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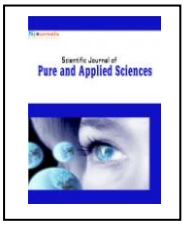

Review article

Consequences of stage of lactation on yield and milk composition in sheep

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ABSTRACT

The stage of lactation was an important source of variation on the contents of all milk components in most studies. A systematic studies on the influence of lactation stage on milk yield and milk composition is of foremost importance to evaluate the milk production ability of milking animals. However, it logical to note that the shape of the lactation curve that describes the level of milk yield in the course of lactation differs among the different species. The highest total solids and fat contents were observed in the late lactation stage, which might be due to low milk yield. There was no variation in solids non-fat content during the different lactation stages, which implies that the variation in total solids was actually influenced by the variation in milk fat. Therefore, the present discussion attempt to explore the influence of stage of lactation on milk yield and milk composition in sheep.

1. Introduction

Milk is a very complex, naturally posssessing many chemical and physical components (Roadhouse and henderson, 1950). Milk from different animal species contain the same kind of constituents but in varying amounts. Within a given species, genetic and non genetic factors, such as stage of lactation influence yield and composition of milk (Kanwal et al., 2004). Within species within breed it is the stage of lactation, regardless of species or breed that has the greatest influence on milk composition (Haenlein, 2002). Other factors such as

breed, age of the ewe, litter size, nutrition, health of the animals, environment, stage of lactation, etc. have been implicated in influencing milk yield and its composition in sheep. However, among these factors, the stage of lactation is very significant (Pavić et al., 2002; Oravcova et al., 2006, 2007; Kuchtik et al., 2008). Stage of lactatation is one of the number of important factors which influence the composition of sheep milk and its production per lactation. In other species, lactation stage has been reported as one of the major factors influencing yield and composition of milk in cattle (Ibeawuchi and Dangut 1996), buffalo (Şekerden 1999) and goat (Akingbade et al 2003). The effect of the stage of lactation on milk composition in different sheep breeds was studied by Jelinek et al. (1990), Maria and Gabina (1993), Čapistrak et al. (1995), Hassan (1995), Fuertes et al. (1998) and Antunovič et al. (2001). The stage of lactation had a highly significant effect both on all the properties of milk and the rennet curdling quality (Kuchtik et al., 2008). The contents of total solids , solids non-fat, fat , protein and casein gradually increased with the advancement of lactation. However, comprehensive information concerning the detailed analyses of the major constituents in ewe milk in the course of lactation is limited (Alichanidis and Polychroniadou, 1995).

2. Milk yield and stage of lactation in sheep

There is a tendency of daily milk yield increasing from lambing to the peak of lactation appearing three to five weeks ahead. Thereafter, it gradually diminishes toward the end of lactation with different persistence, depending on rearing conditions, breed, and individual animal (Ploumi et al., 1998; Ringdorfer and Pockl, 2004; Oravcova et al., 2006). Elsewhere, yield and chemical composition of ewes' milk has been studied by some researchers (Tietze and Majewski, 19975; Jelinek et al., 1990). Ewes' milk has higher dry matter content than cows' and goats' milk (Epstein, 1985). Particularly, ewes milk has higher levels of protein, fat, minerals and vitamins (Alichanidis and Polychroniadou, 1995; Yalcõn,1986). Daily milk yield did not differ among breeds within litter size at any stage of Lactation (Snowder and Glimp, 1991). However, twin lambs induced a larger differential in dam milk production in late lactation (70 to 98 d) than in earlier lactation (28 to 70 d). The effect of twins in increasing late lactation yield (70 to 98 d) and persistence of yield contradicts earlier repom that twins induce a greater yield at early lactation (14 to 42 d) and have little or no effect on persistency of yield compared with the effect of single lambs (Gardner and Hogue, 1964; Treacher, 1983). This disparity may be a result of environmental circumstances or inherent differences between populations sampled in the contradicting studies. Using a model depicting lacation period in three animal species (ewe, cow, doe), late-lactation negatively affected milk yield and milk quality in a coordinated manner (Leitner et al., 2011). Daily milk yield by Dorset ewes averaged in excess of 1000 g during the 1st mo of lactation and decreased to 500 g during the 8th wk of lactation (Wohlt et al., 1981). Sheep milk contains higher levels of total solids and major nutrients than goat and cow milk. The physico-chemical characteristics of sheep milk have unique properties as compared to goat and cow milk (El-Shazly et al., 2012).

3. Milk protein and stage of lactation in sheep

The protein content and composition of sheep milk are important to the cheese manufacturer and are considered amajor factor in determining the yield and quality of the final product (Othmane et al., 2002). The effect of lactation stage was an important source variation on total solid. Milk fat and protein contents were lowest (6.20% and 5.72%) at the beginning and highest (6.44% and 6.80%) at the end of lactation stage (Yilmaz et al., 2011). Days in milk during lactation regressed on ewe milk component contents had coefficients up to 0.71 (Casoli et al., 1989). Many components in ewe or goat milk as in cow's milk, especially fat and protein, are high in colostrum in early lactation, much lower thereafter until they rise again markedly at the end of lactation, when yields are low (Anifantakis & Kandarakis, 1980). The content of protein gradually increased with the advancement of lactation (Kuchtik et al., 2008). The tendency concerning the contents of protein increasing with the advanced lactation was also reported by Casoli et al. (1989), Gonzalo et al. (1994), Čapistrak et al. (1995), Fuertes et al. (1998) and Ploumi et al. (1998). However, Jelinek et al. (1990) and Hassan (1995) reported that during the first 2–5 weeks of lactation the contents of protein content decreased as a result of the increased daily milk yield in this period. Selecting for casein content would constitute a change in breeding goals from the current practice of selecting firstly for milk yield and secondly for fat content and/or protein content (Othmane et al., 2002). Caseins are responsible for the enzymatic coagulation of milk and their hydrolysis pattern is an important characteristic of cheese ripening. Caseins are the major proteins in sheep milk, accounting for 76-83% of the total proteins, being

positively correlated with cheese production (Park et al., 2007). Furthermore, the milk of the local sheep breeds is more appropriate for cheese production because of the higher content of all types of casein (Revilla et al., 2009).

4. Fat content and stage of lactation in sheep

The fat concentration depended significantly on the stage of lactation and milk yield declined with lactation stage, whereas fat and protein contents increased and lactose content decreased (Ploumi et al., 1998). According to Sevi et al. (2004) milk composition in Comisana ewes was affected by the stage of lactation and lambing season. In the sixth week of lactation the milk produced by the two breed groups was similar in quality (mean value of solids-not-fat 11·04% and fat 5·48%) but by the 11th week the fat percentage of milk produced by Blackface ewes had increased significantly to 7·34% whereas that of the cross-breds had remained almost unchanged (Peart et al., 1979). Morgan et al., (2006) working with the East Friesian-cross ewes reported significantly lower milk %fat (by approx. 1 percentage point) at both 21 days and 90 days of lactation than ewes by all other sire breeds, however, all the components of milk composition changed from the peak of milk production at 3 weeks to the end of lactation. Fat contents in goat milk changed from 2.7 percent in mid-lactation to 4.6 percent during the last week 42 of lactation, protein contents from 3.0 percent to 4.2 percent (Voutsinas et al., 1990). Mineral contents also increased with stage of lactation, Ca from 135 to 150 mg/100 g; P from 99 to 122; Na from 50 to 56; Mg 13 to 15; except K decreased from 170 to 144; and citrate from 145 to 81 mg/100 g. Sheep contains a higher portion of short and medium chain fatty acids, which have recognized health benefits (Jandal, 1996).

5. Lactose, minerals as influenced by stage of lactation and the resultant milk processing

Stage of lactation was a major factor that affected milk quality: milk composition changed markedly during lactation, with regard to its basic components, micelle structure, and salt equilibrium and, consequently, its technological and physicochemical properties (Coulon, 1994; Lucey & Fox, 1992). Thus, these changes affected the yield and quality of the resulting cheese (Kefford et al., 1995; Lucey, 1996). Cheese yield is affected by many factors including milk composition, amount and genetic variants of casein, milk quality, somatic cell count in milk, milk pasteurization, coagulant type, vat design, curd firmness at cutting, and manufacturing parameters (Mona et al., 2011). Cheese yield potential of milk is largely dependent on milk composition, particularly fat and protein (Barbano and Sherbon 1984; Gilles and Lawrence 1985; Banks et al. 1986; Lawrence 1993; Lou and Ng-Kwai-Hang 1992; Lucey and Kelly 1994; Van den Berg 1994; Brito et al. 2002; Guo et al. 2004). Early-lactation milk tends to have good coagulability by rennet (White & Davies, 1958) whereas, in contrast, late-lactation milk is considered less suitable for cheese manufacture, mainly because of defects in syneresis of the curd (O'Keeffe, 1984). Observations from milk in high somatic cell count ewe group in early, middle and late lactation, the lactose content was a significantly lower (4.47, 4.08 and 3.70%, respectively) than in milk of ewes from group of low somatic cell count (4.81, 4.59 and 4.36%). the stage of lactation had an effect on the protein and lactose contents in ewe milk, while the interaction between somatic cell count with stage of lactation was not important (**Olechnowicz et al., 2009)**. Infection significantly decreased lactose level in all species, with the highest decrease being recorded in sheep. However, decrease in lactose level in late lactation in sheep and cows were moderate and significantly lower than that in goats (Leitner et al., 2011). Lactose is the least variable component of milk as a close relationship exists between the lactose synthesis and amount of water drawn into milk. A close relationship between lactose synthesis and the amount of water drawn into milk makes lactose a stable milk component (Pollott 2004). Secretion rates of lactose and water are nearly constant throughout lactation and highly correlated. Sheep milk is more nutritious, richer in vitamins A, B and E, calcium, phosphorus, potassium and magnesium than cow milk (Coni et al., 1999). Mineral and vitamin contents of sheep milk are mostly higher than that of cow milk (Park et al., 2007). It must be remembered that milk yield and milk composition (fat, protein, casein and serum proteins, but not lactose) are negatively correlated (Barillet and Boichard, 1987; Molina and Gallego, 1994; Fuertes et al., 1998). This phenomenon generally appears as a result of improved management practices. This is on the background that like for other dairy ruminants, dairy ewe lactation curves, both in terms of milk yield and milk composition, are conditioned by main factors including breed, stage of lactation, milking system and feeding (Flamant and Morand-Fehr, 1982; Treacher 1983, 1989; Bocquier and Caja, 1993; Caja and Bocquier, 1998).

6. Final comment

The stage was a major source of variation on the contents of all milk components. However, despite the stage of lactation, the youngest ewes produced the least amount of milk which was also the least rich in fat, protein, casein and serum protein contents. As the ewes became older, there was an increase in fat and protein contents and the milk yield was higher. The interaction of stage of lactation and nutrition seems to be important which implies that feeding can be maniplated to maximize milk production during different lactation stages. The comparison of dairy animals on milk yield for selection purposes should take into account the stage of lactation in which the milk yield data was collected. The milk yield data data should be adjusted for stage of lactation for accurate evaluation of potentiality of dairy animals.

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