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Influence of farming and feeding systems on composition and quality of goat and sheep milk☆

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Abstract

This paper deals with the effects of farming systems linked to feeding aspects on the composition and quality of ewe and goat milk. When systems based on grazing and indoor systems are compared, the milk components (fat, protein, lactose) appear to be rather less influenced by type of farming system than by level of milk production. Significant differences are observed when ingested energy varies between pasture and indoor systems. Milk production depends on level of intake, and fat content on the indirect effect of dilution, while protein content varies generally like milk production. Goat milk production and its fat content can rise when grass is at an early growth stage. As in cows, fresh grass strongly influences the fatty acid contents of milk by increasing PUFA and CLA percentages. On cultivated pasture, the kind of fodder species, vegetation stage, season, and stocking rate can modify milk composition and quality. Natural pasture based farming systems produce milk rich in fat and in micro-components, which are beneficial to human health (fatty acids, vitamins), and in volatile components (flavour, terpenes). When three feeding systems based on natural pasture in the plain, on hills and on mountains are compared for goats, milk yield is slightly lower on mountain pasture but fat and protein contents and percentages of PUFA are higher, and the terpenes are more numerous in goat milk. Grass of natural pasture at an early stage produces milk richer in CLA. Supply of concentrates up to 0.6 kg/day/goat grazing natural pasture does not seem to modify the contents of volatile compounds, terpenes and flavour in milk, but it should reduce retinol content. In intensive indoor systems, a high level of intake due to fodders of good nutritive value or to high supplies of concentrates enables production of milk rich in protein and relatively low in fat. The ratio of fat to protein percentages can be reversed particularly in mid-lactation, when goats are fed diets short of fibre or fat. Consequently, the quality of cheese (granular paste, lack of nice goat taste) is lowered. When supply of concentrates in diets increases to 60% of total dry matter intake, fat content may decrease slowly and linearly, but if concentrate intake reaches 60–80%, fat content may decrease rapidly due to an increasing shortage of fibrosity in the ration. Studies confirm that the milk fat content influences cheese fat content as well as rheological and sensorial qualities. Thus, this is an important factor, which has direct repercussion on cheese quality such as is appreciated by consumers. In the future, the farmer must select farming or feeding systems in accordance with trade conditions, consumers' demand and socio-economic conditions. If commercialisation of high quality cheeses is possible, farmers will have to define systems, that allow to optimise parameters of quality, even by limiting milk production. In the future, the farmers have to find a balance between the level of intensification and the quality of dairy products.

Keywords: Dairy goat; Dairy sheep; Milk composition; Milk quality; System of production; Pasture; Feeding system

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1. Introduction

The importance of sheep and goat milk to human health, their characteristics and their role in some populations have been demonstrated (Rubino et al., 1999; Boyazoglu and Morand-Fehr, 2001; Haenlein, 2002, 2004). Haenlein (2004) states, that the quantities of these milks consumed by farmers and their neighbours (particularly goat milk) are very important, although they are not included in official statistics. Their role appears to be essential as a source of high quality protein and calcium in arid areas especially for starving or malnourished people, where cattle have difficulties to be maintained. Sheep and goats are often considered by consumers as ecological animals, and their products a priori as more adapted to maintain human health. In industrial countries, sheep and goat cheeses are very well recognised by connoisseurs as gastronomic and festive products. The proportion of these milks processed into cheeses and yoghurts is higher in comparison to cow milk. The cheese quality depends closely on the composition and quality of milk. The quality of these milks can be evaluated by various criteria: sanitary, dietetic, nutritional, technological and after cheese-making under aspects of gustative, rheological, gastronomic and hedonic parameters. All these kinds of quality depend on multi-factors and their interaction. They are mainly linked to their main components (fat, protein, lactose) and to their physico-chemical characteristics, as well as to micro-compounds present regularly or occasionally such as minerals, vitamins, minor fatty acids, CLA, cholesterol and terpenes.

Farmers may be prompted to maintain all quality aspects of their products and to adopt an advanced farming system. In the Mediterranean Basin, the pasture part is decreasing as well as part of the environment in the farming system (Oregui and Falagan Prieto, in press). This evolution may result in a decrease of the "typicity" and quality of some cheeses.

The composition in macro- and micro-nutrients of ewe and goat milk depends on the main production factors constituting the farming system: genotype, reproduction and sanitary characteristics of animals, agro-climatic conditions and socio-economical environment, farming methods such as feeding and milking. Actually, the link between these factors can be close and complex (Morand-Fehr et al., 1991; Morand-Fehr, 2005; Addis et al., 2005; Cabbidu et al., in press; Decandia et al., in press). For cows, breed, feeding and milking are the main factors influencing the composition of milk (Agabriel et al., 2001), but amongst all these factors, feeding appears to be the most important (Agabriel et al., 1995), because some other factors, namely season or sanitary status of flocks are expressed through the changes of the quantity and the nature of feeds ingested. Feeding is an important factor because it is expressed not only by the diet ingested but also by the notion of "terroir" (Coulon et al., 2005). This is even more evident for the sheep (Nudda et al., 2004; Addis et al., 2005) and goat (Morand-Fehr et al., 2000b; Decandia et al., in press) sectors. The feeding system chosen by the farmer is the factor that he masters easily and which results can be quickly appreciated. Moreover, it covers from 50 to 90% of the total production cost of 1 l of sheep or goat milk. So, it is always the farmer's major concern.

Consequently, this paper is aimed at dealing with the effects of farming systems linked with feeding aspects, and particularly feeding system effects on the composition and quality of small ruminant milk. It is not aimed at nutritional factors with a physiological and metabolic approach, even if this approach can likely help the interpretation of the results. We shall especially analyse pasture systems more or less extensive, and goats and sheep indoor systems using fodders conserved or not, or using cultures producing concentrate feeds such as cereal grains.

Accounting for the dietetic importance of milk lipids and particularly fatty acids, Sanz Sampelayo et al. (2007) reports on the effects of the nature of feeds and particularly to fats consumed by ewes and goats on milk fat composition. Accordingly, in this paper, the influence of feeds on the fatty acid composition of milk will be dealt with only when feeding system has a particular and specific effect. As these milks are mainly dedicated to cheese-making, we shall focus on the analysis of variations of fat and protein contents. Cheese yield depends on the protein content. Milk lipids and consequently the fat content are very likely to influence texture and fineness of the cheese paste and the quantities of different fatty acids, cholesterol, lipo-soluble vitamins and compounds modifying flavour important to consumers.

2. Indoor versus pasture farming systems

The two major systems of small ruminant farming are pasture and indoor systems. Between these two farming systems there is a wide scope of mixed systems such as summer pasture/winter indoors or alternatively indoors/outdoors subject to climatic differences. People consider more often pasture systems as more extensive than indoor systems. But, actually, for each of these systems, the level of intensification is very variable, such as, for example, in pasture systems based on cultivated pasture versus poor rangelands. In regards to indoor systems, the level of intensification is tightly linked with