PRODUCTION OF YOGHURT FORTIFIED BY HULL-LESS BARLEY FLOUR

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Abstract

This study was intended to investigate the possibility of making a good quality of yoghurt like product as function food with hull-less barley flour. Buffaloes' milk 15.3 % total solid substituted with 25 , 50 and 75 % was added from 10 % suspension barley flour as a first experimental trial. A second experimental trial was conducted with addition 3, 5, 7 and 10 % barley flour to buffaloes' milk to produce yoghurt. The chemical composition of buffaloes' milk, suspension barley flour and barley flour were determined. Yoghurt samples and their treatments were stored for 15 days. The chemical composition and organoleptic evaluation were determined at fresh, 5, 10 and 15 days respectively in yoghurt and their treatments. The results indicated that the suspensions of barley flour levels were affected by the chemical composition while the total carbohydrates increased with suspension addition and increased levels. The acetaldehyde content decreased with increased barley suspension and addition levels. Rheological and sensory evaluation showed a slight effect of suspension barley flour at 25 and 50 % levels and the addition of barley flour 3, 5, and 7 % levels compared with the control.

It could be recommended that the acceptability yoghurt made from 25 and 50 % suspension barley flour and 3, 5, and 7 % added barley flour to buffaloes' milk since it gave a good quality of yoghurt.

INTRODUCTION

Barley is the world's fourth important cereal crop in terms of cultivated area. It is used for both human consumption and animal feeding. Barley production area in Egypt is located in North Coastal region and in the newly reclaimed lands (El-Bawab, 1999).

Hull-Less barley contained more protein and starch, being the two major components and total soluble ß –glucan. This was due to the removal of fibers of hull which has a dilution effect on these components. Also, hull-less barley contained more total dietary fiber (TDF) and pentosans which largely found in the hull (Bhatty, 1999). In one study (Edney *et al.,* 1992) grain protein varied from 13 to 17% in condor hull-less barley variety (free adhering hulls) grown at two major locations in central U.S.A. Hull-less barley (HB) had higher concentrations of limiting amino acids, lysine and

theronine than wheat or hulled barley (Boros *et al.,* 1996). Components of HB carbohydrates include starch, cell-wall polysaccharides, ß-D-glucan, (1-3) ß-glucan and arabinoxylans (pentosans), cellulose and a number of simple sugars and oligosaccharides (Be Miller, 1999). Moreover, starch is the abundant single component of HB, accounting for 60 – 75 % of grain on a dry weight basis (Bhatty and Rossnagel, 1998).

Barley contains tocotrienols and tocopherols, which are ubiquitous, naturally occurring antioxidants. The essential difference between tocotrienols and tocopherols is the presence of double bonds at carbons 3, 7 and 11 in the isoprene chain of tocotrienols. Their role as inhibitors of cholesterogenesis (Qureshi *et al.,* 1986 and1991), decreased total cholesterol and low density lipoprotein (LDL) cholesterol. These effects were also observed in human fed ingredients made from barley grain that were enriched in tocols (Weber *et al.,* 1991). Also, (Ranhotra *et al.,* 1998), reported significantly lower serum and liver cholesterol in rats fed diets containing bran or flour from hull-less barley. The reductions were related to the ratio of soluble fiber and total dietary fiber in each fraction, the greater reductions occurring with a higher percentage of soluble fiber.

Traditionally barley has been used as general tonic for nerves and laxative, soothing agent, antidiahrreal, hepato-tonic and antihypertensive and was also described for the treatment of respiratory diseases such as tuberculosis B, also for general weakness for slow development of children stomach & intestinal weakens and for inflammation of urinary bladder and kidneys and chronic constipation (El-Tagoury, 1999).

Nowadays, barley is used in U.S.A. and Europe in food meals, in the manufacture of bread, sweets and in many other forms that are preferable for its healthy value and favorite taste (El-Tagoury, 1999).

The consumption of fermented dairy products could lead to reduction in serum cholesterol levels. (El-shewey and El-Abbassy, 1998) showed that feeding on yoghurt or Biograde (new yoghurt –like product) reduced cholesterol, total lipids, triglycerides, LDL, GOT, GPT, acid and alkaline phosphatase, creatinine and uric acid, while increased HDL in blood serum of hypercholesterolemia albinorats. Also, (Volpe *et al.,* 2001) observed the yoghurt with plant sterols (1.0g. plant sterol extracted from soybean/ day) significantly reduced in a dose dependent manner, serum cholesterol and LDL leves and LDL: HDL ratio, whereas no change in HDL and triglyceride leves. They concluded that the low fat yoghurt-based drink moderately enriched with plant sterols may lower total cholesterol and LDL effectively in patients with primary moderate hypercholesterolemia.

Limited research has focused on the use of barley in dairy products, with several papers reporting the utilization of Soya and other legumes in the production of yoghurt like products. Not many publication results are available with regard to the interaction between barley flour and milk components.

The objective of the present study was to investigate the possibilities of making good healthy yoghurt from hull-less barley flour water suspension and barley flour added individually at different levels to fermented buffaloes' milk.

MATERIALS AND METHODS

Materials:

Buffaloes' milk was obtained from processing plant of Food Technology Research Institute, Agricultural Research Center, Giza. Whereas , hull-less barley was obtained from Field Crops Research Institute.

Streptococcus Salvarious subsp. Thermophilus TCC-3 and *Lactobacillus bulgaricus* were obtained from Chr. Hansen laboratories, Copenhagen, Danemark.

Methods:

Preparation of barley flour:

Seeds of hull-less barley were laboratory milled to a fine powder followed by grinding into flour and sieving through 40 mesh screen using a hammer mill. The flour was packed in plastic container and kept at refrigeration temperature until used.

Chemical analysis:

Total solids, total protein, fat, titratable acidity, fiber and ash were determined in buffaloes' milk and barley flour according to the method described by (AOAC. 2000). Total carbohydrates were calculated by difference.

Preparation of mixtures:

Two experiments were used in this study. The first experiment used 10gr. hull-less barley flour dissolved in distilled water to give 100 ml. suspension barley. The suspension barley was added to buffaloes' milk as follows to give three mixtures the first mixture was 25 ml. suspension barley contained about 3gr. barley flour to 75 ml. buffaloes' milk. The second mixture was 50 ml. suspension barley contained about 5gr. barley flour plus 50 ml. buffaloes' milk. The third mixture was 75 ml. suspension barley contained about 7gr. Barley flour and 25ml. buffaloes' milk.

The second experiment was fortified with buffaloes' milk using hull-less barley flour at levels 3, 5, 7 and 10 grams barley flour individually to 100 ml. buffaloes' milk to give four mixtures. Control sample was made from 100% buffaloes' milk. Chemical analysis was determined in the two experiments as previously mentioned.

Manufacture of yoghurt:

All mixtures were mixed by using high speed blender. After that, it was pasteurized at 90°C for 10 min. and cooled to 45°C then incubated with 3 % active subculture *Streptococcus Salvarious subsp. thermophilus TCC-3* and *Lactobacillus bulgaricus* at 45°C for 3h according to the method described by (Fahmi, 1973). The chemical analysis was determined in yoghurt for all mixtures during storage periods as previously. Moreover, pH values were measured in all yoghurt barley using Jenway pH meter (Jenway limited, Gransmore green, Felsted, Dunmow, England). Acetaldehyde and diacetyl were determined in the yoghurt barley according to (Lees and Jago 1969 a and b). The organoleptic evaluation for the yoghurt treatments were assessed by a pannel test staff from the dairy department, Food Technology Research Institute, Agriculture Research Center according to (Pappas *et al.,* 1996).

RESULTS AND DISCUSSION

Chemical composition of raw materials used in yoghurt:

Data represented in Table (1) show the chemical composition of buffaloes' milk, hull-less barley flour and hull-less barley flour water suspension. The total solids were slightly different between buffaloes' milk and hull-less barley flour water suspension (15.3 and 14.3). Also, buffaloes' milk was the highest in fat 6.5% as well as hull-less barley flour was the highest in carbohydrates, proteins and fibers 66.6, 11.7 and 5.4 % respectively, due to barley has excellent sources of carbohydrates, proteins and fibers (Guchajowska *et al.,* 1998).

Table 1. Chemical composition of buffaloes' milk, hull-less barley flour and suspension hull-less on fresh weight basis:

Barley flour water suspension	Barley flour	Buffaloes' milk	Chemical composition
14.3	90	15.30	Total solids (T.S %)
2.1	11.7	4.15	Total proteins (T.P%)
2.08	2.7	6.5	Fat %
10.0	66.6	4.6	Total carbohydrates%
1.0	3.6	0.81	Ash %
---	5.4	---	Fibers %
0.16	----	0.16	Acidity (as lactic acid)

Chemical composition of yoghurt during storage period:

Data presented in Table (2) revealed that the chemical composition of yoghurt during storage period (15days) using hull-less barley flour water suspension as alternative of buffaloes' milk at different levels. The total solids in the yoghurt control

sample and other mixtures ranged from 10.6 to 15.5%. These mean, that the substitution of hull-less barley flour water suspension at different levels during cold storage period was affected. Also, total protein, titratable acidity fat and ash contents behaved in a similar trend as that of total solids. Whilst, total carbohydrates and pH values increased in parallel with hull-less barley water suspension substitution level of the control sample. These results are in agreement with those reported by (Azzam, 1992) and (El-Etriby *et al.,* 1997).

Table (3) indicated the chemical composition of yoghurt during storage periods (15 days) using added barley flour to buffaloes' milk at different levels. From the results in Table (3) it may be noted that the total solids increased 50 % during the cold storage period. Whereas, fat, total proteins, ash contents, acidity and pH value results showed no changes in the yoghurt made from buffaloes' milk and different levels 3, 5, 7 and 10 %of added barley flour. While, total carbohydrates increased 2.5 times by increasing the amount of added barley flour to buffaloes' milk during cold storage period. These results are in agreement with those reported by (Header and Yousef, 2007).

Table 2. Chemical composition of yoghurt made from different ratios of barley flour water suspension during storage period:

Acidity	pH	Ash %	Carbohydrate %	Fat %	T.P %	T.S %	Mixtures	Storage period(days)
0.90	4.51	0.83	4.50	6.50	4.17	15.32	Control	One day
0.84	4.65	0.72	1.50	4.90	3.40	13.75	1	
0.78	4.67	0.65	3.20	3.40	2.70	12.20	2	
0.61	4.68	050	6.10	1.80	1.90	10.60	3	
0.96	4.47	0.89	4.42	6.50	4.29	15.34	Control	5 days
0.88	4.60	0.77	1.45	4.90	3.50	13.85	1	
0.81	4.62	0.71	3.11	3.40	2.80	12.30	2	
0.67	4.65	0.58	5.98	1.80	2.11	10.71	3	
1.11	4.43	0.97	4.37	6.60	4.35	15.43	Control	10 days
0.91	4.55	0.89	1.41	5.00	3.55	13.95	1	
0.86	4.57	0.80	3.06	3.50	2.87	12.37	2	
0.77	4.59	0.67	5.93	1.90	2.26	10.80	3	
1.27	4.39	0.98	4.35	6.60	4.40	15.50	Control	15 days
1.01	4.46	0.89	1.39	5.00	3.61	14.02	1	
0.92	4.47	0.81	3.01	3.50	2.92	12.45	2	
0.80	4.48	0.68	5.88	1.90	2.33	10.89	3	

Control: made from 100 % buffaloes' milk
Mixture 1: 25 % suspension barley flour + 75 % buffaloes' milk.
Mixture 2: 50 % suspension barley flour + 50 % buffaloes' milk.
Mixture 3: 75 % suspension barley flour + 25 % buffaloes' milk.

Table 3. Chemical composition of yoghurt made from different ratios of barley Flour during storage period:

Acidity	pH	Ash %	Carbohydrate %	Fat %	T.P %	T.S %	Additions %	Storage period(days)
0.90	4.51	0.83	4.50	6.50	4.17	15.32	0	
0.95	4.47	0.90	6.50	6.40	4.38	17.54	3	One day
0.98	4.41	0.96	7.70	6.30	4.55	19.05	5	
1.02	4.38	1.02	8.90	6.20	4.70	20.52	7	
1.13	4.34	1.10	10.80	6.10	4.93	22.83	10	
0.96	4.47	0.89	4.42	6.50	4.29	15.34	0	
0.98	4.43	0.93	6.45	6.40	4.48	17.64	3	5 days
1.03	4.39	0.99	7.63	6.30	4.63	19.16	5	
1.06	4.35	1.10	8.78	6.20	4.82	20.71	7	
1.15	4.31	1.22	10.93	6.10	4.98	22.91	10	
1.11	4.43	0.97	4.37	6.40	4.35	15.43	0	
1.13	4.38	0.98	6.39	6.30	4.55	17.75	3	10 days
1.16	4.35	1.07	7.58	6.20	4.68	19.27	5	
1.18	4.32	1.19	8.71	6.10	4.89	20.88	7	
1.20	4.29	1.38	10.77	6.00	5.05	22.97	10	
1.27	4.39	0.96	4.35	6.40	4.40	15.50	0	
1.29	4.27	0.97	6.37	6.30	4.61	17.86	3	15 days
1.30	4.24	1.04	7.52	6.20	4.79	19.75	5	
1.33	4.21	1.15	8.65	6.10	4.99	21.01	7	
1.36	4.18	1.36	10.71	6.00	5.16	23.11	10	

Effect of yoghurt made from suspension barley flour and addition barley flour on acetaldehyde and diacetyl contents:

Table (4) shows the changes in acetaldehyde and diacetyl contents in yoghurt made from suspension of barley flour and added barley flour to buffaloes' milk during storage period. From these results, it could be noticed that fresh yoghurt made from barley flour water suspension (mixtures 1, 2 and 3) were gradually decreased in acetaldehyde content as suspension barley level increased. It decreased from 173 µg/ml in control to 112 µg /ml in blend (3) at zero time. After that, acetaldehyde content was lower in all mixtures during storage after7 days till the end of storage than acetaldehyde yoghurt at zero time. On the other hand, addition of barley flour levels 3, 5, 7 and 10 % to buffaloes'milk, the acetaldehyde contents were slightly increased than suspension yoghurt. Meanwhile, the diacetyl content increased in the yoghurt made from suspension and addition barley flour during cold storage period. The obtained data showed that the addition of hull-less barley flour may give improved yoghurt. These results are in agreement with the findings (Hassanein, 2003).

Table 4. Effect of barley flour and suspension of barley flour in manufacture of yoghurt on acetaldehyde and diacetyl contents (µg/ml.) during storage period:

Diacetyl (µg /ml.)	Acetaldehyde (µg /ml.)	Addition %	Diacetyl (µg /ml.)	Acetaldehyde (µg /ml.)	Mixtures	Storage (days)
133	181	Control	128	173	Control	
121	162	3	110	154	Mix. 1	Zero
112	153	5	102	140	Mix. 2	time
104	120	7	95	112	Mix. 3	
98	107	10	----	----	---	
150	209	Control	139	197	Control	
136	188	3	127	176	Mix. 1	5 days
121	175	5	115	162	Mix. 2	
110	138	7	101	115	Mix. 3	
102	113	10	---	---	---	
165	161	Control	150	134	Control	
144	158	3	139	117	Mix. 1	10 days
137	141	5	125	99	Mix. 2	
122	107	7	116	75	Mix. 3	
118	99	10	---	---	---	
180	113	Control	177	97	Control	
169	106	3	151	78	Mix. 1	15 days
145	96	5	138	51	Mix. 2	
132	88	7	129	37	Mix. 3	
124	65	10	---	---	---	

Organoleptic properties:

The organoleptic properties of yoghurt made by using suspension of barley flour and addition of barley flour are indicated in Tables (5 and 6).

The obtained results shown in Table (5) revealed that the control has the highest score in fresh and during storage period. The suspension of barley flour was affected slightly and had darkened color in all mixtures. The body and texture became softer and smoother in mixture 3 than other treatments. Also, the suspension of barley flour in mixture 3 became beany flavour, as well as mixtures 1 and 2 the acidity masked the beany flavour. The yoghurt-like retained their good properties during storage period till 10 days but not with mixture 3. The organoleptic properties of yoghurt made from fortified 3, 5, 7 and 10 % of barley flour to buffaloes' milk, the results are presented in Table (6). It is clear from the data that the appearance and flavour were increased in all fortified yoghurt than those made using barley flour water suspension except the addition of 10 % barley flour which had low score and quality. It could be recommended that barley flour water suspension with 25 and 50 % and barley flour at levels fortified 3, 5, 7 % were acceptable and had good quality.

Table 5. organoleptic score of yoghurt made from buffaloes' milk and different levels of barley flour water suspension:

Sensory evaluation					Storage period (days)
Total (100)	Appearance (10)	Body& Texture (45)	Flavour (45)		
97	10	43	44	0	One day
93	10	41	42	25	
88	09	39	40	50	
68	08	30	30	75	
95	10	42	43	0	5 days
93	10	41	42	25	
89	09	38	42	50	
67	06	30	31	75	
90	09	40	41	0	10 days
88	09	39	40	25	
83	08	37	38	50	
67	07	30	30	75	
89	09	40	40	0	15 days
86	09	38	39	25	
82	08	37	37	50	
62	06	28	28	75	

Table 6. organoleptic scores of yoghurt made from buffaloes' milk and different levels of barley flour:

Sensory evaluation					Storage period (days)
Total (100)	Appearance (10)	Body& Texture (45)	Flavour (45)		
97	10	43	44	0	One day
95	10	42	43	3	
92	09	41	42	5	
88	08	40	40	7	
79	07	36	36	10	
95	10	42	43	0	5 days
92	10	40	42	3	
89	09	39	41	5	
86	08	38	40	7	
77	07	34	36	10	
90	09	40	41	0	10 days
87	09	38	40	3	
83	08	36	39	5	
79	07	35	37	7	
73	06	33	34	10	
89	09	40	40	0	15 days
85	09	37	39	3	
79	08	35	36	5	
74	06	33	35	7	
69	06	30	33	10	

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إنتاج زبادي مدعم بدقيق الشعير العاري

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معهد بحوث تكنولوجيا الأغذية- مركز البحوث الزراعية - الجيزة

في هذا البحث تم دراسة إمكانية تصنيع زبادي صحي وعالي الجودة من دقيق الشعير العاري واللبن الجاموسي الذي يحتوي علي ١٥,٣ % مواد صلبة وقد تم تقسيم الدراسة إلي جزئين في الجزء الأول تم استبدال اللبن الجاموسي بواسطة ١٠% معلق الشعير بنسب ٢٥ ، ٥٠ ، ٧٥ % ... وفي الجزء الثاني فقد تم تدعيم اللبن الجاموسي بإضافة ٣ ، ٥ ، ٧ ، ١٠ جم شعير عاري لكل ١٠٠ جم لبن جاموسي علي التوالي . وقد تم إجراء التحاليل الكيماوية لكل من اللبن الجاموسي ودقيق الشعير العاري ومعلقه مع الماء .. ثم تم تخزين جميع المعاملات لمدة ١٥ يوم كما تم تقدير التقييم الحسي لكل من الزبادي المصنع من معلق الشعير وكذا المدعم بالشعير..وأوضحت النتائج أن الزبادي المصنع من معلق الشعيربنسب ٢٥ ، ٥٠% كان أفضل من ناحية المظهر و الطعم أما نسبة ال ٧٥ % فكانت أقلهم من حيث التقييم الكلي لها .

أشارت النتائج بالنسبة للزبادى المدعم بالشعير العارى إلي أن المعاملات المحتوية علي نسب ٣ ، ٥ ، ٧ %كانت أفضل من ناحية الطعم والمظهر و التقييم الكلي عن الزبادي المصنعة من معلق الشعير ..

لذلك يوصي باستخدام الشعير العاري بنسب ٣ ، ٥ ، ٧ ،% ومعلقه بنسب ٢٥ ، ٥٠ % مع اللبن الجاموسي حيث أعطت زبادي عالي الجودة وذات قيمة غذائية وصحية عالية لما يتميز به الشعير من مركبات تحافظ علي صحة الإنسان ومنها البيتاجلوكان الخافض لكوليستيرول الدم .