NUTRITIONAL VALUE AND SENSORY PROPERTIES OF YOGHURT ENRICHED WITH BARLEY GRAINS AND MALT EXTRACT

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Abstract
Growing interest of consumers in healthy eating has provided the development of new range of food. Therefore the task of research was to determine the nutritional value, calculate energy value and investigate the sensory properties of yoghurt samples enriched with flakes from biologically activated hull-less barley grains and malt extract.
Results showed that by adding flakes from biologically activated hull-less barley grain and malt extract it was possible to improve the nutritional value of yoghurt, i.e., increased protein, carbohydrate and decreased fat content. The energy value of yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract ranged between 65.96 and 75.72 kcal 100 g^{-1}, which is significantly lower comparing with mean energy value of commercial yoghurts. The changes of sensory properties were affected by the amount of added malt extract in yoghurt samples. The optimal amount of added malt extract for sensory evaluation in yoghurt samples was determined as 2%. The content of carbohydrate in yoghurt sample enriched with 5% of biologically activated hull-less barley grain and 2% of malt extract was two times lower than commercial yoghurts therefore its energy value was significantly lower. Yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract could be competitive.
Key words: yoghurt, nutritional value, sensory properties.

Introduction

Growing interest of consumers in healthy eating has provided the development of new range of food. The dairy sector is the one that has undergone the greatest change, with many new products claiming healthy characteristics, not all of which are equally successful (Bayarri et al., 2011). The wide variety of macronutrient-modified foods available to consumers has enabled people to eat a more healthy diet, along the lines of the recommendations, and so reduce the risk of diseases such as obesity, cardiovascular disease and cancer (Clugston and Smith, 2002). There is increased consumer demand for low fat yoghurt, due to their potential health and nutritional benefits (Prasanna et al., 2013). The nutritional image of milk fat suffers from its content of saturated fatty acids increasing serum cholesterol, which is considered as a risk factor for coronary heart disease (Steijns, 2008). Therefore customers have an interest in yoghurt with low or reduced fat content. Whereas milk proteins are potential ingredients of health-promoting functional foods targeted at diet-related chronic disease, such as cardiovascular disease, diabetes type II and obesity (Korhonen, 2009). The dairy proteins are the preferred choice in special nutrition formulas for (re)building tissues and muscle mass in infants, hospitalized individuals, performance athletes, dieters and the elderly (Steijns, 2001). Therefore it could be concluded that it is significant to produce a new dairy product with low or reduced fat and increased protein content. An important point to consider is that consumer acceptance of a new healthy product is unpredictable, because their benefits may provide added value to consumers but cannot outweight the sensory properties of foods (Siró et al., 2008). The reward value of food products by consumers depends on the sensory properties, e.g., taste, aroma, texture and appearance (Sclafani, 2004), metabolic effects, e.g., energy density and macro-nutrient composition (De Houwer et al., 2001) and learned reward association based on previous experience with the product (Zandstra and El-Deredy, 2011). These three factors influence the acceptance of a new product by consumers. Therefore the task of research was to determine the nutritional value, calculate energy value and investigate the sensory properties of yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract.

Materials and Methods

Materials and preparation of yoghurt samples

Pasteurized milk with a 2.5% fat content and the yoghurt culture YF-L811, containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (Chr.Hansen, Denmark), were used for experiments. Yoghurt culture was stored in the 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 1). The control sample was prepared without the flakes from biologically activated hull-less barley grain and malt extract for comparing results.

Determination of pH and lactic acid

pH of yoghurt samples was determined using pH-meter WTW series inoLAB pH 720. Lactic acid is calculated on the basic titratable acidity. The titratable acidity of yoghurt samples was determined by titration following the LVS ISO 6092:2003 using phenolphthalein as an indicator. The measurements of pH and lactic acid were carried out after yoghurt sample's fermentation, and on the 1st day.

Determination of carbohydrates content

The content of carbohydrates of the yoghurt samples was determined with high-performance liquid chromatographic (Shimadzu LC 20 Prominence). Determination parameters: detector: refractive index RID-10A; column: Alltech NH_2, 4.6 mm x 250 mm, 5μm; temperature +25 °C; isocratic elution regime, mobile phase: A – acetonitrile; B – deionized water (A70:B30); capacity of the injection sample: 10 μL; total time of the analysis: up to 25 min; rate of the flow: 1.0 mL min^{-1}.

Calculation of energetic value

The total energy of samples was calculated according to the following equations (Council Directive 90/496/EEC, 1990):

(1) Energy (kcal) = 4 × (g protein + g carbohydrate) + 9 × (g lipid)

(2) Energy (kJ) = 17 × (g protein + g carbohydrate) + 37 × (g lipid)

Sensory analysis

Sensory evaluation of yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract was carried out on the 1st day. Eight assessors (females, aged 35–52) 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 scale, 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 correspond to the description presented in Table 2.

Table 1

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

Table 2

Quality description of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract

Sensory properties	Description
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

Table 3

Effect of flakes from biologically activated hull-less barley grain and malt extract in yoghurt samples on lactic acid and pH

Yoghurt samples	Lactic acid, %		pH	
	After fermentation	1st day	After fermentation	1st day
Control	0.767±0.009	0.802±0.010	4.35±0.03	4.35±0.03
YFBG5%	0.721±0.007	0.787±0.008	4.47±0.04	4.54±0.03
YFBG5% ME2%	0.747±0.007	0.799±0.007	4.49±0.03	4.52±0.02
YFBG5% ME4%	0.777±0.010	0.901±0.012	4.42±0.02	4.44±0.03
YFBG5% ME6%	0.788±0.007	0.897±0.008	4.33±0.04	4.43±0.04

Table 4

Nutritional and energy value of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract

Yoghurt samples	Protein (g 100 g^{-1}) (Beitane, 2013)	Fat (g 100 g^{-1}) (Beitane, 2013)	Carbohydrate (g 100 g^{-1})	Energetic value	
				kcal 100 g^{-1}	kJ 100 g^{-1}
Control	3.48	2.40	6.08	59.84	251.32
YFBG5%	3.81	2.31	7.28	65.15	274.00
YFBG5% ME2%	3.85	2.28	7.51	65.96	277.48
YFBG5% ME4%	3.77	2.23	8.52	69.23	291.44
YFBG5% ME6%	3.84	2.12	10.32	75.72	319.16

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

Statistical analysis

The measurements of pH and titratable acidity as well the analyses of carbohydrate content in yoghurt samples were performed in triplicate. The results of research were analyzed using the analysis of variance (ANOVA). T-test was applied to compare the mean values, and p-value at 0.05 was used to determine the significant differences. Tukey's test was used for multiple comparisons of sensory attributes at $p<0.05$.

Results and Discussion

The pH and titratable acidity changes in the control (yoghurt without flakes from biologically activated hull-less barley grain and malt extract) and experimental yoghurt samples after fermentation and on the 1st day is shown in Table 3.

pH of commercial yoghurts is largely variable, ranging from 3.7 to 4.6 (Souza, 1991). Nevertheless, to avoid insipidness or excess acidity to the taste, the optimal value of pH should be in the range 4.0-4.4 (Oliveira et al., 2011). The obtained results showed that pH of all yoghurt samples ranged from 4.33 to 4.54, which is close to the optimal value. Evaluating the data obtained for lactic acid it could be concluded that after the yoghurt samples fermentation lactic acid continued to increase, which provided in yoghurt existent lactic acid bacteria (LAB), whose activity influenced the added flakes from biologically activated hull-less barley grain and malt extract in concentration of 4% and 6% in yoghurt. Then the highest value of lactic acid (YFBG5% ME4% – 0.897% and YFBG5% ME6% – 0.901%) was determined.

The significant result, obtained from the evaluation of the new product is this increased nutritional and decreased energy value. Therefore the nutritional and energy value of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract are summarized in Table 4.

By adding flakes from biologically activated hull-less barley grain and malt extract it was possible to improve the nutritional value of yoghurt, i.e., increased protein and decreased fat content. However, the changes of total protein and fat content in yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract and control were insignificant ($p>0.05$), in common with effect of added malt extract in different concentrations was insignificant ($p>0.05$), too (Beitane, 2013). The changes of carbohydrate content in yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract were significant comparing with control ($p<0.05$). Furthermore, the increase of carbohydrate content in yoghurt samples affected the concentration of added malt extract. The content of carbohydrate in yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract ranged between 7.51 and 10.32 g $100g^{-1}$. Carbohydrate content in YFBG5% ME6% sample significantly differed from YFBG5% ME2% and YFBG5% ME6% samples ($p<0.05$).

The calculation of energy value of analysed samples showed that it is possible to produce new products with low energy value, which have significant point for acceptance by consumers. The energy value of yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract ranged between 65.96 and 75.72 kcal 100 g^{-1}, which is significantly lower comparing with mean energy value of commercial yoghurts (Table 5). However, it is known that consumer behaviour about food choice is determined not only by nutritional and energy value but also sensory evaluation of particular food product. Good quality yoghurt should 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 (Srisuvor et al., 2013). The changes of sensory properties in yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract are showed in Figure 1.

Evaluation of intensity of sensory properties of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract shows that there is no significant difference ($p>0.05$) in appearance, aroma and consistence, but there exist significant difference in intensity of taste ($p<0.05$). The obtained results suggested that more intensive taste was established to samples YFBG5% ME2% and YFBG5%.

The changes of sensory properties were affected by the amount of added malt extract in yoghurt samples. The optimal amount of added malt extract for sensory evaluation in yoghurt samples was determined as 2%. Therefore the yoghurt sample enriched with 5% of flakes from biologically activated hull-less barley grain and 2% of malt extract (YFBG5% ME2%) was selected for nutritional and energy value comparing with equal commercial yoghurt (Table 5).

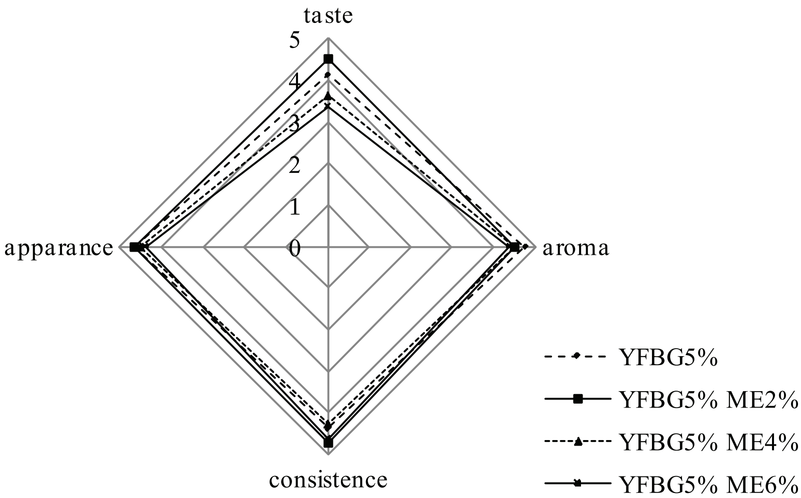

Figure 1. Intensity of sensory properties of yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract.

Table 5

Nutritional and energy value comparison of analysed and commercial yoghurts

Samples	Protein (g 100 g^{-1})	Fat (g 100 g^{-1})	Carbohydrate (g 100 g^{-1})	Energetic value	
				kcal 100 g^{-1}	kJ 100 g^{-1}
YFBG5% ME2%	3.85	2.28	7.51	65.96	277.48
Ecological yoghurt with apples and grain*	4.10	2.50	14.80	98.10	413.80
Drinking yoghurt with grain and seeds*	3.10	1.90	14.30	86.70	366.10

*Commercial yoghurts with declared nutritional value on label

During the study significant differences of carbohydrate content among YFBG5% ME2% sample and commercial yoghurts were determined. The content of carbohydrate in YFBG5% ME2% sample was two times lower as in commercial yoghurts. It affected the energy value decrease of YFBG5% ME2% sample. Therefore, it could be concluded that yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract could be competitive.

Conclusions

1. By adding the flakes from biologically activated hull-less barley grain and malt extract it was possible to change the nutritional value of yoghurt, i.e., increased protein, carbohydrate and decreased fat content.
2. The energy value of yoghurt samples enriched with flakes from biologically activated hull-less barley grain and malt extract ranged between 65.96 and 75.72 kcal 100 g^{-1}, which is significantly lower comparing with the mean energy value of commercial yoghurts. The carbohydrate content in yoghurt sample enriched with 5% of flakes from biologically activated hull-less barley grain and 2% of malt extract was two times lower as in commercial yoghurts.
3. The changes of sensory properties were affected by the amount of added malt extract in yoghurt samples. The optimal amount of added malt extract for sensory evaluation in yoghurt samples was determined as 2%.
4. Yoghurt enriched with flakes from biologically activated hull-less barley grain and malt extract could be competitive.

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