Research Article

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Effect of two different feeding systems on body growth and measurements in Sudan Nilotic male kids

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To study the body growth and measurements of Nilotic male kids from birth till sexual maturity, 13 animals were reared on standard (5 animals) or complete (8 animals) feeding systems. The standard system (SMD) composed of meshed sorghum-based concentrate and sorghum straw portions fed separately. The second system is a complete molasses pelleted diet (MPD) feeding. Animals were reared on creep feeding with their dams till weaning and subsequently penned individually and divided according to the feeding of their dams (SMD or MPD groups). From 4 months of age, kids were exposed weekly to a teaser female. Puberty was recorded at first ejaculate into an artificial vagina and sexual maturity confirmed when the quality of the ejaculated semen became similar to that of their parents. Analysis of covariance (season of birth was the covariate) was used to examine effect of feeding system on body weights, pre- and post-weaning gains, ages at puberty and sexual maturity, body measurements and feed intakes. Birth weight and ratio were 1.99 kg and 9.70%; body weights at weaning, puberty and sexual maturity were 7.79, 10.9 and 12.3 kg. Ages at puberty and sexual maturity were 173 and 224 days, respectively. It was concluded that Nilotic kids attain sexual maturity at an early age with small body and that feeding them MPD reduced feeding cost by 43% without diffracting their growth performance in comparison with the SMD. Live body weight of the Nilotic kids may be predicted by raising heart girth measurement to power 2.89.

Key words: Body weight and measurements, feeding systems, Nilotic kids

Goats contribute substantially to Sudanese households' well being by producing milk, meat, hair and skin (Sulieman, 1986; Mofarrah, 1995). There are four local goat breeds in the Sudan: Nubian, Desert, Tagar, and Nilotic (Sulieman, 1986). Nilotic goat descended from African Dwarf goat (Devendra and Burns, 1983). It is a small, compact bodied goat that is distributed south to 10^{o} N latitude in a large area of political conflicts that prohibited the availability of information about their production and reproduction potential. However, the surveys of El Mahi (1979) and Tilmat *et al.* (1983) revealed that this type of goat has good reproductive performance, but with poor growth rates and high kids' mortality due to poor management and nutrition.

Nilotic goats are mostly raised on open range grazing condition where tropical grasses are known for their early maturity, high fibre, high lignin and low protein contents. This adversely affects livestock production and reproduction potential. Therefore, planning of nutrition and management under intensive condition would allow the animal to perform its maximum production potential. In choosing a feeding system, several factors need to be considered. Most importantly are labour efficiency, safety and cost. According to Jurgens and Bregendahl (2007) the most appropriate livestock feeding system should be advantageous in ease of access to the feed, ease of cleaning feed and minimum feed waste. They added that intensive livestock feeding can be standard when concentrate and roughage portions were offered separately or complete when the two portions were offered in one mixture. Owen (1984) noted that advantages for complete diets appear to be simplicity of management and full mechanization, coupled with

economy of feeding space, safety and flexibility for inclusion of a wide range of ingredients. Disadvantages include high capital cost and risks of mechanical breakdown. Adam *et al.* (2010) found that feeding complete molasses-based diet to Nilotic bucks resulted in marked feeding cost reduction when compared with sorghum-based diets.

Growth is a complex biological process that is induced by differential development rates of body tissues. In practice, external measurements of the body have been used to estimate the development of the skeleton and/or soft tissues of the body. Many investigators used the strong phenotypic correlation between body weight and different linear body measurements to describe and classify animals. Devendra and Burns (1983) used the height at wither as a criterion for classifying goats into three groups (large breeds of over 65 cm, small breeds of 51 - 65 cm and dwarf breeds of less than 50 cm height at wither). When body measurements are taken sequentially over a period of time, they indicate the way in which animal body is changing shape and have been used as predictors of animal body weight when there is no easy access to weighing machines (Atta and El Khidir, 2004).

The objectives of this study were: (i) to investigate effects of standard sorghum-based (SMD) and complete peletted molasses-based diets (MPD) feeding on the growth characteristics of Nilotic kids, and (ii) to evaluate the efficiency of using body measurements for prediction of the live body weight in Nilotic kids.

MATERIALS AND METHODS

This study was conducted at Juba University farm, 15 km north of Khartoum centre, during the period from January 2007 to December 2007. Thirteen male singleton kids, born to Nilotic goats were used. The kids and their dams were reared intensively under two feeding systems. The first was the standard (SMD); under which animals (5 kids) were offered their feed as two separate meshed sorghum-based concentrate and sorghum straw roughage portions. Under the second system, the animals (8 kids) were offered their feed as one complete pelleted molasses based diet (MPD).

The birth season of kids was recorded (dry summer: March to June; wet summer: July to October and winter from November to February). The kids were left all the time with their dams from birth till one week of age. Then they were allowed to stay on creep feeding with their dams from morning after milking up to evening when they were separated over night into two pens and given diets similar to their dams. This practice was continued until weaning (at 90 days of age). After weaning, kids were divided into SMD and MPD groups according to the feeding of their dams and penned individually. The kids were weighed at weekly interval throughout the experimental period (from birth to sexual maturity). The live body weights at birth, weaning, puberty and sexual maturity were also recorded. The heart girth (HG), scapuloischial length (SIL) and height at wither (HW) were measured weekly before weighing using a tape (Atta and El Khidir, 2004).

From the age of 4 months, the kids were exposed at weekly intervals to a teaser female to explore their reproductive abilities and training to mount and ejaculate into an Artificial Vagina. The age at first ejaculate was recorded as the age of puberty. Attainment of sexual maturity stage was confirmed when the characteristic of the semen became similar to that of their parents. Semen collection and evaluation was performed according to the methods of Evans and Maxwell (1987).

The meshed concentrate (24.8% CP and 11.4 MJ ME/kg DM) portion of SMD feeding system had crushed sorghum grains (32%) and groundnut cake (36%) as the main sources of energy and protein, respectively; wheat bran (29%), salt (1%) and limestone (2%) were also added. Sorghum straw (4.14% CP and 6.22 MJ ME/kg DM) was the roughage portion. In this feeding system the concentrate and sorghum straw portions were offered separately in the morning in the ratio of 4:1. On the other hand, the MPD (15.3% CP and 9.14 MJ ME/kg DM) composed of urea (1.5%) and molasses (35%) as the main sources of protein and energy, respectively; crushed sorghum grain (20%), wheat bran (15%), salt (1%) and limestone (2%) were also added. Bagasses (15%) were incorporated in this diet to increase its fiber content. This diet was offered in one morning meal. The quantity of feed for the two groups was adjusted weekly to ensure about 10% weigh back. Fresh alfalfa (*Medicago sativa*) was offered once a week at a rate of 0.5 kg/head as a source of carotene. Fresh water and mineral salt licks

were available *ad libitum*. Daily feed intakes were recorded.

Taking season of birth as a covariate, analysis of covariance (StatSoft, 2001) was used to examine the effect of feeding protocols (SMD vs. MPD) on live body weights at birth, weaning, puberty and sexual maturity, pre- and post-weaning body gains, ages at puberty and sexual maturity, body measurements and feed intakes. The weekly body weight and measurements were subjected to linear ($y = a + bx$) and power ($y = ax^b$) regressions where y is the body weight (kg), x is the body measurement (cm), a and b are constants denoting the intercept and the regression coefficient, respectively.

RESULTS

The coefficients of variations (CV) for the live body weights of Nilotic kids at birth, weaning, puberty onset and at sexual maturity were very low (Table 1). The growth performance of the kids in the SMD and MPD groups did not show significant ($P>0.05$) differences for birth weight, weaning weight, dry matter intake (DMI), weight and age at puberty, age at sexual maturity, daily pre-weaning and post-weaning gains and feed conversion ratio (Table 2). The MPD group had significantly ($P<0.05$) higher metabolizable energy intake (MEI) and heavier weight at age of sexual maturity than that of SMD group. On the other hand, the SMD group had significantly ($P<0.05$) higher crude protein intake (CPI) than the MPD group.

The linear regressions of body weight on heart girth (HG), height at wither (WH) and scapuloischial length (SIL) were significant ($P<0.05$) and the coefficients of determination (r^2) were 0.88, 0.88 and 0.74, respectively. The coefficient of determination for the multiple regression was 0.92 (Table 3). The power regressions of body weight on HG, WH and SIL were also significant and r^2 were 0.94, 0.92 and 0.87, respectively (Table 4).

DISCUSSION

The coefficient of variation of a trait gives an idea of the discrepancy level of the tested data (El Khidir, 2009). In animal production studies, the presence of high level of discrepancy in a trait among individuals of the population indicates a good chance for improving this trait by selection. The body weights and ages of the Nilotic kids at different stages of development had small coefficient of variation indicating low level of discrepancy in these apparently genetically controlled traits.

The mean birth weight of kids was very close to the 2.0 kg birth weight reported by Ageeb (1992) for Sudan Baggara goats (Desert × Nilotic cross goats), but was higher than that (1.2 kg) reported by ILCA (1979) and 1.61 kg reported by Hofs *et al*. (1985) for West African Dwarf goats. The birth weight percentage of dam's weight is higher than the standard (8%) stated by AFRC (1993). This indicates that this birth weight is the maximum output of gestation for this type of goats. For Dwarf goats in Ghana, Sada and Vohradsky (1973) recorded a mean birth weight of 1.40 kg, which was about 6% of the average mature female weight. The present results of birth weight were consistent with those of Farid *et al*. (1984) who found no changes in birth weights of lambs when the source of protein of the dams' diets was changed from cotton seed cake to high urea or low urea sources since all diets were isocaloric and isonitrogenous.

The weaning weight is comparable to 8.15 kg reported for West African Dwarf goats under high levels of feeding and management (Hofs *et al*., 1985). The weaning weights of kids of the present two diet groups showed similar values; this finding was supported by the same values of pre-weaning daily gain for the two diet groups. The daily pre-weaning weight gain in the present study is comparable to 53 $g.day^{-1}$ reported by Sada and Vohradsky (1973) for West African Dwarf goats up to three months of age. The daily post-weaning body weight gains were within the range (30 - 50 $g.day^{-1}$) reported for West African Dwarf goats by Adebowale and Ademosun (1981). The age at which kids attain puberty is primarily influenced by live weight, type of breed, season of birth and exposure to the opposite sex (Ahmad and Noakes 1996). Chakraborty *et al*. (1989) reported that puberty is achieved when the kid reached 30 – 50% of adult body weight. The onset of puberty in Nilotic kids is consistent with that reported by Ahmad and Noakes (1996) for British Sannen, Alpine and Toggenberg breeds, at a mean age of 173 days, and at a mean body weight of 31.3 kg. Consistently, Delgadillo and Malpau (1996) reported that puberty was attained at 8 to 14 months in local goats in a tropical environment although much higher age at puberty has been reported and it appeared to result from poor management.

Table 1: Chronological body weights and ages (means ± SD) of Nilotic kids

Trait	Mean	SD	CV (%)
Birth weight (kg)	1.99	0.37	18.6
Birth weight ratio of dam's weight (%)	9.70	1.65	17
Weaning weight (kg)	7.79	1.14	14.6
Puberty weight (kg)	10.90	1.11	10.2
Sexual maturity weight (kg)	12.20	1.54	12.6
Puberty age (days)	173.0	13.4	7.73
Sexual maturity age (days)	224.0	7.42	3.31

CV**:** coefficients of variations

Table 2: Growth performance of Nilotic kids fed on SMD and MPD

Traits	Type of feeding		± SE	LS
	SMD	MPD		
Number of animals	5	8	-	-
Birth weight (kg)	1.95	2.01	0.148	NS
Dam kidding weight (kg)	19.7	21.2	1.09	NS
Birth weight (%) of dam's weight	10.3	9.30	0.539	NS
Weaning weight (kg)	7.75	7.82	0.503	NS
Concentrate DMI (g/day)	241	-	-	-
Sorghum straw DMI (g/day)	122	-	-	-
Total DMI (g/day)	363	331	10.4	NS
MEI (MJ/day)	3.01^{b}	3.46^{a}	0.079	*
CPI (g/day)	62.4^{a}	50.5^{b}	1.24	*
Puberty weight (kg)	10.4	11.2	0.456	NS
Sexual maturity weight (kg)	11.2^{b}	12.9^{a}	0.463	*
Puberty age (days)	179	169	5.44	NS
Sexual maturity age (days)	222	225	1.63	NS
Daily pre-weaning gain (g/day)	59.1	59.3	4.65	NS
Daily-post weaning gain (g/day)	34.5	36.8	3.42	NS
FCR (g DMI/g body gain)	9.01	9.76	1.05	NS

DMI = Dry mater intake. MEI = Metabolizable energy intake. CPI = Crude protein intake. FCR = feed conversion ratio, LS = level of significance of treatment's effect. NS = effect of treatment is not significant (P>0.05). * = effect of treatment is significant (P<0.05)

The ME intake of kids in the present study is comparable to that stated by NRC (1981) which is 424 KJ $ME.kg^{-0.75}.d^{-1}$ for maintenance and 30.3 KJ ME per gram of daily live weight gain. Zemmelink *et al*. (1985) reported higher requirements for West African Dwarf goats (410 KJ ME. $kg^{-0.75}.d^{-1}$ and 38.0 KJ ME as daily energy requirement for maintenance and daily weight gain, respectively).Referring to the body weight and measurements obtain in this study and according to Devendra and Burns (1983), Nilotic goats can be classified as Dwarf breeds (height at wither less than 50 cm). The regressions of body weight on HG, WH and SIL revealed that HG had the highest coefficients of determination (r^2= 0.88 and 0.94 for the linear and power regressions, respectively) whereas the regression of SIL had the lowest coefficients of determination (r^2=0.74 and 0.87, respectively). The multiple regression of body weight on the studied body measurements had 0.92 coefficient of determination. Similar reports were mentioned by Lawrence and Fowler (1997) and Atta and El Khidir (2004). They reported that skeletal tissue measurements (wither height and body length) were less variable for body weight than for heart girth that measured skeletal and soft tissues. Lawrence and Fowler (1997) also noted that live weight estimations based on two or more body measurements were not more accurate than the estimations based on heart girth alone. The live body weight of Nilotic male kids is equal to the heart girth raised to the power 2.89. This finding is in agreement with that reported by Brody (1945) in cattle and Atta and El Khidir (2004) in Nilotic rams.There were no significant differences between the SMD and MPD groups in most of the growth traits measured in this study. Therefore, feeding molasses-based diet would result in a marked reduction in

Table 3: Linear and multiple regression equations and coefficients of determination (r^2) of body weight (y) on body measurements (x) in Nilotic kids

Body measurement	Regression equation	r^2	LS
HG	y=0.468x–11.2	0.88	**
HW	y=0.397x–8.80	0.86	**
SIL	y=0.469x–9.47	0.74	**
HG, HW , SIL	$y=0.198x_1+0.168x_2+0.116x_3–11.5$	0.92	**

In this table and the following:
** = Regression is significant (P<0.01)
HG, HW, SIL = Heart girth, height at wither and scapuloischial length, respectively

Table 4: Power regressions of body weight (y) on body measurements (x) in Nilotic kids

Body measurement	Regression equation	r^2	LS
HG	$Y= 0.0002 \times HG^{2.89}$	0.94	**
HW	$Y= 0.00008 \times HW^{2.44}$	0.92	**
SIL	$Y= 0.0005 \times SIL^{2.67}$	0.87	**

feeding cost with comparable growth performance to that produced by cereal-based diet. The current prices of one Kilogram of concentrate portion of the SMD, the MPD and sorghum straw are 0.75, 0.50, and 0.75 SDG, respectively. Therefore, the computed daily cost of feed intake per animal would be about 30.5 and 17.5 SDG for SMD and MPD fed kids, respectively. Thus, feeding molasses MPD would reduce the feeding cost by 43% and should be preferred over the SMD as it reduces man-animal competition over cereals.

It is concluded that Nilotic male kids reach the age of sexual maturity at young age with small sized bodies. The MPD can be fed to Nilotic kids so as to reduce the competition for the cereal grains without diffracting from the growth performance produced by the SMD. The live weight for Nilotic male kids can be estimated using heart girth measurement based on the equation: $Y=0.0002 \times HG^{2.89}$. However, this study is based on rather a small number of observations therefore further study using large number is needed.

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