Advances in Dairy Research
ISSN: 2329-888X

Idowu et al., J Adv Dairy Res 2017, 5:2
DOI: 10.4172/2329-888X.1000175

Review Article Open Access

Genetic and Non-Genetic Factors Affecting Yield and Milk Composition in Goats

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Received date: 26 February, 2017; **Accepted date:** 29 April, 2017; **Published date:** 09 May, 2017

Abstract

There is a growing awareness about the use of goat milk as source of protein for man. However, the production level is not enough to cater for the increasing population of the country. Therefore, it is important to look into how to improve the milk production capacity of Nigerian goat breed. This discussion attempts to explore the influence of genetic and non-genetic factors on milk yield and milk composition in goats. Different breeds possess different milking potentials; this is possibly because their genomes are different. Nutrition is a vital component in any attempt to improve milk production in goats, correct estimation of feed requirements is important in the utilization of feed supplements. The ability of a goat to draw upon body reserves to meet the energy requirement during lactation is important in sustaining high level of milk production. Milk production generally peaks as parity increases, thereafter declining slowly and udder size also have a strong and significant effect on milk yield. In order to increase goat milk production, goat farmers need to be focused on the nutrition and other management practices as it affects their herds.

Keywords: Nutrition; Parity; Age; Lactation

Introduction

Goats are among the smallest domesticated ruminants and have served mankind longer than cattle or sheep [1]. Goats in Nigeria are kept mainly for meat productions; the milk is not substantially consumed [2]. Goat rearing for milk production has not attracted attention of policy makers, science managers and researchers in Nigeria since goat production has largely been in the hands of resource-poor farmers who are politically and economically marginalized. However, there is a growing awareness of the importance of goats as source of milk for man [3,4]. Goat milk is of interest because it is nutritious, healthy and a functional food [5]. Also, goat milk has been recommended for patients that suffer allergies from cow milk or other food sources [6]. Goat milk contains protein, vitamins, minerals, trace elements, electrolytes, enzymes and fatty acids that can be easily assimilated by the body [7]. Goats have been reported to be a more efficient milk producer than cattle, sheep and buffaloes based on live weight [3]. According to [8], goats produce more milk compared to cows and other ruminants, because of better feed utilization efficiency, higher lactation persistency, mammary tissue comprising of greater proportion of the body weight and a more pronounced milk ejection reflex. Therefore, there is a need to look into the milk production potentials of goats as it relates to yield.

Milk yield refers to the estimated quantity of milk that can be produced by an animal [9]. Factors that affect milk yield are classified under two broad categories: genetic and non-genetic or environmental factors [10].

Genetic factors affecting yield and milk composition in goats

Genetic factors cause variations between individual animals within and between breeds. The property of non-homogeneity of milk yield characteristics within and between breed is the basis for the improvement of milk productivity in goats by selection of high yielding does [11,12].

Breed of dairy goats has an effect on milk yield. It has been documented by many authors that temperate breeds produce more milk than tropical breeds [13,14]. Tropical breeds have low milk yield due to their low genetic potential and prevailing environmental conditions like stress caused by harsh weather and diseases. Level of milk production depends on breed and there is variation in milk yield among different breeds and within the breed [15]. Several researchers have also investigated milk yield traits in different breeds of goat and have reported on the effects of breed on milk production. Zahraddeen et al. [16] in a study on Red Sokoto, Sahel and WAD goat in Nigeria, reported that milk production significantly varied in different breeds of goat and attributed it to the difference in genetic potentials of the animals. Indigenous goat breeds such as the West African Dwarf and Red Sokoto have much richer milk composition but lower yields than the exotic breeds such as the Swiss breeds [17]. However, some authors reported that breed differences did not cause significant differences in milk production between Iraqi local goats and their crosses with Damascus and Saanen breeds [18]; and between WAD and Red Sokoto goats of Nigeria [19,20].

Non-genetic factors affecting yield and milk composition in goats

Environmental factors represent a host of factors that are non-genetic and impact on the survival and productivity of an animal.

Various studies have reported the effects of various environmental factors on milk production of goats. Among them are parity and age, nutrition, season of kidding, stage of lactation, litter size, sex of kids, body weight, udder size, frequency of milking, photoperiod, length of dry period and environmental temperature.

Effects of age and parity on yield and milk composition in goats

Age and parity of doe at kidding influences milk yield [14]. Milk yield increases with age because as the age of the animal increases, the hormonal status of the animal body, metabolic activity, secretory cells and nutrient intake which are used in milk synthesis increase too [21-23]. Milk from younger goats tends to have a higher fat content than that from older goats [17]. Addass et al. [24] reported that parity had a significant effect on the lactose content of milk with third parity goats having the highest values. The mineral content of milk has been reported to be influenced by parity but with contrasting results [14,25,26]. Zahraddeen et al. [16] reported that the effect of parity on the partial daily milk yield of three Nigerian breeds of goats - Red Sokoto, Sahel and WAD were significant. According to the study, partial daily milk yield increased from 1st parity to the highest value at 3rd parity. Egbowon et al. [20] also found the effect of age significant in milk yield of WAD and Red Sokoto does and that does within the first 3 years of age produced more milk than those above 3 years. Bemji et al. [19] reported that mean daily milk yield increased significantly from 286.05 ml in the first parity to 303.53 ml in the second, while decreasing insignificantly to 286.05 ml at third parity. On the other hand, Phoya et al. [27] reported that an increase in parity resulted in decreased daily milk yield of indigenous Malawi goats, while some other studies found the effect of parity of doe on milk yield non-significant [18,28]. The significant effect of age or parity on milk yield in goats, suggest that milk production tends to increase with parity probably due to increase in the accumulation of mammary alveoli from previous lactation until the process gets interrupted by advances in age [12].

Effects of nutrition on yield and milk composition in goats

Milk productivity depends mainly on the quantity and quality of feedstuffs [29]. It has been reported that any targeted approach to the improvement of WAD goats for milk production must first address the issue of nutrition [30]. The dietary concentrate level and nature of specific concentrate and forage feedstuffs impact level of milk production and characteristics of milk and milk products [31]. Nutrition affects both the yield and composition of the milk produced [32-34]. Energy is one of the limiting factors to high milk production. Increasing the energy intake increases the level of milk production towards the animal's inherited potential. Increase in the energy content of the diet for high-yielding goats tends to increase milk production and the nitrogen content of the milk may increase [17]. Ukanwoko and Ibeawuchi [35] reported that diet did not show a significant difference on milk yield in lactating WAD goats fed Cassava Peel - Cassava Leaf Meal Based Diets. The source of fat in the diet could have an effect on cholesterol status of farm animals, especially by modulating its content in milk [36]. Water availability and intake can impact milk yield, water deprivation for 48 hours in high-yielding breed results in reduction in milk yield but increases content of lactose and protein contents [17]. Severe underfeeding of protein to dairy animals causes a reduction in the SNF% of milk in addition to a drop in the milk yield. Feed composition can affect the fat content of milk and especially its fat composition. Cooper et al. [37], working with indigenous Malawi goats observed that feed supplementation had no effect on milk yield. Concentrate feed is the best means to modify feeding quantitatively and qualitatively since they are used to adjust the energy, protein and mineral balance of forages [38].

Effects of udder size on yield and milk composition in goats

The productive capacity of dairy goats is judged by the physical appearance, size and quality of the udder [39]. Several studies have confirmed that udder and teat characteristics are important determinants of milk yield and ease of milking or milking ability in dairy animals [11,40,41]. Udder and teat characteristics have been shown to be influenced by several factors such as genotype, breeding and management systems [42]. In a study conducted in South Western Nigeria, Amao et al., [43] showed that age, lactation status and live weight are the major factors that influence udder traits in West African Dwarf goats. The study of udder morphology and physiology should be of special interest for rearing ability, dairy potentials and diversification of some breeds considered for meat purpose. Animals that store a large proportion of milk in the gland cistern produce more milk and are more able to tolerate extended milking intervals. Udder size has a strong and significant effect on milk yield [44]. The udder circumference, width and height have been identified as traits which could replace the udder volume measurement because they are easy to measure and have high repeatability [45]. Udder circumference has been reported to explain up to or above 22 % of variation in milk yield in WAD goat whereas teat dimensions could only explain far less than 11% of the variation in milk yield of WAD goats [46]. Hence, in predicting milk yield, measurement of udder circumference is sufficient [44].

Effects of stage of lactation on yield and milk composition in goats

One of the major factors that affect milk yield and composition is the stage of lactation. There are three main stages of lactation namely early, mid and late lactation. Milk composition changes markedly during lactation with regard to its basic components, consequently, its technological and physicochemical properties [47]. The reports of many studies revealed a more or less predictable pattern of milk production in which milk production increases in early lactation, attaining a peak early enough in the lifespan of lactation and thereafter declining more or less gradually as lactation progresses toward its end [16,48]. Egbowon [49] 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 lactation. In a report by Zahraddeen et al. [16] on Red Sokoto, Sahel and WAD does, partial daily milk yield increased from the first week, reached a peak in the third week and thereafter declined up to the fourteenth week. Bemji et al. [19] also reported that daily milk yield was maximum at the first week and gradually declined with progress of lactation. Milk yield in goats is determined by the number of mammary secretory cells and secretory activities per cell. The first part of the increase in milk yield during the ascending (early) lactation in goat can be attributed to the proliferation of secretory cells in the udder, followed by an increase in the amount produced by each cell, while declining lactation is initially characterized by a loss of cells followed by fall in yield [50].

Effects of litter size on yield and milk composition in goats

Number of kids born and age of the goats both influence the milk yield by the doe especially in the early lactation [51]. Milk production of does having twins or more kids was found to be superior to that of does that had single kids [16,23,52]. Alkass and Merkhan [12] reported that does which nursed twin kids produced more milk than does with single kids but that the difference was not significant. However, Bemji et al. [19] found that milk yield of WAD and Red Sokoto goats was not influenced by litter size. There is a greater tendency for does that rear two or more kids to produce more milk, which is a reflection of the role of both the suckling reflex and the physiological mechanism during pregnancy that prepares the udder to produce more milk for does carrying multiple fetuses [53,54].

Conclusion

It has been established that there is a growing awareness in the potential of goats as source of milk for man. The increasing demand for goat milk in Nigeria makes it imperative to look into possible ways of increasing goat milk production. The ever increasing population in Nigeria means there will always be a higher demand than supply for available milk resources in the country. To mitigate against this problem, a critical assessment of the major factors that affects milk yield and composition should be looked into. Nutrition, parity and age of goats which are some of the factors that affect milk yield and composition have been reviewed. Hence, it is suffice to conclude that focusing on the nutritional needs of goats is critical to improving milk yield and milk composition in goats. The use of different ingredients from cheap sources can improve the milk yield and composition so as long as the diet is within the recommended range. Also, higher producing breeds of goats should be harnessed for better milk production. Low producing breeds may be crossed in a controlled program with a superior breed to improve their milking abilities. Parity, udder size and age of goat could predict the amount of milk produced. Therefore, older and non-producing goats should be culled so that attention can be focused on younger goats that have the potential of producing higher milk yield.

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