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A Study on the Milk Yield and Compositional Characteristics in the Sudanese Nubian Goat under Farm Conditions

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Abstract: A foundation flock of 125 young Sudanese Nubian female goats, 6-8 months old, together with five mature males, were used as experimental animals in this study. Relevant performance data on 137resultant progeny female goats were also added to those of the original flock, at a later stage of the study, for an overall and comparative evaluation of this goat. An overall average milk yield of 155±5.10 kg was obtained for an average lactation period of 173±7.20 days. An average lactation peak of 1.4± 0.20 kg milk day^{-1} was noted after 4 weeks. Age of dam, season and type of birth of kid had significant effects on total milk yield with older does ($p<0.05$), dry Summer ($p<0.001$) and does with triplets ($p<0.05$) having the greatest yield of lactational milk within their contrasting groups. While lactational period was similarly influenced by the aforementioned effects the mean daily milk yield was significantly greater ($p<0.001$) only for the dry summer effect compared with that obtained for either wet summer or winter. On the other hand the mean values obtained for peak daily yield were significantly greater ($p<0.05$) for does in the oldest age group and also for does performing in the dry summer ($p<0.01$) compared with their relevant contrasts. Otherwise the time taken to peak daily milk yield was invariably non-significantly influenced by either of the factors studied. The weekly aggregates of lactational milk yield were significantly ($p<0.05$) influenced by parity and dry summer. Likewise these aggregates have been increasing periodically to significantly ($p<0.05$) peak at the 4th week and subsequently dropped to the end of lactation. A heritability estimate of 0.56 was obtained for the milk yield of these goats for the period measured. The mean values for colostrum contents tested dropped significantly ($p<0.05$) for total solids; solids not fat, protein and fat, but tended non-significantly to be lower for ash from the first to the third post-kidding day. The overall average values of the normal milk samples for total solids, protein and fat were 13.7± 0.02, 4.4± 0.007and 4.6± 0.018%, respectively. These values being significantly ($p<0.05$) greater for total solids and fat in dry summer in comparison with those obtained in the wet summer and winter. On the other hand while there was a consistent and significant ($p<0.05$) increase in percentage fat the values of percentage protein and total solids showed significant, but irregular trends.

Key words: Nubian goat, milk yield, composition, summer, winter, Sudan

INTRODUCTION

Goats are efficient users of low quality feeds to produce both milk and meat. Of the multiple groups and subgroups of the Sudanese goats, the Nubian goat constitutes a strategic concern as milk production and supply to the market is considered. According to the FAO (1991) the Sudanese goats contribute to 25.1, 44.4 and 9.5% of total milk production; in the Sudan, Africa and the world, respectively. The availability and distribution of milk supply amongst the strategic users (poor families, children and the elderlies) is of paramount interests in this country. The question of dairy goat development is therefore of great relevance in this respect, especially for the poor sector of the population. As is mentioned above and at the present stage of planning to develop national flocks of dairying goat, the Sudanese Nubian goat is being focused upon. This goat is the most abundant in Sudan making about 46% of the total goat population in the country and is widely distributed North of Latitude 12°N (FAO, 1991). According to Flamant and Morand-Fehr (1982) dairy goats are those goats that provide milk markets with milk for the major part of their lactation pointing out that only a few goat breeds can thus be described as dairy goats. On the other hand, Sands and McDowell (1978) have formerly indicated that most of the goats are described as dual purpose milk and meat producers. These authors considered the Saanen,

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Alpines, Toggenberg, Damascus and Nubian goats as high yielding breeds. However the prevailing information on the Sudanese Nubian goat as a high yielding animal is not satisfactorily verified despite the strong believe that it constitutes a fairly good genetic potential for a dairy goat.

The specific objectives of this study are towards provision of more material, characterizational support in the process of identifying a national dairy goat with prime interest in the Sudanese Nubian goat.

MATERIALS AND METHODS

This study was conducted at the University of El Gezira farm during the period December 1999-June 2002. The farm lies in the Northern part of Wad Medani the capital city of El Gazira State, a region of tropical continental rainfall (June-October), cracking, clay soil and Tropical natural grassland. A flock of 130 Sudanese Nubian goats, 125 females and 5 males were picked out from nomadic breeding flocks (about 900 heads) which prevail in the Butana area under natural grassland and rain fed cereal crops by-products. For the purpose of this study the year has been subgrouped into:-

- Dry summer-from mid-March to June.
- Wet summer-from July to October.
- Winter-from November to mid-March.

Identification by ear-tagging, medical and biological protection, endo-and ecto parasitic control were routine management practices.

Under the experimental conditions that prevailed in the farm these goats were kept on grazing fodder (*Clitoria ternata*) cultivated under irrigation conditions, in addition to rain-fed natural grasses and cereal and other crops by-products. At mating and suckling periods the goat groups relevant to either of these two activities were supplemented with a concentrate mixture (Table 1) at an average intake of about 0.75 Kg/head/day. The latter mixture was formulated with reference to Ellis (1981) and El-Imam (1999). Mineral salt blocks, covering a range of minerals, were placed for the animals as well as fresh water. The goats were handled at mating and kidding in sire groups of 20-25 does/sire. These activities were managed in partially shaded metal-supported pens of 5×4×1.2 m dimensions each, which were used also for casual rearing purposes. Forty eight does were availed to measure parameters of milk production which was started about a week after kidding. These parameters were examined using daily hand-milked measured samples and weekly aggregates of such samples up to 12 weeks of lactation and they included the following:-

Table 1: Supplemental concentrate mixture for grazing sudanese nubian goat

Form Feed Ingredient	Gross (%)	Crude protein contribution, g Kg^{-1} mixture	Metabolizable contribution MJ Kg^{-1} mixture
Wheat bran	40	067.30	4.18
Groundnut seed cake	28	120.40	3.26
Sorghum vulgare grains	31	041.01	3.99
Common salts	01	-	-
Total	100	228.71	11.43

Lactational Period (LP), total Lactational milk Yield (LY), Daily Milk Yield (DMY), Peak Milk Yield (PKY), Time taken to attain Peak milk yield (TPK) and weekly aggregate samples. These parameters were examined under the effects of age of dam, parity number, kidding season, sex and type of birth of kid. The highest yield test and date for each doe was considered the peak yield and time, record.

Colostrum and aggregates of daily into weekly milk samples were chemically analysed to determine percentage levels of some of the chemical components of the milk samples. Milk fat percentage value was determined by Gerber test according to Golding (1959) while percentage protein was determined following Foley *et al.* (1955).

Total Solids (TS) and Solids Not Fat (SNF) were obtained using Richmond formula (Golding, 1959) and percentage lactose was calculated by difference, while ash was estimated by proximate analysis.

Data statistical analysis: Data collected were treated for statistical analysis using SPSS package (Harvey, 1977). The model $Y_{ij} = U + S_i + K_j + l_{ij}$ was used to validate the data to allow for evaluation of some genetic influences. Thus the heritability of milk yield was calculated as: 4 times the ratio of between sire variance divided by the sum of the between and the within sire variances. The model mentioned above is explained as:-

Y_{ij} = Individual observations of the trait Y_{ij}.
U = Overall mean of trait.
S_i = Random effect of sire.
K_j = Other fixed factors effects.
l_{ij} = Error or residual effects.

RESULTS

The results (Table 2) obtained on the Sudanese Nubian goat for milk production in this study showed an overall mean value of 155.5±5.10 kg, 173±7.20 days, 0.9±0.01 kg, 1.4±0.20 kg and 28±0.80 days for Lactational Yield (LY), Lactational Period (LP), Daily Milk Yield (DMY), Peak Daily Yield (PKY) and Time taken to attain that Peak Yield (TPK).

Table 2: Least squares mean for total Milk Yield (LY), Lactation Period (LP), Daily Milk Yield (DMY), Peak Milk Yield (PKY) and time to peak (TPK)

Traits factors	N	LY×±SE (kg)	LP×±SE(days)	DMY×±SE(kg)	PKY×±SE(kg)	TPK×±SE(days)
Overall	137	155±5.10	173±7.20	0.9±0.01	1.4±0.20	28±0.80
Age group:-		*	*	NS	*	NS
1.5-2.0 …	45	151±9.20	165±10.00	0.8±0.01	1.10±0.18	28±0.70
>2-2.5….	56	154±11.00	166±4.00	0.9±0.01	1.40±0.01	28±0.60
>2.5-3.0...	36	156±18.00	176±5.00	0.9±0.01	1.50±0.01	30±0.80
Season:-		**	**	**	**	
Dry summer	31	196±6.10	195±7.3	1.00±0.01	1.40±0.02	31±0.50
Wet summer	49	144±8.10	137±6.9	0.90±0.01	1.30±0.01	27±0.90
Winter…..	67	170±4.70	179±7.10	0.9±0.01	1.30±0.02	29±0.80
Sex:-		NS	NS	NS	NS	NS
Males	86	153±5.00	167±6.80	0.9±0.01	1.4±0.02	29±0.70
Females	51	152±5.00	167±7.90	0.9±0.01	1.3±0.01	28±0.80
Type of birth:-		*	*	NS	NS	NS
Singles	43	150±4.50	166±7.10	0.9±0.00	1.3±0.01	27±0.70
Twins	35	154±4.80	168±7.30	0.9±0.00	1.4±0.02	31±0.70
Triplets	38	155±5.20	175±7.50	0.9±0.00	1.3±0.01	28±0.60

*= Compared means are significantly different at p<0.05, **= Compared means are significantly different at p<0.01, NS= Compared means are not significantly different

Table 3: Least squares means of weekly patterns of milk yield (kg) as affected

Main effect	N*	Mean	SE**
Overall	167	7.55	0.012
Parity:-			
1st	69	7.48^{a}	0.094
2nd	58	7.51^{b}	0.059
3rd	40	7.60^{c}	0.053
Season :-			
Dry summer	72	7.67^{a}	0.052
Wet summer	58	7.52^{b}	0.058
Winter	37	7.46^{b}	0.046
Weeks of lactation:-			
1st vk	167	8.73^{a}	0.042
2nd	167	8.78^{a}	0.043
3rd	167	8.81^{a}	0.045
4th	167	8.89^{b}	0.041
5th	167	7.84^{a}	0.042
6th	167	7.89^{a}	0.041
7th	167	7.31^{a}	0.042
8th	167	7.19^{a}	0.040
9th	167	7.24^{a}	0.041
10th	167	6.71^{a}	0.041
11th	167	6.90^{a}	0.041
12th	167	6.30^{c}	0.046

Means within variable groups bearing different letters differ significantly (p<0.05); those with the same letters are non-significantly different. *N = Number of animals, **SE = Standard Error

Statistically significant influence of age (p<0.05) and season (p<0.01) on all the listed lactational characteristics was noted with the exception of age on DMY and age and season on TPK. This indicated that the oldest does of more than 2.5 and up to 3.0 years of age and those does lactating during the summer season had the best performance on milk yield and its contributing traits. The least average milk yield performance was shown for these does falling in the youngest age group (1.5- 2.0 years) and those lactating during the wet Summer season. On the other hand while sex of kid did not play any significant role on the performance characteristics studied, does with triplet kids had the greatest mean values (p<0.05) for both lactational yield and period. Does with twin kids followed in the second degree.

For Table 3 the aggregate weekly yield average mean values were compared for the effects of parity, season and pattern of weekly milk yield distribution. An overall average weekly milk yield of 7.55±0.012 (SE) kg is evidential. Does lactating in the third parity have significantly (p<0.05) the greatest mean value. For weekly the milk yield compared with either mean values in the first or second parities, which compared significantly (p<0.05) different, on their on too.

Unlike parity seasonal variations have only influenced a greater value for average weekly milk yield for those does lactating during the dry summer in contrast to either of the wet summer or winter average weekly milk yields. The distribution of the mean weekly average from week one to week twelve (Table 3) depicted a peak of weekly yield at the fourth week at 7.89 kg which is significantly (p<0.05) higher than either of the other values on either of the sides of this peak.

As is known colostrum differs from ordinary milk in multiple of ways and functions. The results on chemical composition of colostrum worked and shown in Table 4 depicts a significant (p<0.05) trend of dropping values of TS, SNF, Protein and Fat in colostrum from day one to day three, while those for ash, though consistently dropping, are not significantly different.

In Table 5, the mean values of TS, SNF, Fat, Protein, Lactose and Ash of the normalized milk of the present goats are:- 13.81, 9.65, 4.71, 4.34, 4.40 and 0.81%, respectively. These values fall within a range of variations of 5.0, 4.7, 15.2, 3.7, 2.5 and 21% of the respective maximum and minimum individual values of the TS, SNF, Fat, Protein, Lactose and Ash, respectively.

Table 4: Least squares means of chemical composition of Sudanese Nubian goat's colostrum between days 1-3 postpartum

Factor	TS* (%)		SNF** (%)		Protein (%)		Fat (%)	Ash (%)		
Overall	X	SE	X	SE	X	SE	X	SE	X	SE***
N = 48	16.2	0.3	11.7	0.6	7.99	0.8	4.8	0.3	0.87	0.01
Days after kidding										
1st day	22.62[a]		16.41[a]		14.0[a]		5.78[a]		0.92[a]	
2nd day	14.00[b]		9.99[b]		5.31[b]		4.51[b]		0.85[a]	
3rd day	13.62[b]		8.87[b]		4.50[b]		4.21[b]		0.83[a]	

Means within variable groups bearing different letters differ significantly ($p<0.05$) those with the same letters are non-significantly different. *TS = Total Solids, **SNF = Solids Not Fat, ***SE = Standard Error

Table 5: Percentage composition of Sudanese Nubian goat milk

(%)	Maximum	Minimum	Mean	SD***
TS*	16.6	11.7	13.81	0.69
SNF**	10.9	8.5	9.65	0.45
Fat	5.9	3.4	4.71	0.72
Protein	5.4	3.3	4.34	0.16
Lactose	5.4	3.0	4.40	0.11
Ash	0.81	0.76	0.81	0.17

*TS = Total Solids, **SNF = Solids Not Fat, ***SD = Standard Deviation

Table 6: Least squares means for percentage total solids, protein and fat of Sudanese Nubian goat milk

	(%) total solids		(%) protein		(%) fat	
Factor	Mean	SE*	Mean	SE*	Mean	SE*
Overall season	13.7	0.02	4.4	0.007	4.6	0.018
Dry summer	14.1[a]	0.04	4.46[a]	0.012	4.72[a]	0.03
Wet summer	13.5[b]	0.04	4.43[a]	0.011	4.69[b]	0.03
Winter	13.4[b]	0.05	4.44[a]	0.014	4.65[b]	0.03
Weekly milk yield						
1-2	13.7[a]	0.0	4.65[a]	0.017	4.00[a]	0.04
3-4	13.7[a]	0.061	4.41[b]	0.017	4.17[a]	0.041
5-6	13.6[b]	0.062	4.38[b]	0.016	4.36[b]	0.04
7-8	13.5[b]	0.07	4.41[b]	0.018	4.34[b]	0.042
9-10	13.4[b]	0.061	4.30[c]	0.017	5.31[c]	0.042
11-12	13.7[a]	0.07	4.42[b]	0.019	5.72[d]	0.040

Means within variable groups bearing different letters differ significantly ($p<0.05$); those with similar letters are non-significantly different, *SE = Standard Error

The least square means of Table 6 indicate that the TS and Fat values were significantly ($p<0.05$) greater for milk samples of the dry summer lactating does in contrast to that from does lactating during either wet summer or winter season.

On the other hand, the protein percentage of the milk was invariably non-significantly affected by season of lactation.

It is also obvious that the weekly aggregate milk samples had consistently and significantly greater values for percentage fat contents from week 5 right week 12 in comparison with either values obtained for week 1-2 and 3-4 (Table 6). But the trend for percentage TS and protein was that of a decreasing value from those of weeks 1-2 and 3-4 to that of week 9-10 for TS, while the trend for percentage protein was significantly, but irregularly decreasing from week one to week 12.

DISCUSSION

Since long there has been a great concern about the situation of milk supply in the country regarding its sufficiency to supplement human nutritional needs. Due to the high nutritional and physiological vitality of milk, great efforts have been and are on the pipeline to improve its availability and accessibility especial for the poor sector of the population. In that respect the image of the goat comes forth to promote a salvation strategy to make such efforts meaningful. The goat comes forth because of its relatively high biological efficiency in one hand and its greater feasibility to participate in solving the nutritional question in relation to the most needy population sector.

In this respect, some of the earlier efforts engaged with the goat as milk producer, considered the Sudanese Nubian goat as it is conventionally believed to have fairly good dairying potential compared with either of the remaining Sudanese goat groups or their subgroups. Of the earlier research work was that of Osman and Mukhtar (1970), El Naim (1979), Sulieman and El Shafei (1984) characterizing this Nubian goat, whereas more specific research was conducted at a later date towards evaluation of nutritional implications on their milk yield as was shown by Ahmed (1993), Gubartalla *et al.* (2002b).

The lactational milk yield of the Nubian goats in this study summed up to an average total of 155.5±5.1 kg in a lactational period of 173.0±7.1 days (Table 2). In

a previous study of Sudanese Nubian goats Osman and Mukhtar (1970) reported a lactational total yield of 47-73.5 kg, whereas Khalafalla and Suleiman (1990) have shown a lactational yield of 72 kg for a similar group of goat. The average daily yield in the present study of 0.9±0.01 kg is greater than that shown lately for a range of 0.76-0.79 kg by Gubartalla *et al.* (2002a). But the same authors (Gubartalla *et al.*, 2002b) have obtained better average daily yields for similar but differently fed two Nubian goat groups. 1.14±0.40 and 1.74±0.33 kg were recorded for either of them as average daily milk yield when fed either molasses or *sorghum* based diets. Another earlier work on Sudanese Nubian goats has also indicated a better daily average yield than that of the present study which amounted to 1.17 litres by Sulieman and El Shafei (1984) and 2.2 pounds (about one litre) by Osman and Mukhtar (1970).

A number of factors are known to play, in one way or another, a sizable role on goat milk yield. For example the role of age and parity are quite clear in this study (Table 2 and 3) indicating a high performance at older age and greater parity numbers, especially for peak yield which was attained, on average, at the fourth week of lactational period. Similarly Ehoche and Buvanendran (1983) have noted that milk yield was affected by doe's age, whereas Kennedy *et al.* (1992) indicated that doe's age at kidding accounted for 30-40% of variation within a flock of goats for milk production which increased up to 5 years of age then declined there after. As for peak milk yield and unlike the present findings, Ehoche and Buvanendran (1983) have shown a lactational peak occurring within two weeks in Red Sokoto goat while Banda (1992) noted a yield peak occurring at the 5th lactational week in the Small East African goat. This trend adds the effect resulting from differences due to breed groups as well rather than to management solely.

Variations due to climatological influence have also been known to create some different trends in milk yield performance in goats as well as in many other kinds of livestock. The picture in the present study (Table 2) supported a significantly greater milk yield in the dry summer season in contrast to the yield during either of the remaining seasons of the year. Many factors might have been interplaying to produce that effect of which increased humidity, circumstantial insect disturbance, slackening of feeding periodicity during the wet summer added to the increased bodily nutritional requirements during Winter season are but some of these effects.

Some of the supporting evidences to our present findings on the effect of season on milk yield are those of Devendra (1985), Blackburn and Field (1990), Kennedy *et al.* (1992) and Montaldo *et al.* (1995) who found that does kidding in the dry season had better yields on average than those kidding in the wet season.

In regard to the effect of type of birth on lactation performance the present results (Table 2) tended to indicate that multiple birth induced significantly ($p<0.05$) more milk yield compared to single birth, but the difference between twins and triplets in milk yield was only of a minor degree. In a previous study, Treacher (1983) explained that does suckling twins generally produced about 40% more milk than those rearing singles. This trend could be, perhaps, partially linked with the instinctual motivations of mothering ability. However, Hayden *et al.* (1979) explained the increase in milk yield in goats with multiple birth in terms of increased level of placental lactogen.

On the other hand the genetic influence on milk yield is well established and hence the environmental effects have to be properly monitored in order to allow for an appropriate estimate of that influence. It is generally reported that this influence is of a moderate magnitude, but with a wide range for its estimated value, heritability. The present value 0.56 for the Sudanese Nubian goat milk yield heritability fits well within the general concept of the genetic influence on this vital trait. It supports such a functional role and plans to improve this goat group by selection. Some heritability estimate values on milk yield quoted from literature indicate 0.23 for the Indian Beetal goat (Amble *et al.*, 1964) and 0.40; 0.41 and 0.71 for mixed dairy goat breeds in Norway (Ronningen, 1964, 1967).

The quality of milk is governed by the level of its chemical constituents and according to the latter, normal milk varies widely from the colostral milk that is secreted by the animal at birth time and usually lasts for about a week before milk becomes normal to be tested for its quality. A number of factors influence the quality of normal milk in the way of changing the percentage of its total solids, solids not fat, protein, fat, lactose and ash contents. For the present work Table 4 and 5 depict a comparison between the composition of subsequent three post-partum colostral daily samples and normal lactational milk samples. For colostrum, the percent total solids (-39.8%), percent solids not fat (-45.9%) and percent protein (-67.9%) have undergone significantly ($p<0.05$) drastical reduction from day one to day three while the percent fat was the least significantly reduced (-27.2%). Colostral percent ash was non-significantly depressed by 9.8% three days following parturition.

The mean values of the milk constituents (Table 5) as measured by proximate analysis for the overall milk samples varied widely from the mean colostrum samples.

The major drastic change (-45.6%) occurred for the protein constituent while that of fat (-1.9%) and ash (-6.9%) was only minimal for the present lactational period. Mean total solids and solids not fat were reduced by 14.8 and 17.5%, respectively, in the normal milk in contrast to their respective average values in the colostrum. That evaluation supports the vitality of colostrum as an initial concentrated source of nutrients as well as a provider of defensive mechanism to the newly born kid.

On the other hand the overall percentage average mean for each of total solids, protein and fat shown in Table 6 for the present study indicate, most probably, better nutritional conditions in contrast to these under which the Nubian goats of Sulieman and El Shafei (1984) were raised. The latter study noted a lower contribution level of total solids (10.5%), protein (3.1%) and fat (2.9%) in a similar Nubian goat group milk. But the percentage levels of these three components in the milk of the mixed exotic dairy goats group (Sulieman and El Shafei, 1984) were similar for total solids (13.7 vs 13.7%), about 27% higher for fat (5.8 vs 4.6%) but about 25% lower for protein (3.2 vs 4.4%) compared to the present results.

Season of lactation (Table 6) tended to favour higher ($p<0.05$) percent total solids and percent fat in dry summer lactation to either wet summer or winter lactation. This was explained above in terms of better management and feeding conditions and better utilization of feed outside wet summer and winter seasons. Blackburn and Field (1990), Kennedy *et al.* (1992) and Mantaldo *et al.* (1995) noted that the variation in milk composition associated with season is attributed, partially to variations in feed supply and/or management.

Regan and Richardson (1938) and Karua (1989) indicated that high temperatures seem to have greater influence on solids not fat than on milk fat. The latter constituent is increased by concentration (Mathewman, 1984).

In addition to the effect of season, milk composition is also influenced by the stage of lactation. For example Banda (1992) studying the trends of fat and total solids in lactating Malawi goats, observed that percent fat and percent total solids were high after parturition, then dropped, but gradually increased later on for the remainder of the lactation period. For the present study there is a similar trend whereby percent fat level was on a consistent increasing mode, percentage total solids was inconsistent (Table 6) whereas that of protein was on the descending trend except for the latest period (week 11, 12) when its percent value rose again. The rise in total solid percent could be explained partially on the basis of the greatest increase for percent fat.

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