World Academy of Science, Engineering and Technology
International Journal of Nutrition and Food Engineering
Vol:8, No:3, 2014

Effect of Hull-Less Barley Flakes and Malt Extract on Yoghurt Quality

Ilze Beitane, Evita Straumite

Abstract**—**The aim of the research was to evaluate the influence of flakes from biologically activated hull-less barley grain and malt extract on quality of yoghurt during its storage.

The results showed that the concentration of added malt extract and storage time influenced the changes of pH and lactic acid in yoghurt samples. Sensory properties – aroma, taste, consistency and appearance – of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract changed significantly ($p<0.05$) during storage. Yoghurt with increased proportion of malt extract had sweeter taste and more flowing consistency. Sensory properties (taste, aroma, consistency and appearance) of yoghurt samples enriched with 5% flakes from biologically activated hull-less barley grain (YFBG 5%) and 5% flakes from biologically activated hull-less barley grain and 2% malt extract (YFBG 5% ME 2%) did not change significantly during one week of storage.

Keywords**—**Barley flakes, malt extract, yoghurt, sensory analysis.

I. Introduction

AMONG the different product sectors, the dairy sector is the one that has undergone the greatest changes, with many new products claiming healthy characteristics, not all of which are equally successful. In recent years, the market of traditional healthy dairy products, like skimmed dairy products, or those with probiotic characteristics, like yoghurt, has expanded to incorporate an ample range of fermented milks of prebiotic or probiotic nature, with different active ingredients that offer the consumer an alternative to conventional dairy product. The dairy industry has been quickly revitalized by the introduction of products characterized nutritional value, pleasant taste and positive effects on the consumer's health [1], [2]. Yoghurt has gained considerable economic importance worldwide because of its high nutritional content [3]. Furthermore the nutritional value of yoghurt could be increased by adding bioactive compounds. *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* are traditionally used as starters for milk fermentation in production of yoghurt [4], where *Lactobacillus delbrueckii* subsp. *bulgaricus* contributes to accelerate lactic acid development and improve flavor and textural properties in yoghurt [5]. Consumer acceptance of yoghurt depends on acidity, aroma perceptions and textural properties of the product [6]. The research of Pohjanheimo and Sandell [2] about the influence of sensory and non-sensory characteristics of drinking yoghurt showed that food choice motives (importance of natural content, ethical concern and health) influenced liking and not all consumers' preferred sweeter yoghurt. Therefore it is significant to understand which sensory attributes drive liking is a key issue when developing new products [7]. An important point to consider is that consumer acceptance of a new healthy product is far from being unconditional, not all of many new products claiming healthy characteristics are equally successful [8]. The benefits of healthy products may provide added value to consumer but cannot outweigh the sensory properties of foods [9]. Therefore it is important to produce new products with increased nutritional value, positive effects on the human's health and excellent sensory properties. The aim of the research was to evaluate the influence of flakes from biologically activated hull-less barley grain and malt extract on quality of yoghurt during its storage.

I. Beitane is with Faculty of Food Technology, Latvia University of Agriculture, Jelgava, LV-3001 Latvia (phone: 00371 63005647; fax: 00371 63005729; e-mail: Ilze.Beitane@llu.lv).

E.Straumite is with Faculty of Food Technology, Latvia University of Agriculture, Jelgava, LV-3001 Latvia (phone: 00371 63005643; fax: 00371 63005729; e-mail: Evita.Straumite@llu.lv).

II. Materials and Methods

Pasteurized milk with fat content 2.5% and the yoghurt culture YF-L811, containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (Chr.Hansen, Denmark), was used for experiments. Yoghurt culture was stored in freezer at -18°C and used directly for milk fermentation.

Flakes from biologically activated hull-less barley grain (Latvia) were added to milk in concentration of 5% and malt extract (Ilgezeem, Latvia) in different concentrations (2%, 4% and 6%). Milk samples with flakes from biologically activated hull-less barley grain and malt extract were inoculated with yoghurt culture and fermented at 43±1°C for 4 hours. After fermentation the maturation of yoghurt samples was done at 5±1°C for 24 hours. Five yoghurt samples were analyzed (Table I). All yoghurt samples were stored at 5±1°C for 14 days.

pH of yoghurt samples was determined using pH-meter WTW series inoLAB pH 720. Lactic acid is calculated on the basic titratable acidity by using the following equation:

Lactic acid (%) = 0.0090 × volume of NaOH used × 100/weight of the sample [10].

Titratable acidity of yoghurt samples was determined by titration following the LVS ISO 6092:2003 using phenolphthalein as an indicator. Triplicate measurements of pH and lactic acid were carried out after yoghurt sample's fermentation, maturation and cold storage on the 1st, 3rd, 5th, 7th and 14th day.

TABLE I
YOGHURT SAMPLES DESCRIPTION

Code	Sample
Control	Yoghurt without flakes from biologically activated hull-less barley grain and malt extract
YFBG5%	Yoghurt enriched with 5% of flakes from biologically activated hull-less barley grain
YFBG5% ME2%	Yoghurt enriched with 5% of flakes from biologically activated hull-less barley grain and 2% of malt extract
YFBG5% ME4%	Yoghurt enriched with 5% of flakes from biologically activated hull-less barley grain and 4% of malt extract
YFBG5% ME6%	Yoghurt enriched with 5% of flakes from biologically activated hull-less barley grain and 6% of malt extract

Sensory evaluation of yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract was carried out on the 1st, 7th and 14th day.

Eight assessors (females an age profile of 35–52 years) selected from Latvia University of Agriculture Faculty of Food Technology staff members, who consume different yoghurts and had previous taste panel experience, rated sensory properties of yoghurts. They were selected according to their willingness, availability, motivation, and previously demonstrated capability to work as a member of a sensory panel.

Four sensory properties – aroma, taste, consistency, appearance were evaluated. The intensity of each attribute was scored on a 5 point scales, according to ISO 4121:2003: 5 – excellent quality; 4 – good quality; 3 – passable, insignificant defects; 2 – bad, pronounced defects; 1 – very bad, hard pronounced defects. When evaluating the samples with 3 or lower score the assessors indicated the defects.

The characteristics of good quality yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract should correspond to the description presented in Table II.

Samples of yoghurts for sensory evaluation were presented in coded glass containers (approximately 50g products) and served at 12±2°C. Between one sample and the next assessors used warm black tea to cleanse their palates.

TABLE II
QUALITY DESCRIPTION OF YOGHURT ENRICHED WITH FLAKES FROM BIOLOGICALLY ACTIVATED HULL-LESS BARLEY GRAIN AND MALT EXTRACT

Code	Sample
Taste	Pleasant lactic acid taste, yoghurt like with malt extract and cereals taste, clean, refreshing, slight acid taste
Aroma	Lactic acid aroma, intensive, clean, refreshing aroma
Consistency	Uniform and compact with cereals flakes, creamy not lumpy, without syneresis
Appearance	Intense white to slightly creamy/yellow/brown, if more of malt extract is added colour can be brown

The measurements of pH and titratable acidity were performed in triplicate. Differences in sensory quality among samples were analyzed by a two-way analysis of variance (ANOVA), and differences in mean were analyzed by one-way analysis of variance. Tukey's test was used for multiple comparisons of sensory attributes at $p < 0.05$.

III. RESULTS AND DISCUSSION

The pH and lactic acid changes in the control (yoghurt without flakes and malt extract) and experimental yoghurt samples after fermentation, maturation and during cold storage for a 14 days period are shown in Tables III and IV.

TABLE III
PH CHANGES OF EXPERIMENTAL YOGHURT SAMPLES AFTER FERMENTATION, MATURATION AND DURING STORAGE

	Control	YFBG5%	YFBG5% ME2%	YFBG5% ME4%	YFBG5% ME6%
After fermentation	4.35	4.47	4.49	4.42	4.33
After maturation	4.49	4.54	4.57	4.50	4.49
1st day	4.35	4.54	4.52	4.44	4.43
3rd day	4.33	4.35	4.37	4.30	4.30
5th day	4.29	4.31	4.30	4.26	4.25
7th day	4.28	4.30	4.28	4.24	4.23
14th day	4.27	4.28	4.27	4.22	4.20

After fermentation the pH of all samples decreased from 6.5 (pH of milk) to range of 4.33 to 4.47, whereas after maturation the pH slightly increased in the ranges 4.49 to 4.57. The pH value during 14 days of storage decreased gradually, the changes were conditioned on added malt extract concentration. The added malt extract concentration of 4% and 6% in yoghurt samples provided lower pH values from 4.20 to 4.22 on the 14th day of storage. pH of commercial yoghurts is ranging from 3.7 to 4.6, nevertheless, to avoid insipidness or excess acidity to the taste, the optimal value of pH should be in the ranges 4.0-4.4 [4]. Therefore, it could be concluded that pH of experimental yoghurts conformed with the optimal value of pH during storage time.

Lactic acid of control and all yoghurt samples increased gradually as storage period progressed (Table IV). These results confirmed the results found in literature [11].

TABLE IV
LACTIC ACID CHANGES OF EXPERIMENTAL YOGHURT SAMPLES AFTER FERMENTATION, MATURATION AND DURING STORAGE, %

	Control	YFBG5%	YFBG5% ME2%	YFBG5% ME4%	YFBG5% ME6%
After fermentation	0.767	0.721	0.747	0.777	0.788
After maturation	0.798	0.767	0.777	0.859	0.854
1st day	0.802	0.787	0.799	0.901	0.897
3rd day	0.808	0.818	0.844	0.936	0.920
5th day	0.854	0.828	0.910	0.951	0.992
7th day	0.864	0.839	0.982	1.043	1.059
14th day	0.910	0.892	1.064	1.156	1.161

Adding of malt extract significantly increased ($p<0.05$) the development of lactic acid in yoghurt samples during storage comparing with control and yoghurt sample enriched with only flakes from biologically activated hull-less barley grain. As well there was established significance of the added malt extract concentration. The highest lactic acid was determined in yoghurt sample enriched with flakes from biologically activated hull-less barley grain and 4% and 6% malt extract on the 14th day (YFBG5% ME4% – 1.156% and YFBG5% ME6% – 1.161%). Therefore could be concluded that after yoghurt samples fermentation lactic acid continued to increase, which provided in yoghurt existent lactic acid bacteria (LAB), which activity influenced the added flakes from biologically activated hull-less barley grain and malt extract in concentration of 4% and 6% in yoghurt.

Good quality yoghurt should maintain strong curd integrity without any sign of shrinkage and disintegration into lumps and whey-off. It should also possess pleasant odor and flavor and, especially with the set yoghurt, the defect of syneresis, which relates to the appearance and mouthfeel, can adversely affect acceptability or preference of consumers [12]. Changes in sensory properties of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract during storage are summarized in Table V.

TABLE V
SENSORY PROPERTIES OF YOGHURT WITH HULL-LESS BARLEY FLAKES AND MALT EXTRACT

Sensory properties	Storage day	Samples			
		YFBG5%	YFBG5% ME2%	YFBG5% ME4%	YFBG5% ME6%
Taste	1st day	4.25a*	4.75a	3.62a	3.12b
	7th day	4.22a	4.44ac	3.78a	3.56b
	14th day	3.13b	3.00bc	2.75b	2.50c
Aroma	1st day	4.75a	4.50a	4.50a	4.38a
	7th day	4.67a	4.67a	4.33a	4.33a
	14th day	3.50b	3.75b	3.38b	2.88c
Consistency	1st day	4.38a	4.75a	4.25a	4.63a
	7th day	4.33a	4.11a	3.67b	3.56b
	14th day	3.75b	3.25b	3.00b	2.63c
Appearance	1st day	4.63a	4.63a	4.50a	4.38a
	7th day	4.78a	4.67a	4.56a	4.33a
	14th day	4.25a	4.00a	4.13a	4.00a

* Values of sensory properties, marked with the same letters in columns, are not significantly different ($p>0.05$)

Sensory properties of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract changed significantly during its storage time and the changes were affected by the amount of added malt extract concentration. The sample YFBG5% ME6% had sweet taste and taste and aroma of lactic acid was less intensive, that was influenced by amount of added malt extract. Due to enzyme presence in malt extract, which splits polysaccharides, the consistency of all samples became more liquid after 14 storage days and the evaluation was no passable, insignificant defects for the sample YFBG5% up to bad, pronounced defects for the sample YFBG5% ME6%. During the storage time, the least changes were observed in appearance and colour, which allows drawing conclusion that adding of flakes from biologically activated hull-less barley grain and malt extract did not have significant ($p>0.05$) effect on yoghurt appearance. After 14 storage days yoghurt sample enriched with 5% flakes from biologically activated hull-less barley grain and 6% malt extract (YFBG5% ME6%) had very sweet, unpleasant taste and aroma, possibly due to use of simple sugars, formed by enzymes, in lactic acid fermentation.

The optimum shelf-life for yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract was established 7 days, when no significant ($p>0.05$) changes were observed in aroma, taste, consistence and appearance.

IV. Conclusion

1. Concentration of added malt extract and storage time influenced the changes of pH and lactic acid in yoghurt samples.
2. Sensory properties of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract changed significantly ($p<0.05$) along the storage time and the changes were affected by the amount of added malt extract.
3. Sensory properties (taste, aroma, consistency and appearance) of yoghurt samples enriched with 5% flakes from biologically activated hull-less barley grain (YFBG 5%) and 5% flakes from biologically activated hull-less barley grain and 2% malt extract (YFBG 5% ME 2%) did not change significantly during one week of storage.

Acknowledgment

This paper is a result of the research within the State Research Programme "Sustainable use of local resources (earth, food, and transport) – new products and technologies (NatRes)" Project No. 3. Sustainable use of local agricultural resources for development of high nutritive value food products (Food)".

References

[1] M.C. Casiraghi, E. Canzi, R. Zanchi, E. Donati, L.Villa, "Effects of Symbiotic Milk Product on Human Intestinal Ecosystem", *Journal of Applied Microbiology* 2007, vol. 103, pp. 499-506.

[2] T. Pohjanheimo, M.Sandall, "Explaining the Liking for Drinking Yoghurt: The Role of Sensory Quality, Food Choice Motives, Health Concern and Product Information", *International Dairy Journal* 2009, vol. 19, pp. 459-466.

[3] D. Guggisberg, J. Cuthbert-Steven, P. Piccinali, U. Bütikofer, P. Eberhard, "Rheological, Microstructural and Sensory Characterization of Low-Fat and Whole Milk Set Yoghurt as Influenced by Inulin Addition", *International Dairy Journal* 2009, vol. 19, pp. 107-115.

[4] R.P. De Souza Oliveira, A.C.R. Florence, P. Perego, M.N. De Oliveira, A.Converti, "Use of Lactulose as Prebiotic and Its Influence on the Growth, Acidification Profile and Viable Counts of Different Probiotics in Fermented Skim Milk", *International Journal of Food Microbiology* 2011, vol. 145, pp. 22-27.

[5] B. Curry, V. Crow, "*Lactobacillus* spp General Characteristics", in: H. Roginski, et al (Eds.), *Encyclopedia of Dairy Science*. Cornwall, UK: Academic Press Elsevier Science, 2003, pp. 1479-1511.

[6] T. Erkaya, M. Şengül, "Comparison of Volatile Compounds in Yoghurts Made From Cows', Buffaloes', Ewes' and Goats' Milks", *International Journal of Dairy Technology* 2011, vol. 64(2), pp. 240-246.

[7] B. Villegas, A. Tárrega, I. Carbonell, E. Costell, "Optimising Acceptability of New Prebiotic Low-Fat Milk Beverages", *Food Quality and Preference* 2010, vol.21, pp. 234-242.

[8] S. Bayarri, I. Carbonell, E.X. Barrios, E. Costell, "Impact of Sensory Differences on Consumer Acceptability of Yoghurt and Yoghurt-Like Products", *International Dairy Journal* 2011, vol. 21, pp. 111-118.

[9] I. Siró, E. Kàpolna, B. Kàpolna, A. Lugasi, "Functional Food. Product Development, Marketing and Consumer Acceptance. A Review", *Appetite* 2008, vol. 51, pp. 456-457.

[10] AOAC, 1990. Official Methods of Analysis Chemists. 15th ed. Association of Official Analytical Chemists AOAC. USA, Virginia: Arlington, 1990.

[11] K.M.K. Kebary, A.H. El-Sonbaty, K.M. Kamaly, K.R.M. Badawi, "Effect of Using Normal and Ropy Strains of Yoghurt Starter in the Manufacture of Yoghurt from Cow's Milk Fortified with Different Levels of Inulin and Non-Fat Dried Milk", *Egyptian Journal of Dairy Science* 2012, vol. 40, pp. 99-111.

[12] N.Srisuvor, N.Chinprahast, C.Prakitchaiwattana, S. Subhimaros, "Effects of Inulin and Polydextrose on Physicochemical and Sensory Properties of Low-Fat Set Yoghurt with Probiotic-Cultured Banana Purée", *LWT - Food Science and Technology* 2013, vol. 51, pp. 30–36.

Ilze Beitane, Dr.sc.ing., assistant professor at the Latvia University of Agriculture, Faculty of Food Technology, was born in Latvia, Jelgava in 1976. In 2008 she defended PhD thesis and obtained doctoral degree in food science. Main topics of research: functional dairy products. She has 20 scientific publications and participated in 4 different projects.

Evita Straumite, Dr.sc.ing., leader researcher at the Latvia University of Agriculture, Faculty of Food Technology, was born in Latvia, Skrunda in 1975. She acquired doctor's degree in Food Science, defending her thesis "Research on baking properties of rye flour produced in Latvia". Research interests – development of new cereal based products, sensory evaluation of food. She participates as an expert in the annual evaluation of Bread, pastry and cereal processing products in Germany, organized by DLG (Deutsche Landwirtschaftliche Gesselschaft). She has 52 scientific publications and participated in 17 different projects.