THE STUDY OF RHEOLOGICAL PROPERTY OF FUNCTIONAL FERMENTED MILK

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Abstract

The role of *Bifidobacterium lactis* and the effect of the addition of inulin and lactulose on the viscosity of a functional fermented milk product have been investigated.

The effect of chosen starter and prebiotics on the properties of the functional fermented milk was significant for the apparent viscosity. Generally the viscosity of analyzed products was lower than the viscosity of classical fermented milk products, such as yoghurt, kephir or others. The viscosity was strongly affected by the content of total solids of the analyzed products: with an increase in the total solids there was increase in the viscosity. Among analyzed fermented milk samples, sample with 5% of lactulose had the highest viscosity. In general, inulin did not seem to have an effect on the viscosity of the analyzed product samples compared with the control sample. *Bifidobacterium lactis* has a weak proteolytic activity, therefore the structure and consistency of functional fermented milk product were characterized as weak, too. It is known that inulin is not only dietary fibre or prebiotic, it has the functions of food additives, too. Inulin is added to food formulations to modify products' texture or viscosity and sweetness of products. Comparison of the obtained results shows that the viscosity of the functional fermented milk product with various concentrations of lactulose or inulin is different. This suggests that the role of inulin in a food matrix is bi-functional. Inulin does not increase the viscosity of a milk product but gives a richer texture to liquid products and spreads.

Keywords: viscosity, shear rate, functional fermented milk, *Bifidobacterium spp.*

Introduction

Continuously increasing consumer health consciousness is responsible for the expanding worldwide interest in functional foods. Fermented dairy products, such as yoghurt, have been known for their use in managing intestinal disorders such as lactose intolerance or acute gastroenteritis. There are different approaches in the dairy industry, which are aimed at modifying the intestinal microflora and thereby beneficially influencing the health of the host. These include the fermentation of milk with probiotics, such as various strains of *Lactococcus, Lactobacillus* and *Bifidobacterium spp.* which inhabit the human gut. The addition of prebiotics is supposed to stimulate the growth of various health-promoting bacteria in the human colon. The application of each treatment potentially influences the rheology property, as different starter cultures are used, or conventional starter cultures show other modified fermentation patterns (Torre et al., 2003). Therefore the task of current study was to investigate the influence of *Bifidobacterium lactis* and the different concentrations of prebiotics on the rheological property of a functional fermented milk product.

Materials and Methods

The research was performed at the laboratory of the investigations of the properties of packaging materials at the Department of Food Technology of Latvia University of Agriculture.

The strain of *Bifidobacterium lactis* (BB-12, Chr.Hansen, Denmark) was used for experiments. During the experiments, the culture was maintained at -18 °C. The lactulose syrup (Duphalac®, Netherland) was used for growing of bifidobacteria in milk. The composition of the syrup of lactulose was as follows (%): lactulose – 67, lactose – less than 6, galactose – less than 10. The inulin Raftiline®HP (ORAFI Active Food Ingredients, Belgium) was used for growing of bifidobacteria in milk. The composition of inulin was (%): inulin – more than 99.5, glucose, fructose and sucrose – less than 0.5.

Bifidobacterium lactis was incubated in milk. Different lactulose and inulin concentrations (1, 2, 3, 4, and 5%) were added individually to 100 g of milk. *Bifidobacterium lactis* was inoculated with 2 ml of milk suspension (10^6 cfu ml^{-1}) and cultured at 36 °C for 16 hours. The control sample was prepared without the prebiotics for comparing with the obtained results.

The rheological property was examined with the *DV-III Ultra Rheometer BROOKFIELD* equipped with TC-102 water bath for keeping temperature at 20.0±0.3 °C. All measurements were carried out by BROOKFIELD standard methods in three independent repeats on 1st, 2nd, 5th, 6th, and 7th day of fermented product storage with a controlled shear rate using a spindle SC4-16.

Results and Discussions

The effect of starter and prebiotics on the properties of the functional fermented milk was significant to the viscosity. Quantity of added oligosaccharides is one of the significant factors which have an influence on the fermentation process and the consistency of product. Some authors suggest that lesser than 5% addition of oligosaccharides would improve the growing of *Bifidobacterium lactis* in milk during fermentation and the products' consistency, too (Palframan et al., 2002). The data of viscosity of the analyzed functional fermented milk samples is shown in Figure 1.

Generally, the viscosity of analyzed products was lower than the apparent viscosity of classical fermented milk products, such as yoghurt and others. Yoghurt produced using the starter culture YC-180 (*Lactobacillus delbrueckii subsp. bulgaricus, Streptococcus thermophilus*) was characterized by the following apparent viscosity from 4506 till 4764 mPa s (Benezech et al., 1993). The viscosity was strongly affected by the content of total solids of the analyzed products: with an increase in the total solids there was increase in the apparent viscosity (Penna et al., 2006). Among analyzed fermented milk samples, sample with 5% of lactulose had the highest viscosity. In general, additional inulin did not seem to have an effect on the viscosity comparied with the control sample. According to Tamine and Marstall, the fast development of acidity in fermented milk, for example, yoghurt, is necessary for making of a stable product with desirable rheological parameters (Tamine et al., 1997). Although, the development of acidity of *Bifidobacterium* species compared with *Lactococcus spp.* and *Lactobacillus spp.* is weak. The differences in acidic abilities of bacteria, which are included in cultures used for functional products production, mainly *Bifidobacterium spp.*, were probably main reason for differences in rheological properties of the investigated product samples.

Also, for the analyzed product, stated the lowest viscosity and the lowest shear stress at maximum shear rate were stated. The data regarding the influence of shear rate on the

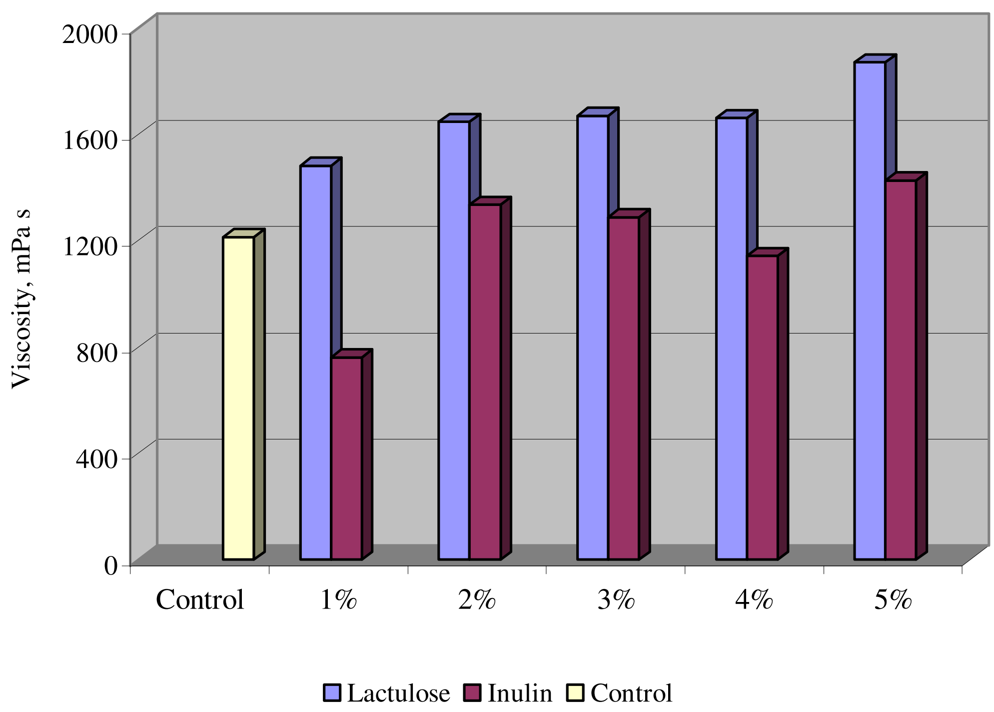

Figure 1. Viscosity of functional fer ented ilk with different concentration of lactulose and inulin is easured at shear rate of 3 s^{-1}.

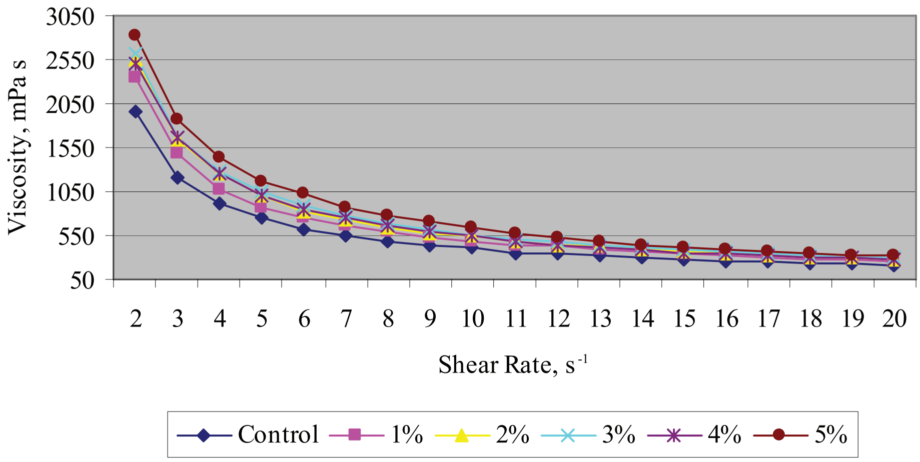

Figure 2. The influence of shear rate on the viscosity of functional fer ented ilk with lactulose.

viscosity of analyzed products is shown in Figures 2 and 3.

These results have been obtained during the tests where the samples structure was disrupted or weakly disrupted. The rheological behavior of functional fermented milk samples makes the comparison of data from shearing tests, where the samples structure was disturbed, possible.

In practice, among all fermented milk products obtained using classical starter cultures from the genera *Lactococcus* and *Lactobacillus* was characterized by the hysteresis loop area (Domaga et al., 2004). The hysteresis loop area can be interpreted as measure of fermented milk structure breakdown during shear rate, and a slant of curve can testify to resistence of fermented milk gel to action of shear forces (Benezech et al., 1993). Functional fermented milk obtained using *Bifidobacterium lactis* (Bb 12, Chr.Hansen, Denmark) was not characterized by the hysteresis loop. As described above, *Bifidobacterium lactis* has a weak proteolytic activity therefore the structure and consistency of functional fermented milk product were characterized as weak, too. It is known that inulin is not only dietary fibre or prebiotic, supposed to stimulate the growth of lactic acid bacteria during the fermentation process of milk or other substrates and also various health-promoting bacteria in the human colon, inulin has the functions of food additives, too. Inulin is added to food formulations to increase products' texture or viscosity and sweetness of products (Kip et al., 2006). If we compare the obtained results we can see that

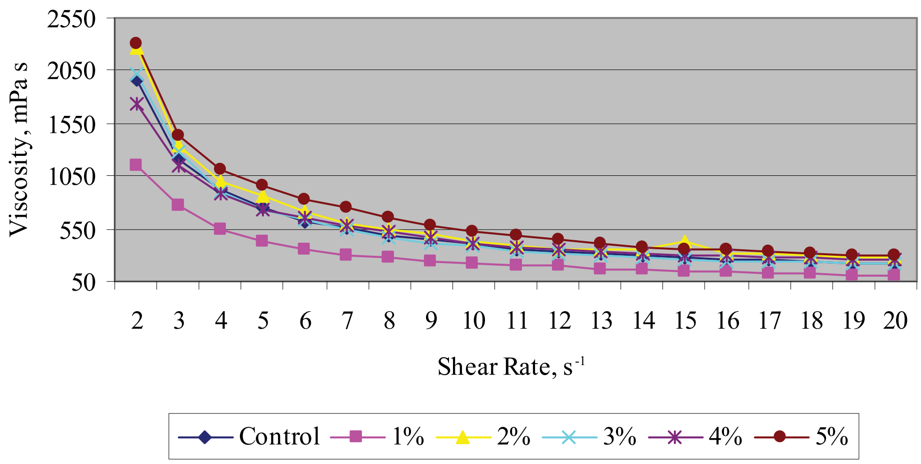

Figure 3. The influence of shear rate on the viscosity of functional fer ented ilk with inulin.

the apparent viscosity of the functional fermented milk product with various concentrations of lactulose or inulin is different. This suggests that the role of inulin in a food matrix is bi-functional. Inulin does not increase the viscosity of a milk product but gives a richer texture to liquid products and spreads (Leporanta, 2001).

Also some extracellular polysaccharides produced by lactic acid bacteria are known to cause an increase in viscosity, thus leading to improved physical stability of a fermented product. Due to the lack of the weak proteolytic or other technological properties, *Bifidobacterium lactis* could not be able to synthese extracellular polysaccharides. Abovementioned information would be a possible explanation for these results.

Conclusions

1. The differences in rheological property of functional fermented milk with different prebiotic (oligosaccharides) concentrations were ascertained.
2. The investigated functional fermented milk samples were characterized by lower viscosity than other fermented milk products.
3. The viscosity was strongly affected by the content of total solids of the analyzed products, with an increase in the total solids there was increase in the viscosity.

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