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# *Short communication:* Effect of the addition of *Bifidobacterium* monocultures on the physical, chemical, and sensory characteristics of fermented goat milk

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## ABSTRACT

The aim of the study was to use 3 monocultures of *Bifidobacterium* (*Bifidobacterium animalis* ssp. *lactis* AD600, *Bifidobacterium animalis* ssp. *lactis* BB-12, and *Bifidobacterium longum* AD50) in fermented goat milk to assess the microbial, physicochemical, rheological, and sensory quality of beverages during a 3-wk storage period at 5°C. The results indicated that selected bifidobacteria may be used for production of fermented goat milk because they comply with the minimum standards specified by the Food and Agriculture Organization of the United Nations and the World Health Organization during the entire period of storage. However, goat milk fermented by *Bif. longum* AD50 had less than $10^6$ cfu/g after 21 d of storage. The acidity, acetaldehyde content, viscosity, and hardness of fermented goat milk beverages depended on the strain and the storage period. Sensory properties were similar and acceptable, with a tendency for the quality to be reduced with an extended storage time. Depending on the monoculture of bifidobacteria used to manufacture fermented goat milk, the product had a different pH value. Titratable acidity in all fermented goat milk increased significantly along with the time of storage. Our study has shown that monocultures of bifidobacteria had a significant effect on the content of acetaldehyde, but the lowest effect over the entire storage period was observed in goat milk fermented by *Bif. animalis* ssp. *lactis* BB-12. This sample also had the lowest viscosity values compared with other samples and the best organoleptic properties during a 3-wk storage period.

**Key words:** milk processing, goat milk, lactic acid bacteria, fermentation, cold storage

## Short Communication

Fermented dairy products are a crucial part of the human diet in many regions of the world. The most popular fermented milks, predominantly yogurts, are mainly made of cow milk. However, the growing demand for alternative dairy products such as fermented goat milk supplemented with several ingredients, such as fruit, cereals, or pro- and prebiotics (Coda et al., 2012; Eke et al., 2013; Velez-Ruiz et al., 2013), has been observed. Probiotics are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host (FAO/WHO, 2001, 2002; Mohania at al., 2013; Hill et al., 2014). Probiotic microorganisms mainly consist of lactic acid bacteria of the *Lactobacillus* genus as well as the *Bifidobacterium* genus, namely *Bifidobacterium longum* and *Bifidobacterium bifidum* (Cebeci and Gurakan, 2003; Avonts et al., 2004). It is quite uncommon to ferment a milk with just one monoculture of probiotics such as the *Bifidobacterium* genus. A pure probiotic fermentation of milk usually leads to products with relatively specific tastes of low sensory acceptance. In technological practice, other starter cultures (e.g., yogurt bacteria) are normally used as a background fermentation culture compensating for these disadvantages (Baron et al., 2000; Gueimonde et al., 2004; Zaręba et al., 2008; Mazochi et al., 2010). Attempts are being made to produce milk products fermented only by monocultures of probiotic cultures (Mituniewicz-Małek et al., 2013; Slačanac et al., 2013). However, it is difficult to produce fermented goat milk with properties comparable with those of fermented cow milk. *Bifidobacteria* have been suggested to have probiotic or beneficial effects in humans and are therefore used in probiotic dairy products (Fuller and Gibson, 1997). The aim of this study was to use commercial monocultures of *Bifidobacterium* spp. (*Bifidobacterium animalis* ssp. *lactis* and *Bif. longum*) in the manufacture of fermented goat milk and the assessment

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of the quality of the obtained beverages during a 3-wk storage period (5 ± 1°C).

The raw material in the experimental manufacture of fermented milk products was pooled goat milk purchased from the Jasionek Hodowla Kóz organic farm in Cewlino near Koszalin, Poland. The following 3 commercially available strains were used: *Bif. animalis* ssp. *lactis* AD600 (Abiasa, Tui, Spain), *Bif. longum* AD50 (Abiasa), and *Bif. animalis* ssp. *lactis* BB-12 (Chr. Hansen, Hoersholm, Denmark). Goat milk was pasteurized using a batch method (85°C for 15–20 min), cooled down to 40°C, and normalized by adding goat milk powder (Danmis, Wyszyny, Poland) up to 14% of DM. Next, the milk was divided into 3 batches, and each batch was inoculated with 1 of 3 previously activated cultures of *Bifidobacterium* spp. (in the form of a bulk activated at 40°C for 5 h, which was added to the milk samples in the amount of 5%). Incubation was carried out at 40°C until the formation of curd after approximately 5 h. The end of the fermentation was based on the experimental results of the goat milk fermentation by this group of starter cultures (Mituniewicz-Małek et al., 2014) and based on the pH and fermentation curve set in the culture specification. Next, the samples of fermented goat milk were cooled down to 5 ± 1°C and stored at the same temperature for 3 wk. As a result, 3 types of samples of fermented goat milk were obtained in this study: goat milk fermented by *Bif. animalis* ssp. *lactis* AD600 (**FNP-A**), goat milk fermented by *Bif. longum* AD50 (**FNP-B**), and goat milk fermented by *Bif. animalis* ssp. *lactis* BB-12 (**FNP-C**). The samples were tested after d 1, 7, 14, and 21. Physicochemical analysis included determination of titratable acidity in Soxhlet-Henkel degrees, active acidity with a pH meter (IQ 150, Spectrum Technologies, Bridgend, UK), and acetaldehyde content (Lees and Jago, 1969). Rheological analysis included measurements of viscosity and texture. Viscosity was measured using a double gap system of coaxial cylinders in a rheometer (AR2000, American Instruments, Hartland, WI). Apparent viscosity was determined at a coagulation rate ranging from 1 to 400/s and at a constant temperature of the sample (Peltier module). Texture profile analysis was performed with a TA.XT Plus texture analyzer with a computer set (Stable Micro Systems, Surrey, UK). Fermented goat milk samples (in 220-mL cups) were penetrated by an aluminum cylinder (20 mm diameter) to the depth of 15 mm at a speed of 5 mm/s and a press force of 1 N (Domagała and Juszczak, 2004). Hardness, as a major parameter of texture (Salvador and Fiszman, 2004), was only measured and discussed. Organoleptic evaluations were conducted by trained participants (consumers of fermented goat milk) according to ISO (1998). The appearance, taste, smell, and consistency of samples were evaluated on a 5-point scale where 1 is the worst score (appearance: 1 = separation of the serum, precipitate; taste: 1 = tastes enough sweet, off-flavor; smell: 1 = odor feebly marked, strange odor; consistency: 1 = insufficiently precipitate, not the corresponding color filler) and 5 is the best score (appearance: 5 = appearance without separation of the serum; taste: 5 = tastes pure; smell: 5 = fermented, without foreign flavor; consistency: 5 = homogeneous, viscous, dense, the corresponding color filler). Microbial analysis included a viable cell count of starter bacteria in fermented goat milk after 24 h of fermentation (d 1) and again after d 7, 14, and 21 of storage at 5 ± 1°C. To count viable bacteria, the plate method was applied in 2 replicates for 3 independent replicates of each sample (ISO, 2010). A relevant dilution of samples was prepared in sterile peptone water (10 g/L). Viable counts were enumerated on De Man, Rogosa and Sharpe agar (Merck, Kenilworth, NJ) fortified with cysteine hydrochloride at an amount of 0.05% (wt/vol; Sigma-Aldrich, St. Louis, MO) at pH 5.7 after 72 h of anaerobic incubation of plates (Anaerocult A system, Merck) at 37°C (Simpson et al., 2004). The viable counts were expressed as the number of colony-forming units per gram. The microbiological analysis also included the determination of the contaminating yeasts and molds (YGC agar, Merck). The obtained results of microbial, physicochemical, and rheological analyses were statistically analyzed. These are expressed as arithmetic means and standard deviations. The statistical analyses were carried out by 2-way ANOVA with repeated measures and tests to determine the differences in 2 dependent and independent means (Student's *t*-test). The statistical significance of all the tests was $P = 0.05$.

Table 1 shows the mean results of sensory evaluations, the physicochemical and rheological properties of fermented goat milk within 3 wk of cold storage, and the results of 2-way ANOVA. Statistically significant differences among the strains were observed as well as significant effects of storage time on titratable acidity, pH, acetaldehyde content, viscosity, and hardness. Moreover, significant interactions were reported in all fermented goat milk samples between both tested factors and compared with all the quality indicators, such as titratable acidity, pH, content of acetaldehyde, viscosity, and hardness. The titratable acidity of fermented goat milk varied from 31.07 to 54.00 Soxhlet-Henkel degrees. The highest value during the 3-wk storage period was observed in FNP-B, and the lowest value was observed in FNP-C (Table 1). Titratable acidity in all fermented goat milk samples increased significantly along with the time of storage (Table 1).

As far as active acidity is concerned, different pH levels were observed in samples within the time of study