Development of Functional Yogurts Prepared with Mulberries and Mulberry Tree Leaves

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Abstract

In order to develop new functional yogurts using mulberries and mulberry leaves, which were cultivated in Hwasun-gun, Jeonnam Province, Korea, the nutritional compositions, fermentation conditions, sensory properties, and storage stabilities of the yogurts were analyzed. The mulberry powder yogurt contained 87.96% moisture, 3.21% carbohydrate, 4.52% protein, 3.63% lipid, and 0.68% ash, and the mulberry leaf yogurt contained 86.36% moisture, 4.13% carbohydrate, 4.87% protein, 3.79% lipid, and 0.85% ash. A yogurt base was fermented for 13 h with 0.01% ABT-5 starter inoculum at 40°C. To prepare the mulberry jam and mulberry leaf yogurts, a variety of mulberry jam and mulberry leaf samples were added to the yogurt base. The sensory evaluation results of the yogurts containing the mulberry jam and mulberry leaves indicated that a product made with 15% mulberry jam was more strongly preferred than other samples. When the mulberry jam and mulberry leaf yogurts were stored at 4°C for 15 d, there were no significant changes in pH, titratable acidity, or viable cell numbers of lactic acid bacteria and Bifidobacterium bifidum.

Key words: mulberry, mulberry leaf, yogurt, sensory evaluation

Introduction

Mulberries (Mulberry bombycis Koids) and mulberry leaves have been used as traditional medicines and foods since 200 years B.C. (Park et al., 2000). Mulberry fruits are nutritionally rich in flavonoids such as sanggenon, moracin, cyclomulberrin, and kuwanon, which are recognized as antioxidants and anti-aging substances (Hassimoto et al., 2005; Hong et al., 2004). Mulberries also contain anti-bacterial components such as alabafuran and anti-inflammatory materials such as bergapten, as well as cyanidin-3-glucosides, which have anti-diabetic and anti-oxidant properties (Hong, 1997; Kim, 1996; 1998). Mulberry leaves contain protein, vitamins, minerals, fibers, flavones, steroids, and triterpenes, and show various functional properties (Chae et al., 2003). Mulberry leaves have also been applied in anti-diabetic, anti-hyperlipidemia, antioxidant, and anti-heavy metal treatments (Kim et al., 1998; Kim et al., 1998; Kim and Kwon, 1996; Kimura et al., 1995; Yen et al., 1996). The blood sugar reducing compound 1-deoxynojirimycin (DNJ), the blood pressure reducing compound gamma-aminobutyric acid (GABA), and antioxidant flavonoids are recognized as biologically active substances (Chae et al., 2003).

Yogurt is a fermented milk product made from milk and lactic acid bacteria and may contain different herbs. It is a well-known probiotic food that is good for the digestion and it has anti-bacterial, cholesterol-reducing, and diarrhea-preventive properties. Yogurt is nutritionally rich in protein, calcium, riboflavin, vitamin B_6, and vitamin B_12. And it has nutritional benefits beyond those of milk (Gilliand, 1989; Hood and Zottoloa, 1988).

Recently, many kinds of yogurts containing plant components such as bamboo shoots (Park and Jhon, 2006), berry fruits (Seeram, 2008), cherry fruit (Kim et al., 2009), mulberry extract (Suh et al., 2006), chlorella (Sung et al., 2005), and green tea (Bang and Park, 2000) have been introduced, and have shown positive biological functions. In this study, we attempted to develop functional yogurts containing mulberries and mulberry leaves, and in order to determine optimal manufacturing conditions, their physicochemical, microbiological, functional, and sensory properties were analyzed.

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Materials and Methods

Materials
The mulberries and mulberry leaves were purchased from a mulberry farm in Hwasun-Gun, Jeonnam, Korea, at the beginning of June and August 2008, respectively. The mulberry leaves were dried and powdered immediately after purchase and stored at -70°C, and the mulberries were stored at -18°C. Milk, skim milk powder, and sugar were purchased from a local market. Pectin was purchased from Kelco (Grossenbrode, Germany). The starter culture ABT-5 (Lactobacillus acidophilus, Bifidobacterium bifidum, and Streptococcus thermophilus) was purchased from Chr. Hansen’s Lab (Horsholm, Denmark), and stored at -20°C.

The mulberries and mulberry leaves were dried with a freeze-dryer (Bondiro DC1316, Ilshin Lab Co, Seoul, Korea), pulverized with a Hanil grinder (FM-681C, Seoul, Korea), and screened with a 50 mesh sieve.

Mulberry jam was prepared by mixing 50% of freeze-dried mulberry powder, 50% of sugar, and 1% of pectin. Analytical-grade chemicals were purchased from Sigma Chemical Co. (St. Louis, MO, USA).

Methods

Composition measurements
The water, carbohydrate, crude fat, crude protein, and crude ash contents of the powdered mulberry and mulberry leaf were analyzed by AOAC methods (AOAC, 2000).

For composition analysis, the concentrations of the mulberry and mulberry leaf yogurts were 15, 10, 1.5, and 0.5%, respectively.

Water content was measured using a drying method at normal pressure, ash was measured by ashing in an electric furnace (JEIO Tech, Seoul, Korea) at 550°C, protein was measured via micro-Kjeldahl analysis, and crude fat was analyzed by the Soxhlet method.

Optimization of yogurt manufacturing conditions
Yogurts containing mulberry jam and mulberry leaves were made from market milk with 5% powdered skim milk by mixing with starter microorganisms at 0.005% (w/v). The mixtures were then kept at 40°C for 16 h, where the pH reached 4.2. The mulberry jam and mulberry leaf powder were added before and after fermentation, respectively. The yogurts were stored at 4°C and analyzed.

The pH values of each of the solutions were adjusted with 1 N HCl or 1 N NaOH solution.

Physicochemical and microbiological analyses
Physicochemical and microbiological changes were analyzed during the manufacture of the mulberry-added yogurts. The pH values of the yogurts were measured by an Orion 3Star bench-top meter (Thermo Electron Co., Beverly, MA, USA) and viable bacterial numbers were counted. To determine viable bacterial numbers in the samples, Lactobacillus sp. were counted after incubation at 37°C for 24 h on BCP plate count agar (Eiken Co., Japan) and Bifidobacterium sp. were counted after incubation at 37°C for 72 h on BL agar (BBL, Cockeysville, MD, USA).

Sensory evaluation of mulberry and mulberry leaf yogurts
Sensory evaluations of the yogurts were performed by 10 trained graduate student panelists by testing color, flavor, sweet taste, sour taste, and texture. The Sensory evaluations of products were classified on a 10-point scale by giving 1 point for the worst sample, 10 points for the best sample, and those remaining were assigned in-between numbers.

Storage stability of yogurt
The storage stability of the yogurts was assessed by measuring bacterial counts, titratable acidity, and pH.

Statistics
All measurements were performed in triplicate and mean values and standard deviations were calculated. The statistical analysis was performed with the SPSS package (Version 14.0) using Duncan’s multiple test.

Results and Discussion

Composition of yogurts
The compositions of the mulberry jam and mulberry leaf yogurts are shown in Table 1. The mulberry jam yogurt contained 83.70% moisture, 7.81% carbohydrate, 4.40% protein, 3.28% lipid, and 0.81% ash, and the mulberry leaf yogurt contained 86.36% moisture, 4.13% carbohydrate, 4.87% protein, 3.79% lipid, and 0.85% ash.

The compositions of the mulberry jam and mulberry leaves were similar to those found in other studies (Lee, 2009; Lee et al., 1998; Park et al., 2000).