Small Ruminant Research 134 (2016) 1–7

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

How kefir fermentation can affect product composition?

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ARTICLE INFO

Article history:
Received 3 August 2015
Received in revised form 14 October 2015
Accepted 15 October 2015
Available online 14 November 2015

Keywords:
Goat
Kefir
Saanen goat
Hair goat
Vitamin
Mineral

ABSTRACT

The aim of this study was to investigate the effects of kefir fermentation on the chemical properties, as well as the vitamin and mineral compositions of hair and Saanen goat milk samples, including intensive and extensive nutritional regimes. Kefir samples were produced with natural kefir grains (2%). Chemical properties (pH, titration acidity, total solids, fat, protein and ash), vitamin (A, E, B_1, B_2, B_3, B_6 and C) and mineral (Na, K, Ca, Mg, P, Fe, Zn, Se, Cu and Mn) compositions were analyzed using liquid chromatography.

Kefir made from hair goat milk had a higher content of proximate values and vitamin–mineral composition. Local (indigenous) breed hair goat milk exhibited important nutritional and functional properties, including high contents of protein, fat, total solids, vitamins and minerals. This study demonstrated that feeding conditions, breeds and fermentation have significant influences on vitamin–mineral contents of milk and kefir. Both the extensive feeding regime and breeding led to enhanced concentrations of fat-soluble vitamins in milk.

1. Introduction

For centuries, humans have used goats for many purposes. Although goats are present on all of the continents (FAO, 2014), the goat sector has not been well supported publicly or academically in comparison with other animal production sectors, especially the cow or bovine milk sectors (Dubeuf and Boyazoglu, 2009). Additionally, despite its quality, the commercial potential of goat milk has not been recognized. However, goat milk has remained popular throughout history and is still more extensively consumed worldwide than cow milk.

The chemical composition, mineral and vitamin contents of milk vary widely due to several important factors, such as the lactation period, animal breed, season of the year, type of animal feed and environmental conditions. Pasture-based animal feeding results in higher contents of healthy compounds in the milk of small ruminants than those found in milk from animals exposed to more intensive feeding systems (Morand-Fehr et al., 2007). Although feeding and breed are only two factors that significantly affect the quality of goat milk and milk product composition, these are factors that can be vital to human health. Unique characteristics of goat milk have been reported (Park, 2012; Park and Haenlein, 2007; Silanikove et al., 2010; Satır and Güzel-Seydim, 2015).

Turkey is a major goat producer in the Mediterranean Region with 8,400,000 animals and generates approximately 4,16,000 tons of goat milk per year (FAO, 2014). Turkish hair goats are the most common native breed (98%) in Turkey (TUIK, 2014) and are inexpensive to feed, durable and well-adapted to the mountainous environmental conditions. Hair goats are known to produce 70–90 kg of milk in lactation periods from 190 to 220 days. Saanen goats, which originated in Switzerland, are preferred dairy goats primarily because of their ability to consistently produce large quantities of milk, as well as their sturdiness, ease to maintain and capacity to tolerate environmental changes. Goat milk in Turkey is mainly used to make cheese, and recently, there has been an increased consumption of fluid and fermented milk on a commercial basis.

Kefir is a fermented milk product that has been historically used to promote and maintain good health, especially in Caucasia. Kefir is produced using different types of milks. It is easily digested and is the best source of natural probiotics. Kefir is produced by fermentative activity of kefir grains, a natural starter culture, which contain a diverse range of inherent lactic acid bacteria, acetic acid bacteria and yeasts in a polysaccharide matrix of semi-hard granules. Microorganisms in the grains proliferate in milk and produce lactic acid and other flavor compounds, causing physicochemical changes with fermentation. One feature of kefir that differs from other fermented milk products is that kefir grains can be recovered after fermentation with a slight increase in grain biomass (Guzel-Seydim et al., 2011). Tremendous health benefits based on contents

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http://dx.doi.org/10.1016/j.smallrumres.2015.10.022
0921-4488/

of natural probiotics and bioactive substances have been found for goat kefir (De Moreno de Le Blanc et al., 2006; Hertzler and Clancy, 2003; Liu et al., 2005; Park, 2012; Park and Haenlein, 2007; Quiríos et al., 2005; Sokolińska et al., 2015; Thoreux and Schmucker, 2001; Urdaneta et al., 2007; Vinderola et al., 2005).

One specific feature in Mediterranean areas, such as Turkey, is that the extensive goat farming systems, which are almost solely based on mountain grassland pasture, play essential ecological and cultural/traditional roles. The properties of goat milk products are unique in extensive feeding operations and cannot be reproduced by intensive commercial farming systems. The bioactive components of goat kefir are mainly attributed to the properties of goat milk (breed type, feeding conditions, etc.). Therefore, goat kefir with superior microbial properties would be a significant natural dairy beverage in consumer demand on probiotics and functional properties.

The results of this research will shed on unique properties of goat milk kefir such as natural probiotics and bioactive substances. It will be important since there is a significant consumer demand on healthy foods, probiotics, and functional foods.

Goat kefir has not been studied extensively; however, it contains valuable information regarding goat milk compositions. The purpose of this study was to determine the effects of feeding systems and kefir fermentation on the chemical properties, including the vitamin and mineral compositions, of various breeds of goat milks and cow milk. Also, in this study the effects of different breeds, feeding regimes and fermentation with natural kefir grains on the content of vitamin and mineral composition of goat milk were determined.

2. Materials and methods

2.1. Milk samples, kefir production, and experimental design

This study was performed using milk samples obtained from Turkish Saanen exposed to both intensive and extensive feeding conditions, Hair goat exposed to extensive feeding conditions and cows exposed to intensive feeding conditions. Goat milk samples were collected from Atabey, Isparta province of Turkey. Isparta is located between 30° east longitude and 37° north latitude in the province of southwestern Turkey, where climatic conditions are Mediterranean temperate with hot summers and cool winters. The southwestern Mediterranean region (TR61-Antalya-Isparta and Burdur cities) is the most common area (25%) for goat farming in Turkey.

For the experimental design, goat milk samples were taken from a mixture that was obtained from three herds, consisting of approximately 300 heads. Four different kefir samples were produced from four different milk samples. Samples were taken during April and July, and the experiments were repeated 3 times.

The animals were fed from May to August (mid-lactation) using intensive and extensive feeding systems. Extensive feeding was performed on natural highland pastures. The animals receiving intensive feeding were fed alfalfa and a mixture of 60% maize silage and 40% concentrated feed mixture. Cow milk was collected from Süleyman Demirel University, Faculty of Agriculture. All of the milk samples were taken during the mid-lactation period and appropriately transported to the Department of Food Engineering, Süleyman Demirel University.

Goat milk samples were pasteurized at 85 °C for 15 min and subsequently cooled to the fermentation temperature (25 °C). Reconstituted milk was inoculated with natural Kefir grains (2%) and incubated at 25 °C for 20 h. The Kefir grains were separated by filtration, and the fermentate was used as a natural starter culture for kefir production. Milk samples were inoculated with the natural starter culture and incubated at 25 °C for approximately 20 h until a pH value of 4.6 was reached. Kefir samples were stored at 4 °C for one day. The information regarding sample design is shown in Table 1. Both Kefir samples and milk samples were analyzed.

2.2. Proximate analysis

All milk and kefir samples were analyzed for acidity level (pH and lactic acid%), total dry matter, fat, protein and ash contents according to the AOAC standard method (AOAC, 2006a,b,c,d,e).

2.3. Vitamin analysis

2.3.1. Vitamins A and E

Vitamins A and E were detected according to the AOAC method (Anonymous, 2000a,b). Briefly, Vitamins A and E from saponified dairy samples were partitioned with organic solvents, separated from matrices, and quantified by liquid chromatography.

A high-performance liquid chromatograph (Shimadzu, Kyoto, Japan) was used to identify and quantify vitamin compounds in the samples. This system consisted of an LC-10ADvp model pump, a fluorescence detector (for vitamin A, excitation at 325 nm, emission at 480 nm; for vitamin E, excitation at 293 nm, emission at 326 nm), an SCL-20ADvp system controller, a DGU-20A degasser, a CTO-10Avp column oven and a Maxsil 5 Silica 250 × 4.00 mm, 5 μm P/NO 00G-0053-D0 phenomenex column. The chromatographic conditions for the samples were as follows: 20 μL injection volume; 1.0 mL min^{-1} flow rate; 30 °C column temperature. The mobile phases utilized for vitamins A and E consisted of Eluent A (980 mL hexane and 20 mL isopropanol solvents) and Eluent B (970 mL hexane and 30 mL 1,4 dioxane solvents), respectively. The data were integrated and analyzed using the Shimadzu Class-VP Chromatography Laboratory Automated Software system.

Approximately 30 g of the homogenized samples were extracted with 50 mL of extraction solution that consisted of ascorbic acid, ethanol, methanol and 5 mL of 50% KOH. A small amount of butylated hydroxytoluene was added. The solution was boiled in a water bath (80 °C) for 30 min and cooled to room temperature. The extraction solution was extracted with diethyl ether in a separation hopper at room temperature. The solvent was evaporated using a rotary evaporator and filtered with 0.45 μm filters. Next, 20 μL aliquots of vitamin A and E were injected to analyze retention times and compared with those of tocopherol authentic standards (retinyl acetate, Sigma R7882 and DL-α tocopherol, Sigma T3251), and their contents were calculated based on weight.

2.3.2. Vitamins B_1, B_2, B_3, and B_6

Vitamins B_1, B_2, B_3 and B_6 from milk and kefir samples were partitioned with acid, separated from the matrix, and quantified by HPLC (Anonymous, 2003a,b, 2008, 2009). The chromatographic conditions for the samples were as follows: flow rate, 1.0 mL min^{-1}; injection volume, 20 μL; column temperature, 30 °C. Eluent A (1.48 g KH_2PO_4, 1.03 g hexanesulfonic sodium, 0.94 g octanesulfonic sodium, 1 L deionized water, 5 mL triethylamine, and pH 2.4)

Table 1
Identity and classification of the milk and kefir samples examined.

Milk type	Sample code
Saanen goat milk with intensive feeding	SIGM
Kefir made from Saanen goat (intensive feeding) milk	SIGK
Saanen goat milk with extensive feeding	SEGM
Kefir made from Saanen goat (extensive feeding) milk	SEGK
Hair goat milk with extensive feeding	HEGM
Kefir made from hair goat (extensive feeding) milk	HEGK
Holstein cow milk with intensive feeding	CIM
Kefir made from Holstein cow (intensive feeding) milk	CIK