RESULTS AND DISCUSSION Chemical composition of barley, durum wheat, and broken wheat flour

Table 2 shows the chemical composition of two classes of barley (IPA 99 and IPA 265) flour. The percentage of moisture, protein and fat in class IPA 265 was higher (12.60%, 13.20%, 2.8%) respectively, than that for class IPA 99 (12.05%, 11.70%, 1.50%) respectively. While the percentages of fiber, carbohydrates and ash were lower in the flour of class IPA 265, being 5.9, 66.5 and 4.9% respectively, as compared to that of class IPA 99 flour, being 6.15%, 69.4% and 5.14% respectively. The results obtained in this study are coincident with the findings of other authors (8, 31, 32). The same Table shows the chemical composition of the durum wheat flour and broken wheat flour under study. The percentages of moisture, protein, fat, fiber, ash and carbohydrates for broken wheat flour were (8.4%, 10.78%, 1.2%, 75.6%, 4%, and 4.8%) respectively, the results were different than that reported by Al-Saaduin (6) which were (11.3%, 3.2%, 11%, 2.2%, and72 %) respectively, and these differences may be due to the variation in the experimental grain mix and the storage conditions. The percentages of the same components for durum wheat flour were 9.5%, 13%, 1.9%, 4.1%, 1.5%, and 74.1%, respectively, it has been noticed that the protein in broken wheat and durum wheat flour were high being (13.0%, 10.78 %), respectively, and this will provide good gluten for the production of barley bread.

Table 2. Chemical composition of the experimental barley, durum wheat and broken wheat flour

Cereals varieties	Ash%	Carbohydrates %	Fiber%	Protein%	Fat %	Moisture%
Barley (IPA 99)	5.14	69.40	6.15	11.70	1.50	12.05
Barley (IPA 265)	4.90	66.50	5.90	13.20	2.80	12.60
Broken wheat	4.00	75.6	4.8	10.78	1.2	8.4
Durum wheat	1.5	74.1	4.1	13	1.9	9.5

Staling characteristic

Effect of added gluten on the crust and crumb moisture content in barley bread

Tables 3 and 4 shows the effect of adding gluten to the bread mix on the moisture content of the crust and crumb of barley bread during different storage period at (20◦C). The moisture content in the fresh bread is distributed continuously between the inside (crumb) and outside (crust) of the bread. During bread storage, the moisture is migrated from the crumb to the crust and then to the outside depending on the relative humidity of the store's atmosphere. With gradual loss of product moisture and reduced amount of soluble starch (re-crystallization of starch), which is usually "high" in fresh bread, the staling of bread increases with the aging of the product. The results in Table 3 indicated a gradual increase in the moisture content of the bread crust, with the storage period for all treatments, and reached the highest value after 72 hours of storage in T3, being (46.3%).The results of statistical analysis showed no significant differences ($p \leq 0.05$) among the T2, T3, T4, and T5 as compared to the T1 treatment (control) through the storage periods, whereas there were significant differences ($p \leq 0.05$) between T6 and T7 compared with T1 during the storage periods. This could be attributed to the difference in the source of the gluten used in these treatments and in the ratio of its association with water. The same Table shows significant differences in moisture content at ($p \leq 0.05$) between T2, T3, T4 and T5 as compared to the control treatment, for all storage periods, while the differences were not significant between T6 and T7 as compared to the control treatment and for all storage periods.

Table 3. Effect of added gluten on the moisture content (%) of barley bread crust

Treatments	Moisture content (%)				LSD value
	1 h.	24 h.	48 h.	72 h.	
T1	34.75	35.50	36.00	37.40	3.13 NS
T2	42.50	43.10	43.60	44.80	3.92 NS
T3	44.10	44.20	45.00	46.30	3.05 NS
T4	39.00	41.00	41.04	42.40	4.83 NS
T5	40.60	41.20	42.81	43.60	4.19 NS
T6	36.50	38.65	39.99	41.80	4.07 *
T7	35.23	37.27	40.00	41.20	4.35 *
LSD value	4.73*	5.66*	4.93*	4.27*	--------

The results of Table 4 revealed a gradual decrease in the moisture content of the bread crumb, during storage period for all treatments. Also, it is obvious from the data listed in Table 4 that there was a significant decrease in crumb moisture content (p≤0.05) between T4 and T5 as compared to T1 at all storage periods. In contrast there were no significant differences between T6 and T7 as compared with the control treatment for all storage periods. This may be due to the high content of pentosanes and beta-glucan in these treatments (25) as well as the effect of the use of broken wheat gluten in their formula.

Table 4. Effect of added gluten on the moisture content of barley bread crumb

Treatments	Moisture content (%)				LSD value
	1 hr.	24 hr.	48 hr.	72 hr.	
T1	44.80	42.90	42.00	41.10	3.96NS
T2	50.60	49.60	48.50	47.30	3.77NS
T3	51.00	50.60	50.30	50.20	2.15NS
T4	50.40	49.00	48.50	48.00	4.55NS
T5	50.80	49.40	48.66	46.10	3.15NS
T6	49.76	48.80	48.66	46.10	3.62 NS
T7	49.45	48.48	48.42	46.40	3.96NS
LSD value	5.38*	5.09*	4.62*	5.22*	--------

Effect of gluten addition on the swelling power of barley bread crumb

Table 5 shows the effect of added gluten on the swelling power of barley bread crumb (SP) during different storage periods. The results of the statistical analysis showed significant differences (p≤0.05) among the swelling power of crumb for all treatments, where all treatments gradually decreased as time proceeded. This decrease is due to the starch's re-crystallization state (It is a situation where the starch becomes less soluble in water), (22). The results of statistical analysis showed no significant differences (p≤0.05) in the swelling power (SP) for crumb between T4 and T5 as compared to the control treatment, for all storage periods. The high percentage of damage starch (in treatments, where durum wheat gluten was used) could be the main reason for increasing swelling power for these treatments crumb. At the first hour of storage T2, T3, T6 and T7 treatments showed significant differences as compared to control treatment, while after 24 hours of storage, the differences between treatments were insignificant. This indicates the similarity in re-crystallization of wheat starch and barley starch. The high content of pentosanes and beta-glucan in the T4, T5, T6 and T7 in general and particularly in T2 and T3 treatments is the reason behind non-significant differences between the studied treatments and control treatment, so similar freshness was noticed, with bread of the control and other treatments as well (19) and (25).

Table 5. Effect of added gluten on the swelling power of bread barley crumb.

Treatments	The swelling power				LSD value
	1 h.	24 h.	48 h.	72 h.	
T1	0.98	0.70	0.57	0.40	*0.369
T2	0.81	0.54	0.46	0.42	*0.294
T3	0.77	0.54	0.50	0.42	*0.206
T4	0.90	0.82	0.67	0.20	*0.445
T5	0.96	0.80	0.50	0.30	*0.575
T6	0.82	0.80	0.48	0.43	*0.326
T7	0.80	0.73	0.47	0.40	*0.361
LSD value	0.137*	0.206*	0.146*	0.131*	--------

Effect of gluten addition on the volume of sediment in the barley bread crumb aqueous suspension

Table 6 shows the effect of adding gluten on the volume of sediment in the barley bread crumb aqueous suspension, during different storage periods (1, 24, 48, 72 h). A gradual decrease in the volume of sediments were observed for all treatments as the storage period proceeded. The results of statistical analysis ($p \leq 0.05$) showed no significant differences in the volume of crumb sediment in the aqueous suspension during the storage periods of most treatments (T1, T2, T3, T6 andT7). It is noteworthy that the amount of soluble starch decreases with the age of product storage, due to the re-crystallization of starch which causes a reduction in starch water solubility (22). This test was first used in 1949 by Strandine, who stated that the increase in the volume of crumb sediment aqueous suspended reflected positively on the phenomenon of staling bread. Both T4 and T5 treatments showed significant differences ($p \leq 0.05$) compared to the control treatment at all storage periods, where the volume of sediment was 28 and 30 cm^3 respectively, compared with that for the control treatment which was 22 cm^3 after an hour of product manufacturing. This means that T4 and T5 were more resistant to staling compared to other treatments. This is due to the ability of durum wheat gluten to bind water, to barley flour content of pentosanes (19, 25),as well as the ability of beta-glucan to extend the shelf life of the product and maintain its freshness (27).The statistical analysis results showed insignificant differences between T6 and T7 as compared to the control treatment and for each storage period, this is due to the high percentage of pentosanes and beta-glucan in barley and the addition of broken wheat gluten to bread mix. The same table shows high volume of sediment for T4 and T5 treatments as compared to T6 and T7 for all storage periods, therefore the barley bread with the durum wheat gluten was more resistant to staling compared to barley bread with the broken wheat gluten in this study. Additionally , there were no significant differences ($p \leq 0.05$) between T2 and T3 as compared with the control treatment for all storage period

Table 6. Effect of added gluten on the volume of sediment in the barley bread crumb aqueous suspension (cm^3).

Treatments	The volume of sediment (cm^3)				LSD value
	1 h.	24 h.	48 h.	72 h.	
T1	22	20	19	19	3.55 NS
T2	19	19	16	16	3.41 NS
T3	19	17	15	15	* 3.86
T4	28	26	26	25	3.56 NS
T5	30	28	28	28	2.61 NS
T6	25	22	20	18	3.77 *
T7	22	21	21	19	3.57 NS
LSD value	4.29*	4.77*	4.02*	5.17*	--------

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