J. Basic. Appl. Sci. Res., 3(1s)205-210, 2013

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Effect of Prebiotic Beta-Glucan Composite on Physical, Chemical, Rheological and Sensory Properties of Set-type Low-Fat Iranian Yogurt

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Received: June 10 2013
Accepted: July 10 2013

ABSTRACT

Increasing the food quality is a goal in recent years. Beta-glucan composite is a dietary fibre and has beneficial health effects that can be used as a prebiotic and fat replacer in the manufacture of dietary products such as low-fat yogurt. In this study, beta-glucan as a fat replacer was added at levels of 0.25% and 0.50% to low-fat milk (1.2%) and full-fat milk (2.92%) was used as a control sample. Physical, chemical, rheological and sensory properties of samples were analyzed after 1,7 and 15 days of storage. Fat and protein contents in the yogurts differed, while ash content was identical. Adding the beta-glucan composite did not show significant changes of PH and titratable acidity contents during storage. However, it caused a decrease of whey separation.($p<0.05$) Viscosity values in the yogurts increased by adding the beta-glucan and sensory evaluation were acceptable. The use of beta-glucan in low-fat formulations significantly increased the viscosity and caused decrease in whey separation and intake of calories. This properties are related to increasing the total solids present in the formulations and the ability of the beta-glucan as a fat replacer to entrap water within network of the product.
KEYWORDS: Yogurt, Hydrocolloid, beta-glucan

1. INTRODUCTION

Yogurt is a fermented dairy product obtained by lactic acid fermentation of milk by the action of yogurt starter bacteria, and is a popular product throughout the world. Yogurt by itself has been recognized as a healthy food, due to the beneficial action of its high level of protein and calcium contents. Yogurt is an important dairy product, particularly for consumers with lactose intolerance.

Traditionally produced yogurts contain 3–4% fat, it increases to 9–10% in concentrated yogurts, but it has been produced using skimmed milk in developed countries due to the fat level. Excessive intake of dietary fat causes some disorders, such as cardiovascular diseases, obesity and certain forms of cancer and diabetes[1],[2].

A recent World Health Organisation (WHO) report recommended that the level of total fat intake should be between 15% and 30% of the energy, of which saturated fatty acids should account for less than 10% energy [3].

Fat plays an important role in controlling the firmness/viscosity and perceived creaminess of yogurt due to the formation of a larger number of smaller fat particles during homogenisation when they are stabilized by milk proteins and interact with the protein matrix[4]. Therefore, consumers began to look for low or non-fat variants of yogurt in the markets. However, the consumers' demand for non-fat yogurt also included a similar sensory quality as in full-fat yogurts Partial or total removal of fat in a yoghurt formulation can cause product deficiencies such as weak body texture, higher whey separation and poor sensory quality[5].

Reduced-fat yoghurt can be produced by partially replacing the fat content of the milk base with either milk protein solids such as skim milk powder, sodium casein ate, or whey protein concentrates (WPCs), or by including other fat replacers such as starch granules[6].

To improve textural and/or increase functional properties of yogurt, some alternative materials including gelatin , pectin , k-carrageenan , inulin and dietary fibres were used in the manufacture[1],[7],[8]. DF is resistant to digestion and absorption in the human small intestine, with complete or partial fermentation taking place in the large intestine. High fibre foods increase the feeling of fullness, provide more nutrients with fewer calories and could help to reduce childhood obesity [5].

Dietary fiber, such as, barley/oat mixed linkage (1-3), (1-4)-b-D-glucan (beta-glucan (BG)), is known to confer important health-promoting properties. Increased fiber consumption has been linked to a decrease in serum cholesterol

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and glycemic index, cardiovascular diseases, cancer, diabetes and hypertension, as a result, many food products, including yogurt, are produced incorporating this valuable ingredient [9-13].

The (1-3), (1-4) b-D-glucans (beta-glucans) are cell wall polysaccharides of endosperm and aleurone cells of the most commercial cereals, such as oat, barley, rye, and wheat [14-15].

The release of low-molecular fatty acids during beta-glucan fermentation in the colon preconditions its potential anti-carcinogenic effect. In addition, beta-glucan is known as prebiotic, stimulating the growth of some beneficial residential colon microorganisms such as bifidobacteria [16].

The efficacy of beta-glucans may be related to extraction procedures, and factors such as dose, molecular weight and fine structure, and rheological characteristics of extracted and native beta-glucans. A part from their positive health benefit, they also possess unique functional properties such as their ability to hold a large amount of water and their intrinsic rheological properties which make them ideal candidates as 'cleanlabel' viscosifiers or thickeners to structure manufactured food products while achieving desirable texture and sensory properties [6] .

2.MATERIALS AND METHODS

2.1.Chemical composition of beta-glucan hydrocolloidal composite

Raw cow's milk was obtained from the dairy farm in Qazvin. beta-glucan composite Was used from Biovelop AB Alvasvagen 1 . 610 20 Kimstad. The chemical composition of the material used as a fat replacer is listed in Table 1. Lyophilized-mixed starter cultures containing Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus were used as a starter culture.

Table 1 Chemical composition of b-glucan hydrocolloidal composite

Values expressed on dry matter	Value (%, w/w)
Soluble b-glucan	34-36% * (Total Dietary Fiber : 36-38%)
Carbohydrate (oat maltodextrin)	52-54%
Protein	2-3%
Ash	3-4%
Fat	0.5-1%

Beta Glucan content determined using AOAC method 995.16

2.2.Yogurt manufacture

Skimmed milk with Maximum fat level of 1.2 (v / v) was prepared by separating whole raw milk using a cream separator at 40 C. Skimmed milk, was divided into two parts and beta-glucan hydrocolloids composite was added in level of 0.25% and 0.5%. Then 1% dry milk powder (SMP) and 0.5% whey powder (WPC) added and with stirring at high speed for 5 minutes at a temperature C ° 65 DF and other added compounds were dissolved in milk. Then, the homogenates were pasteurized at 85 C for 5 min and cooled to 47 C, inoculated with a starter culture at a ratio of 1% (w/v), dispersed into plastic cups, ca. 200 g, and incubated at 43 C until pH 4.7. Following incubation, all samples were kept at room temperature (21 1C) for 30 min and moved to a cold room. The yogurt samples were stored at 4 C for 15 d and sampled at 1, 7 or 15 d of storage. Yogurt samples was kept at C ° 5 for 15 days and on days 1, 7 and 15 of storage were tested.

2.3.Chemical analysis

Total solids, protein and ash were measured by using method AOAC 1990[17] and fat contents of samples by zherber method. The titratable acidity in terms of lactic acid was determined that 9 g of yogurt mixed with 9 g distilled water and then using indicator phenol Ftalyyn was titred with NAOH solution (0.1N) to light pink appearance. pH values were measured using a digital PH meter (WTW, Wielheim, Germany).

2.4.Syneresis

Twenty-five grams of yogurt samples were weighed on a filter paper placed on top of a funnel(W_1). Syneresis of whey was carried out by gravity and the quantity (grams) of whey collected in a flask of known weight was used as a syneresis value. The drainage time and temperature was 120 min and +4℃, respectively[1].

$$(\%)\textbf{Syneresis} = (W_2 - W_1 / M) \times 100$$

2.5.Viscosity

Viscosity of the samples was measured at +4℃ with a spindle (No. 63) rotation of 100 rpm using a Brookfield viscometer (model DV-II+Pro, USA) during 15 d of storage.

The method is as follows that after ensuring a balance of device and select appropriate spindle at the desired temperature Spindle at different speeds read the viscosity value and with respect to the momentum Reported in the digital home Edit rapidly taken up too high or low until the torque figure is closer to 100. If you selected a different spindle Spindle torque and 100 rpm higher than the previous show the more accurate number is a prime number. The measurements were made in triplicate for each yogurt sample and the readings were recorded as centipoises [1].

2.6.Sensory analysis

Sensory analyses of the yogurt samples were evaluated by the five expert panel members from the yoghurt qazvin dairy Co. According to scoring scale (0–4 point) for appearance(colour,syneresis) , oral texture(mouth feel) and other oral texture (Spoonability and shooting) , consistency, odour and flavour [2] .

2.7.Statistical analysis

Statistical analyses of the data were made using ANOVA of SPSS package program, version 16.0. Differences between means were determined by Duncan's multiple range test at a level of 0.05 graphs were plotted by Excel.

3.RESULTS AND DISCUSSIONS

3.1.Chemical composition

The chemical composition of the experimental yogurt samples is shown in Table 2. Total solid contents of the samples increased with increasing level of beta-glucan composite in low fat milk. Fat and protein contents in the yogurts did significantly differ, while ash content no differed.

During this study samples of milk contains 0.5% beta-glucan in time to get the appropriate temperature for adding starter culture two-phase medium that is related to change the PH probably.

Table 2 Chemical composition of full-fat yoghurts(A) as control and samples made with beta-glucan hydrocolloidal composite(B) (0.25%)

Samples	Total solid (%)	SNF (%)	Fat (%)	Protein (%)	Ash (%)
A	13.24±0.27	11.25	3.47±0.12	3.93	0.74
B	13.26±0.38	11.63	1.48±0.05	3.26	0.86

*(P<0.05, n=3)

3.2.Changes in pH and acidity during storage

pH values for yogurt samples during15 d ranged from 4.36 to 4.48.not significant differences were noted between samples at any storage points (p>0.05) .changes of pH of the yogurts were similar during the storage (table 3).These values are within the normal ranges for set-type yogurts. Comparing yoghurts with beta-glucan composite and control samples showed that addition of beta-glucan composite into the yogurt did not change pH and titratable acidity significantly.

Table 3 Chemical characteristics of full-fat yoghurts(A) as control and samples made with beta-glucan hydrocolloidal composite(B) (0.25%)

Variables	Days	Yoghurt samples A	B
pH	1	4.32±0.5416	4.375±0.6959
	7	4.2775±0.3594	4.3125±0.6131
	15	4.1580±0.4658	4.1625±0.3594
Titratable acidity(%)			
	1	1.086±0.13663	1.10325±0.19276
	7	1.25250±0.69462	1.380±0.52281
	15	1.35280±0.62990	1.53150±0.23700

*(P<0.05, n=3)

3.3.Changes syneresis during storage

Whey separation is an important defect in yogurt and can be defined as the appearance of whey (serum) on the gel surface of set-type yogurts. Syneresis is the shrinkage of the gel, which then leads to whey separation. Manufacturers try

to reduce whey separation by increasing the total solids content of milk or by adding stabilisers such as gums and starches[1,6].

Yogurt made from full-fat milk retained significantly higher percentage of serum within its structure, thus being characterized by decreased syneresis in comparison to the yogurt made from low fat milk. These results may be explained by the presence of fat globules which may limit casein aggregation, preventing the shrinkage and rearrangement of the three-dimensional network into a more compact structure. Figure 1 showed Changes in syneresis values during 15d of storage . Addition of beta-glucan in the formulations led to decreasing values for syneresis. Yogurt containing beta-glucan had a syneresis level comparable with the full-fat control. (P<0.05 و n=3) The mount of syneresis decreased in both of yogurts during storage. These results are in agreement with previous studies by Tamime et al. (1996)[18] , Guzel-Seydim et al. (2005)[19], Guven et al. (2005) and Isleten and Karagul-Yuceer (2006).[20] This ability of the beta-glucan was attributed to entrap water within the three-dimensional network of the product. A reduction in fat content can be achieved by replacing it with water and several ingredients to control this water and to provide the functionality of the missing fat.

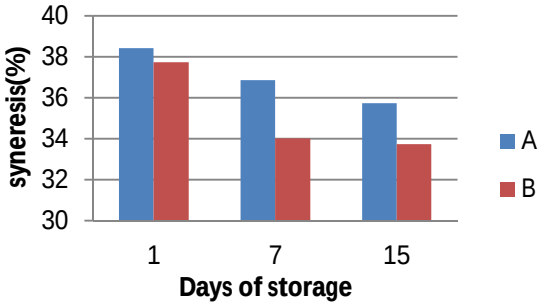

Fig 1. Changes syneresis during storage full-fat yoghurts(A) as control and samples made with beta-glucan hydrocolloidal composite(B) (0.25%)
*(P<0.05 و n=3)

3.4.Changes in Viscosity during storage

Figure 2 shows Changes in syneresis values during 15d of storage. Significant differences were noted between some samples (P<0.05).The results showed that yogurts with beta-glucan composite had higher viscosity than the control yogurt. Viscosity values increased throughout storage . the increasing viscosity during storage could be due to the protein rearrangement and protein–protein contact. Likewise,it was reported that the viscosity of beta-glucan in the presence of starch that probably related to the hydrophobicity of the hydrogen-bonded regions of amylase and beta-glucan may be responsible for such destabilization.

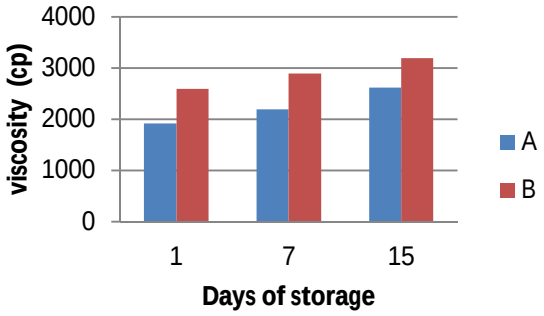

Fig 2. Changes Viscosity during storage full-fat yoghurts(A) as control and samples made with beta-glucan hydrocolloidal composite(B) (0.25%)
*(P<0.05, n=3)

3.5.Changes in sensory properties during storage

Sensory properties of the yogurts are shown in Table 4. Samples of Yoghurt with beta-glucan and full fat yogurts (control) received similar scores in taste and oral texture(P>0.05). Addition of beta-glucan composite improved consistency , oral texture and appearance of samples while Significant differences were observed in the yogurt samples in 15d of storage time. (P<0.05)

Table 4 Sensory properties of full-fat yoghurts(A) as control and samples made with beta-glucan hydrocolloidal composite(B) (0.25%)

Variables	Days	Yoghurt samples A	B
Flavor (taste and odor)	1	3.20±0.837	3.20±0.447
	7	2.00±0.00	2.80±0.447
	15	2.00±0.707	2.20±0.447
oral texture	1	3.00±0.707	3.40±0.548
	7	2.60±0.548	2.40±0.894
	15	2.40±0.548	2.00±0.707
appearance	1	2.60±0.548	3.00±0.41
	7	2.40±0.894	2.60±1.517
	15	1.40±0.548	2.80±0.447
other oral texture	1	3.20±0.447	3.40±0.548
	7	2.80±0.447	3.00±0.707
	15	1.40±0.548	3.00±0.00

4.CONCLUSIONS

Use of fibres in the manufacture of non-fat yogurt is advantageous due to their beneficial effects for human health, with a recommended daily intake of 0.025–0.030 kg for adults Coronary disease, hypertension, diabetes, hypercholesterolemia and gastrointestinal disorders may decrease or be prevented by consuming fibre in the diet [21,22] .

The use of beta-glucan in low-fat formulations significantly increased the viscosity of the product. This improvement in product viscosity is likely to be related to increased total solids present in the formulations, as yoghurt manufacturers use this method to improve the texture and reduce the syneresis of their products. Samples of low fat yoghurt with beta-glucan showed significant reduction of syneresis compared with full fat yoghurt.($p<0.05$)

Thus, the presence of beta-glucan in yogurt formulation modifies its viscoelastic behaviour, intensifying its gellike characteristics. Interactions between DF and milk protein were seen to promote changes in product structure; these could be directly related to changes in rheological properties and improved yield of yogurt, decreased syneresis and overall improved acceptability in terms of sensory attributes. Thus, the potential utilisation of beta-glucan into the dairy industry situation is useful in terms of both human nutrition and product texture[23] .

The increase of gel strength and reduction of whey loss could be due to the reduction of pH during storage, causing the gel to contract and consequently an increased gel firmness. But also reduce the whey loss. With consumers demanding more “natural” products with fewer or no stabilizers, natural plant cell wall fibers that have not been chemically modified could be used as alternative particulate fillers to enhance milk gel network strength and to reduce product defects such as whey loss. In addition, intake lower calorie content of fibers [24].

5.Acknowledgements

This work was supported by Qazvin Medical sciences university . The authors are very grateful to yoghurt Qazvin dairy Co, Glucosan Co , Arian Sina co and Food Control Laboratory of Qazvin Medical sciences university for providing the materials needed for yogurt preparation ,tests and to all the panelists who participated in the study.

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