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Review article

Effect of breed, stage of lactation and nutrition on milk production traits in goats

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ABSTRACT

This discussion attempt to explore the influence of breed, stage of lactation and nutrition on milk yield and major milk components in goats. Different breeds protray different lactation curves, this is possibly that their genomes from a genetically point of view are different. Crosses of pure breeds and local goat genetic resources will improve milk production in an extensive traditional system because they will be able to deal with low input that characterize the traditional extensive farming systems. However, nutrition is a vital component in an attempt to maximise milk synthesis in goats, as a result correct feed management is desirable through appropriate estimation of roughage to concentrate intake in order to optimize the utilization of feed supplements. It is suffice to suggest that feeding high producing dairy goat may be a major constraint in milk production, which implies greater attention to diet composition, feed quality, and the physical form of feedstuffs is required. The rate and extent to which a dairy goat is capable of drawing upon body reserves to meet the energy requirement at different stages of lactation is critical in determining her ability to produce and sustain a high level of milk production. In order to increase goat milk production and to ensure high feed efficiency, goat farmers need to pay close attention to the lactation curves of dams within their herds.

1. Introduction

Goat milk is more widely produced than sheep milk, and globally goat production yields 60 per cent of its value as milk, 35 per cent as meat and 5 per cent as skin (Devendra and Mcleroy 1988). There is evidence that on live weight basis the goat is a more efficient milk producer than the other species (Malau–Aduli, 2001). Malau-Aduli et al 2001). However, the composition of goats milk and its production per lactation are influenced by a large number of factors; however, the most important factors are breed, nutrition, health of the animals, environment and the number and stage of lactation (Mestawet, et al., 2012; Zahraddeen, et al., 2007). Malau-Aduli et al (2001) reported goat milk yield and composition are affected by breed, stage of lactation and plane of nutrition. Different factors may influence the composition of milk (Lindmark-Mansson et al., 2000). Information about variation of milk composition in relation to breed, stage of lactation and nutrition is essential for implementing appropriate management practices in order and improved milk production. The goat milk nutritive value varies with its lactation stage, breed type and nutriotional regime. It has been argued that goat farming has multifold advantages like short generation interval, high rate of prolificacy, easy in management and marketing over large ruminants in the world (Singh et al., 2014). Dairy goats in their prime (generally around the third or fourth lactation cycle) average 6 to 8 lb (2.7 to 3.6 kg) of milk production daily (roughly 3 to 4 US quarts (2.7 to 3.6 liters) during a ten-month lactation, producing more just after freshening and gradually dropping in production toward the end of their lactation (Rashmi et al., 2013). The present discussion is an attempt to explore the significance of breed, stage of lactation and nutrition on yield and major milk constituents in goat milk production.

2. Breed effect on milk production traits

Same breed in different locations gave the mean values of the measured milk constituents (Lafuente etal., 1993; Pedauye, 1989) and slightly high relative to the composition for different breeds (Flamant and Morand-Fehr, 1982; Gall, 1981). This obsrvation could be related to both the genetic traits of the goat dairy breed where milk yield may be associated with a high nutritional environment. In general, as milk yield increases, the proportion of milk components decreases (Morand-Fehr, 1986). In Ethiopia Mestawet, et al., (2012) studying four goat breeds namely, Arsi-Bale, Somali, Toggenburg-Arsi-Bale cross and Boer to assess milk yield and composition at different lactation stages, observed a higher daily milk yield for Boer goats as compared to Arsi-Bale, Cross and Somali goats. Milk from crosses was lower in total solids and fat than Arsi-Bale, Boer and Somali, while Arsi-Bale goats having a higher protein content, than the rest of the breeds. However, breed was not a source of variation for lactose content of milk.

Working with three goat breeds Addass et al., (2013) found out that crude protein in these breeds was lower than what was obtained by Agbede, et al., 1997 in West African Dwarf does. Protein content reduction was associated with breed difference, health status of the udder and stage of lactation (Mahmood and Sumaira, 2010). The other paulsible reason was that inherent breed differences may have been attributed to the variances. However, the study results were within the range obtained by Mba et al., (1975), Beyene and Seifu (2005) in Borana goat milk in Ethiopia. Ueckermann et al (1974) observed that breeds that have never been selected for milk production are inclined to very strong mothering instinct experiencing low milk yields. It is envisaged that the low milk yields of the local breeds could probably be increased by both selection and crossbreeding with well known high milk producing breeds. Studying indigenous goats in Nigeria the per cent crude protein, fat, lactose and total solid contents were significantly affected by breed; with pH and ash contents differed non-significantly in the three breeds (Zahraddeen, et al., 2007). In a study to assess milk composition and yield from non-dairy goats in Malawi, local goats and Boer goats had essentially the same milk composition in terms of total solids, butterfat, lactose and energy and these values except those for lactose, were significantly higher than those for the

Boer x local crossbred goats (. There were no significant differences between their crosses and Boer goats for solid non fat, but solid non fat was significantly higher in local goats. In terms of protein content it was highest in local goats and lowest in Boer goats.

Milk fat content was reported to be higher (Egbowon, 2004) in dual purpose breeds than those for milk production alone, which was attributed the negative correlation between milk fat and yield. This implies that when selection for milk yield, concentration of milk fat reduces. In comparison of milk fat content of Sokoto Red, Sahel Goat and West African Dwarf, Addass et al., (2013) found out that were higher than what was obtained by Agbede, et al., (1997). In West African Dwarf does and lower than what was obtained by Beyene and Seifu (2005) in Borana goats.

Variation of lactose content among the goat breeds in this work agreed with what was reported by Agbede, et al., (1997) who reported differences of lactose content of goat milk in different breeds. The pH content could not be affected by either of the breed, stage of lactation, season or parity which was similarly observed by Beyene and Seifu, (2005). In other livestock species the pH of milk is influenced by hygienic and climatic conditions, and slightly higher acidity is typical of sheep milk compared to cow milk (Pavič et al., 2002). Martini and Caroli (2003) reported that the pH of milk was significantly influenced by the breed of sheep.

3. Stage of lactaction and milk production parameters

Milk production is largely dependent on the shape of the lactation curve. Relevant elements of the lactation pattern are the peak yield, which represent the maximum milk yield during the lactation and the lactation persistency which expresses the ability of animals to maintain a reasonable constant milk yield after the lactation peak (Cannas et al., 2002). The percentages of fat, protein, lactose, ash, total solids and solids non fat were higher with advancement of lactation in different breeds (Gitam, et al., 2014). Stage of lactation had conspicuous effects on milk quality of goats despite different rearing systems (Singh et al., 2014). Each component, protein, lactose and solid non fat showed the lowest values during early lactation, and then significantly increased towards the end of lactation (Darwesh, et al., 2013). The pattern of daily milk yields in goats significantly rising to maximum within two weeks and then decreasing afterwards to end of lactation was observed by Ehoche and Buvanendran (1983) in the Red Sokoto goat. Stage of lactation significantly affected milk constituents where fat and protein contents were negatively and lactose contents positively correlated with milk yield. The observed trend of milk yield could have resulted due to proliferation of myoepithelial cells of the mammary gland especially at the early stage of lactation. Knight and Wilde (1993), reported that mammary cells multiplied during early lactation and declines as lactation progresses. According to Stojević et al., (2005) during the early stage of lactation the liver of high productivity dam undergoes extensive physiological and biochemical changes to counteract the adverse effects of negative energy balance The correlations between protein, lactose, fat, and dry matter yields with liver metabolites activity. Determination of biochemical parameters in blood serum can provide valuable information regarding dairy dam nutrition and physiological status in relation to age and stage of lactation. Due to liver functionality blood biochemical attributes are important indicators of the metabolic activity in lactating animals (Karapehlivan et al., 2007). During lactation, secretary cells of mammary gland utilize 80% of the blood circulating metabolites for milk synthesis, depending on the speed of infiltration of precursors of milk compounds (i.e. free amino acids, glucose and fatty acids). Lipogenesis is impaired and the increased fatty acid release, supported by norepinephrine and epinephrine stimulation, induce an increase in lipase activity of mammary gland, to provide the substrates for milk fat synthesis (Nazifi et al. 2002). Milk production throughout lactation, in goats as in other domestic ruminants, is the result of the processes of synthesis and secretion of organic and inorganic compounds and of active and passive blood filtration by specialized epithelial cells of the mammary gland (Mepham, 1987). As a result lactating goats experience an increased in total protein level of serum with the progress of lactation due to the catabolism of protein for milk synthesis (Krajnicakova et al. 2003). There is a phase of rapid cellular activation, starting from the end of gestation and followed by cellular regression (cellular remodeling) at varying rates, that ends with the cessation of lactation or dry-off (Hurley, 1989). Physiological mechanisms result in a typical pattern of milk yield over time, characterized

by an initial phase of increasing production which reaches a maximum (lactation peak) and then declines more or less rapidly until dry-off.

Therefore, composition of goat milk varies considerably during a lactation, with the major changes usually occurring soon after the start of lactation. The first secretion to be collected from the gland is called colostrum. The composition of the secretion gradually changes to that of mature milk. Evidence exists that efficient milking is of supreme importance for goats at peak lactation stage because of a higher secretion rate at this stage of lactation (Knight, 1995). Kuchtik et al., (2008) observed that the stage of lactation had a highly significant effect on the contents of all milk components. However, only the contents of total solids, solids non-fat, fat, protein and casein gradually increased with the advancement of lactation. The percentages of crude protein, fat and lactose contents were significantly different in the four stages of lactation (colostrum, early, mid and late), while the differences in the total solid, pH and ash contents were not affected by the lactation stages (Zahraddeen, et al., 2007). Early and late lactation milk had significantly higher contents of milk components (Mestawet et al., 2012). Lactation stage affected all milk constituents, and glucose, due to the fact that body condition at kidding decreased significantly at week 4 and then increased during mid and late part of lactation (Darwesh, et al., 2013).

Stage of lactation was an important source of variation on crude protein content of goat milk (Beyene and Seifu (2005) in Borana goat milk in Ethiopia. Protein content showed a downward trend until mid-lactation before significant increase towards the end of lactation. Egbowon (2004) reported that milk protein percentage is inversely related to milk yield. This parameter started at a moderate level, decreased to the lowest level during peak lactation and gradually increased towards the end of lactation in accordance with the inverse relationship with milk production. Protein percentage was highest in late lactation (Peris et al., 1997; Soryal and El Shaer, 2006; Mohammed et al., 2007; Norris et al., 2011). This appears to reflect a low degree of proteolysis in late-lactation milks. Proteins of goat milk are more digestible and their basic amino acids are absorbed easily in comparation to cow milk (Jandal, 1996; Ceballos et al., 2009) and in addition, goat milk contains six out of ten essential amino acids in higher amounts (Haenlein, 2004).

Fat and total solid percentage was at its highest at the late stage of lactation and followed by early stage and mid stage of lactation. This variation could be explained by the negative correlation between milk yield with fat and total solid content (Merkhan, 2011). A similar trend was found earlier by Baker (2007), Agnihotri and Rajkumar, (2007), Mohammed et al. (2007), Guler et al. (2007) and Rajkumar, (2007). The behaviour of fat content showed a decreased with advances in stage of lactation (Zahraddeen, et al., 2007). This was contray to reports by Beyene and Seifu (2005) who observed significant increase in the fat content of Borana goat with stage of lactation. However, Egbowon (2004) reported that fat content of milk decreased from the beginning of lactation to a minimum in mid-lactation and continuously increased until the end of lactaton; an inverse relationship with milk production similar to the case of protein content. Fat content was lowest in mid lactation and significantly increased in early and late lactation stages. The influence of stage of lactation on goat milk fat was reported by Bhosale et al., (2009).

The lactose content was initially high (in the colostrum) but decreased significantly during the remainder of lactation. Similarly, Brendehaug and Abrahamsen (1986) found that lactose content decreased throughout lactation. Boros (1986) however observed that lactose was fairly constant over the lactation period showing no substantial changes. Lactose content showed the lowest value during early lactation and then significantly increased to attain the maximum value during mid and late lactation (Soryeal and El Shaer, 2006; Hassan et al., 2010). The lactose content in the course of lactation was relatively the most constant of all components of milk which confirms its role as an osmotic regulator and a compensator for variations in all other components.

4. Influence of nutrition on milk production characteristics yield

Egbowon (2004) highlighted that under feeding reduces total milk production and milk components generally. The significant correlations between measurable goat milk content could be useful for selection of does for milk yield improvement strategies. One of the most important nutritional factors which determine milk production is energy intake especially in the intensive management systems, particularly

in the early stages of lactation in goats (Flamant, et al., 1982; Morand-Fehr, et al., 1980) but also under extensive systems. Under semi-arid conditions in Mexico (Martinez-Parra, et al., 1981) and India (Shiarma, 1982) the milk yield of goats was positively related to energy intake. However, pre-partum energy levels did not influence the performance of Damascus goats in early lactation (Economides and Louca, 1981) when offered a high level of energy during lactation. However, the milk yield of high yielding dairy goats (Skjevdal, 1982; Morand-Fehr and Sauvant, 1980) was improved by higher levels of energy intake in late pregnancy becuase of the building up of body reserves and their mobilization in early lactation to produce milk. Under such conditions a protein supplement is also necessary. Suspect that pregnancy nutrition in goats might only have a marginal effect on subsequent milk production when grazing on high quality pasture or high level of feeding in early lactation. It has been demonstrated that even in diets with concentrate levels above 60 – 70%, goats do not greatly alter their productive capacity or their metabolic well-being (Bailoni and Andrighetto, 1995; Economides, 1998; Goetsch et al., 2001; Fedele et al., 2002). However, for correct feed management in milking goats, it is desirable to estimate roughage to concentrate intake in order to optimize the utilization of feed supplements. Roughage to concentrate ratio of 30 to 70% favoured milk secretion rate the most, which was attributed to high level of concentrate which led to an increased feed and energy intake thereby increasing milk secretion (Shittu et al., 2011). Morand-Fehr et al. (1982) affirmed that the synthesis of goat milk largely depends on nutritional milk precursors present in the blood plasma and taken up by the udder. In addition an increased feeding level of 5% body weights of dry matter of fresh-cut P. purpureum was sufficient in meeting the nutrient requirements of the does hence, an increased milk secretion rate. Lactose content was found to be significantly lower in the dry season than wet season which might be due to poor nutrition during the season (Addass et al., 2013). Lactose is the main determinant of milk volume and close relationship between lactose synthesis and the amount of water drqwn into milk makes lactose a stable milk component (Pollot, 2004). Seasonal variation in feed resources influenced lactose content which was lower in the dry than wet season. This low value in the dry season may be linked to lower nutrition during the season. Egbowon (2004) highlighted that under-feeding reduces total milk production and milk components.

5. Final comment

Goat milk composition varies gradually throughout lactation, as indicated by various authors for fat and protein percentages through the dams's lactation. From the discussion it is suffice to conclude that many factors, in addition to those of nutrition, stage of lactation and breed can influence milk yield and composition. This is very important point to remember when evaluating quality and in an attempt to improve milk yield and composition in goats. The information on breed difference, nutrition and lactation stage and their interaction with other factors are valuable for making management decisions in order to get the best milk composition. For instance, the lactose or fat content of goat milk can be improved appreciably by combining breed x season or parity. It is important for goat dairy farmers to effectively plan their production in relation to the development of knowledge of the changes in milk composition throughout lactation.

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