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Supplementation of Meal Concentrate on Growth and Subsequent Reproductive Performances of Woyto-Guji Goats

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ABSTRACT

The growth and subsequent reproductive performance of Woyto-Guji goats was evaluated under varying levels of meal concentrate supplementation in the hot to warm semiarid environments of southwestern Ethiopia. Forty five primiparous Woyto-Guji goats aged 14.3 ± 0.49 mth, with 15.0 ± 2.9 kg mean bodyweight (BW) and mean body condition score (BCS) of 2.9 ± 0.05 were allotted in a completely randomized design to three treatment groups—no concentrate (T_0, control), 200 g per goat daily (T_1) and 400 g per goat daily (T_2). Concentrate was fed for 90 d before mating and during the last 2 mth of pregnancy. Rhodes grass hay (*Chloris gayana*) was fed *ad libitum* to all goats. Supplementation significantly increased the feed intake, BW and BCS of the goats. The final average BW observed was 15.0, 18.1 and 20.2 kg and average daily gain (ADG) values were 2.7, 33.5 and 54.7 $g.d^{-1}$ for the T_0, T_1 and T_2 treatment groups, respectively. The supplemented groups mated and kidded earlier (within 4 and 3 d, respectively, from the first mating and kidding of goats) compared to the control (mated and kidded within 12 and 10 d, respectively, from the first mating and kidding of goats). Compared to the control, the pregnancy rate and kidding rate of goats were improved by 17% (T_1) and 29% (T_2) and by 71% (T_1) and 83% (T_2), respectively. The concentrate supplement may offer benefits in promoting growth, pregnancy, kidding rates and early mating and kidding of Woyto-Guji goats before the subsequent hot dry season of southwestern Ethiopia.

Keywords: growth, reproduction, supplementation, Woyto-Guji goats

INTRODUCTION

Ethiopia hosts large goat genetic resources that are adapted to the diverse agricultural production systems of the country. It has been estimated that there are more than 22.6 million goats in Ethiopia (Central Statistical Agency, 2012). The Woyto-Guji goat is one of the eight indigenous goat breeds that are distributed widely in the western arid and semiarid areas of the country being used as a source of income, meat and milk by rural people and used for various cultural and religious functions (FARM-Africa, 1996). Currently, the role of goats in improving the income and livelihood of rural people in the country is gaining importance (Kocho *et al.*,

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2011). However, sheep and goat production in Ethiopia suffers from nutritional constraints and this is aggravated by the seasonal availability of forage and by recurrent and prolonged drought in the arid and semiarid lowlands of the country (Yami, 2008). The nutritional stress, consequently, results in a slow growth rate, loss of body condition and increased susceptibility to diseases and parasites, which contribute to lower production and reproductive performance in the animals (Tolera *et al.*, 2000). Thus, effective utilization of the available feed resources and appropriate supplementation of poor quality natural pasture and crop residue-based diets appear to be necessary steps to alleviate the nutritional constraint (Tolera *et al.*, 2000). Moreover, under semiarid conditions, the early mating and kidding of goats before the hot dry season (December to February, in south western Ethiopia) is crucial to ensure high survival rates of kids and success in the *post partum* reproductive performance of goats (Hary, 2002).

Despite the adaptation of Woyto-Guji goats to the semi-arid southwestern conditions of Ethiopia, information on their growth and reproductive performance is lacking for possible improvement of the goats. Therefore, the objective of the current study was to evaluate the effects of meal concentrate supplementations before breeding on the growth rate and the subsequent reproductive performance of Woyto-Guji goats.

MATERIALS AND METHODS

Location of the study

The experiment was conducted for 9 mth starting from February 2011 at the Jinka Agricultural Research Center (JARC) of the Southern Agricultural Research Institute, which is located in the South Omo zone of the Southern Nations, Nationalities, and People's Region of Ethiopia. Geographically the area is located around 5°47′N 36°34′E at an elevation of 1490 m above sea level and its climate is hot to warm semiarid. Data collected during the study indicated that the total rainfall was 492.3 mm and the mean daily minimum and maximum temperatures were 17.5 and 29.2 ^{0}C, respectively.

Experimental animals

Forty five primiparous female Woyto-Guji goats aged 14.3 ± 0.49 mth (mean ± SE) , with 15.05 ± 0.23 kg body weight (BW) and body condition score (BCS) of 2.9 ± 0.05 were used for the experiment. The goats were purchased from pastoral villages in Hamer district (southwest Ethiopia) after arrangements and price negotiations were made with local traders and goat farmers who were willing to sell healthy and non-bred yearling female goats. The animals were brought to the goat farm at JARC, ear tagged and further examined for parasites and diseases and treated with oxy tetracycline 20% L.A, (Chengdu. Q. Vet. Phar., China) and Vectocid (Ceva Interchem, Tunisia) to control respiratory diseases. Tetramisol and Ivermectin 1% (Chengdu. Q. Vet. Phar., China) were injected to control internal and external parasites. All goats were vaccinated against peste des petits ruminants. The goats were allowed to graze during the day and were provided with grass hay at night for one month before the start of the experiment.

Feeding and measurements

Starting from February 2011, the experimental animals were randomly divided into three groups and allotted in a randomized complete block design to three treatment feeds—no concentrate (T_0, control), 200 g per goat daily (T_1) and 400 g per goat daily (T_2, as-fed basis). Rhodes grass (*Chloris gayana*) hay was fed *ad libitum* to all goats. A flow chart of meal concentrate feeding is presented in Figure 1. The goats were housed in separate pens as groups and fed for 90 d in individual pens. The concentrate used was commercially prepared by Alema Koudijs Feed Plc., Debrezeit, Ethiopia and contained 18.5% crude protein and 9.544 $MJ.kg^{-1}$ metabolizable energy (ME). The ingredients in the concentrate included wheat bran 20%, wheat middling 18%, noug (*Guizotia abyssinica*) seed cake 15%, cassava peel 18%, corn 12%, rye bran 10%, molasses sugarcane 6%, limestone 2% and salt 1%. The amounts of both hay offered and refusals were weighed daily to derive intakes during the feeding period. The BW of goats was measured weekly. Feed efficiency was calculated as feed per gain defined as the total dry matter intake (TDMI) per average daily gain (ADG). Chemical analysis of the basal feed was conducted according to Association of Official Analytical Chemists (1990) and by the procedures of Van Soest *et al.* (1991).

In early May 2011, supplementation with meal concentrate was discontinued and the goats were allowed to graze on an outdoor paddock with native pasture for 4 $hr.d^{-1}$ (between 0800 and 1000 hours and between 1600 and 1800 hours) to facilitate mating and during this period two entire bucks were introduced for 42 d to detect estrous behavior of the goats and for mating. Signs of estrus were recorded in the morning and evening and a female was recorded in estrus if she stood still when mounted by the male.

Dates for the first sign of estrus and successful mating were recorded and the goats that had not exhibited estrus up to 42 d after mating were considered pregnant. All the non-pregnant goats after 42 d of buck introduction were excluded from the experiment. Concentrate supplementation at the same levels as previously was resumed after 90 d of pregnancy for goats in the T_1 and T_2 treatment groups (Figure 1). During the pregnancy period, a basal ration of Rhodes grass hay was provided for all goats *ad libitum* and all had free access to fresh water and salt blocks. The BW of the goats was recorded weekly and their BCS was recorded at the start of the feeding period, mating, 90 d of pregnancy and at parturition. A five-point scale was used for body condition scoring (Villaquiran *et al.*, 2004).

The reproductive traits of goats recorded consisted of: 1) Pregnancy rate = (number of pregnant goats (kidding and aborting animals) / number of goats mated × 100); 2) Gestation length (the difference between mating and parturition dates); 3) Kidding rate = (the number of goats

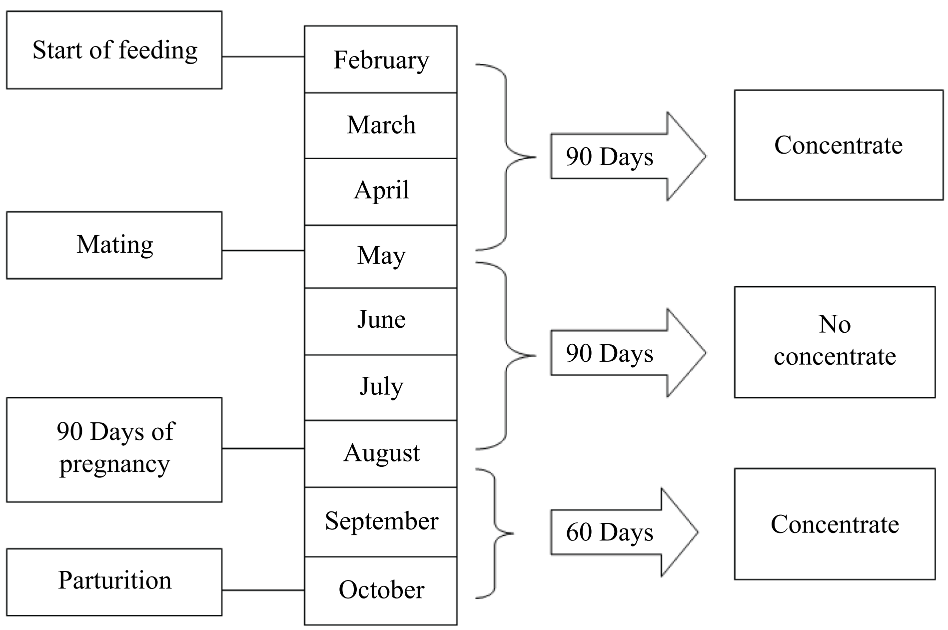

Figure 1 Flow chart of meal concentrate supplementation during the experimental period

kidding / number of goats pregnant × 100); 4) Litter size = (number of total kids born / number of goats kidded); 5) Abortion rate = (number of aborted goats / number of pregnant goats × 100); and 6) Kid's birth weight (recorded within 24 h of birth).

Statistical analysis

Data on feed intake, BW and BCS during the feeding period were analyzed with SAS GLM procedures, using the MEANS statement (SAS, 2002). The data on mating days, gestation length, kidding days, kid's weight at birth, litter size, BW and BCS at the end of pregnancy and at parturition were analyzed using the LSMEANS statement in SAS PROC GLM (SAS, 2002). Diets were used as a fixed effect and when differences between the treatments were observed, Tukey's test was applied (Steel and Torrie, 1980). The data on the proportion of goats in estrus, goats mated, goats kidded and pregnancy and kidding rates were compared using the SAS PROC Freq Chi square procedure (SAS, 2002).

RESULTS

Feed intake and growth performances

The hay consumed by the goats was 89.2% dry matter (DM), 89.3% organic matter (OM), 6.9% crude protein (CP), 73.1% neutral detergent fiber (NDF), 44.9% acid detergent fiber (ADF), 5.6% acid detergent lignin (ADL), 10.7% ash, 28.2% hemicelluloses and 39.3% cellulose (DM basis). Intake of grass hay and concentrate during the feeding period is presented in Table 1, and Figure 2 shows the growth rate of Woyto-Guji goats before the mating period. Concentrate supplementation reduced the grass hay intake. However, the TDMI and feed efficiency significantly increased with concentrate supplementation. Though initial weights of animals between treatments were similar, their final weights and ADG significantly varied among the treatments.

Body weight and body condition

Figures 3 and 4 show the BCS and BW

Table 1 Feed intake and body weight changes (mean ± SE) of Woyto-Guji goats before the mating period with three different concentrated feed supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily).

Parameter	Treatment			P-value
	T_0	T_1	T_2	
Initial average BW (kg)	14.7 ± 1.7	15.0 ± 1.5	15.2 ± 1.9	0.6675
Final average BW (kg)	15.0 ± 1.5^c	18.1 ± 1.7^b	20.2 ± 2.3^a	<0.0001
Total weight gain (kg)	0.26 ± 0.3^c	3.0 ± 0.5^b	4.9 ± 1.1^a	<0.0001
Average daily gain (ADG g.d^{-1})	2.7 ± 4.0^c	33.5 ± 5.2^b	54.7 ± 11.9^a	<0.0001
Concentrate intake (DM g.d^{-1})	-	169.9 ± 0.1^b	326.4 ± 3.0^a	<0.0001
Grass hay intake (DM g.d^{-1})	380.5 ± 41.6^a	242.3 ± 41.2^b	182.3 ± 39.4^c	<0.0001
Total DM intake (TDMI g.d^{-1})	380.5 ± 41.6^b	412.2 ± 41.3^b	508.7 ± 40.4^a	<0.0001
Feed per gain (TDMI / ADG)	140.9 ± 130.4^a	12.3 ± 2.3^b	9.3 ± 2.2^b	0.0079

BW = Body weight, DM = Dry matter, TDMI = total dry matter intake, ADG = Average daily gain

^{a,b,c} = Values in the same row with different superscripts differ significantly at $P < 0.05$ level.

changes of the pregnant goats at various stages of the experiment. At the start of the feeding period, the goats in all treatment groups had similar body weights. However, the BW of goats in the T_1 and T_2 groups were significantly ($P < 0.05$) higher than the control throughout the reproductive period. The BCS of the treatment groups, however, differed significantly ($P < 0.05$) only in the mating and parturition periods with no significant difference in BCS at the start of feeding and at 90 d of pregnancy (Figure3).

Reproductive activities

Data on reproductive activities of goats since the time of estrus are presented in Table 2. Supplementation with concentrate significantly ($P < 0.05$) increased the proportion of goats in estrus and goats mated. Figure 5 shows the variation in mating and kidding days between the treatment groups. The supplemented groups mated and kidded earlier (within 4 and 3 d, respectively, since the first mating and kidding of goats) compared to the control (mated and kidded within 12 and 10

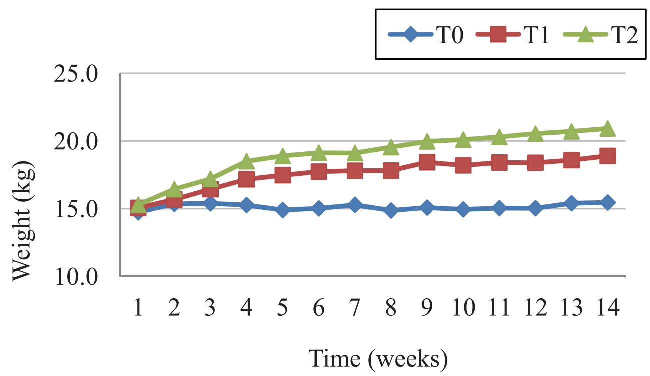

Figure 2 Growth rate of Woyto-Guji goats before the mating period with three different concentrated feed supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily).

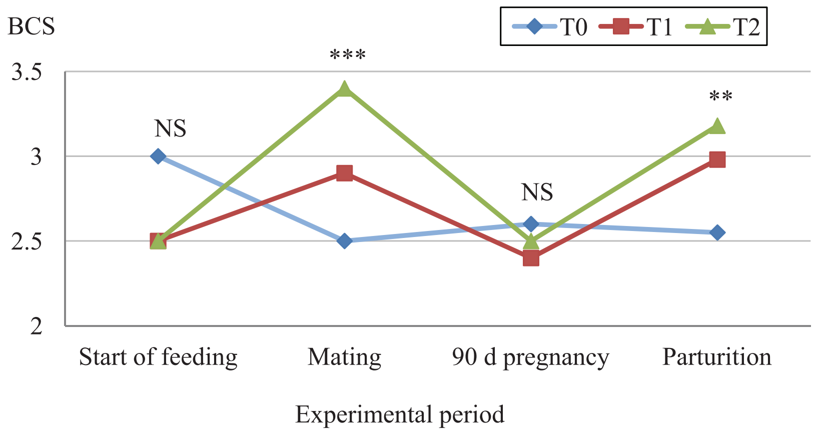

Figure 3 Body condition score (BCS, 5-point scale) of pregnant goats during the experimental period involving three different concentrated feed supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily). (** = $P < 0.05$; *** = $P < 0.001$; NS = Not significant.)

d, respectively, since the first mating and kidding of goats, respectively). The pregnancy rate and kidding rate of goats were improved by 17% (T_1) and 29% (T_2) and by 71% (T_1) and 83% (T_2) over the control, respectively.

The gestation length and other parturition parameters of the goats are presented in Table 3. A significant difference ($P < 0.05$) was observed between the treatment groups in the birth weight of kids and *post partum* dam weight (PPW) of goats.

DISCUSSION

In the current study, the low CP and high NDF values in the grass hay suggest that the basal ration used was low quality forage (Leng, 1990). The reduction in hay intake and

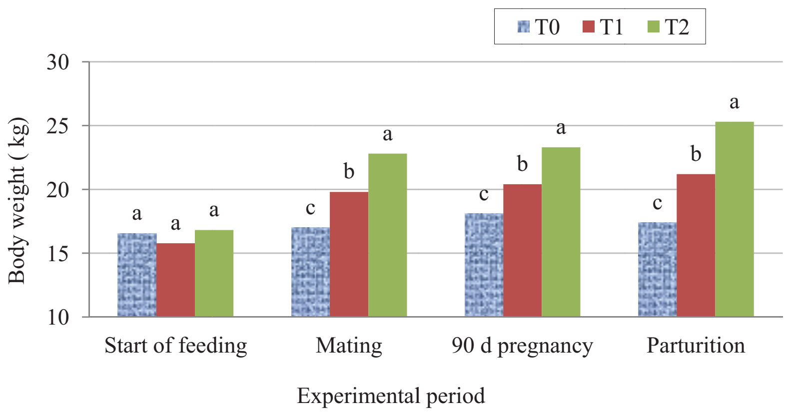

Figure 4 Body weight changes of pregnant goats during the experimental period involving three different concentrated feed supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily). Columns within each parameter with different letters (a-c) are statistically significant ($P < 0.05$).

Table 2 Reproductive activities of goats since time of estrus with three different concentrated feed supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily).

Parameter *	Treatment			*P*-value
	T_0	T_1	T_2	
Number of goats	15	15	15	
Goats in estrus	3	9	14	0.0307
Goats mated	3	9	14	0.0307
Goats anestrus	12	6	1	0.0082
Goats pregnant	2	7	12	0.0286
Goats aborted	1	1	1	1.0000
Goats kidded	1	6	11	0.0158
Abortion rate	50	14.3	8.3	<0.0001
Pregnancy rate	66.6	77.7	85.7	0.3095
Kidding rate	50	85.7	91.6	0.0013

* = Observed in the first service of goats.

the apparent increase in TDMI with increasing level of concentrate supplement could have been due to the substitution effect of the basal diet with the concentrate feed as reported by Kraiem *et al.* (1997). The significant increase in ADG values in the current study with meal concentrate supplementation could be associated with the greater DM and nutrient intake by the supplemented groups as a result of higher energy and protein levels in the concentrate supplement than in the basal feed.

Even though data on ADG values for female indigenous Ethiopian goats is limited, the ADG values obtained in the current study for growing female Woyto-Guji goats are comparable to the ADG values of 35 to 53 $g.d^{-1}$ reported for indigenous dairy type (Begait) female goats of Ethiopia under varying amounts of legume (vetch) hay supplementation (Berhane and Eik, 2006). These authors also reported ADG values of 28 to 46 $g.d^{-1}$ for indigenous meat type (Abergelle) goats of Ethiopia on a similar diet. Chentouf *et al.* (2011) observed post-weaning ADG values (mean ± SE) of 36.0 ± 6.0 and 20.0 ± 7.0 $g.d^{-1}$ for female adult Moroccan indigenous goats under high and low nutritional regimes, respectively.

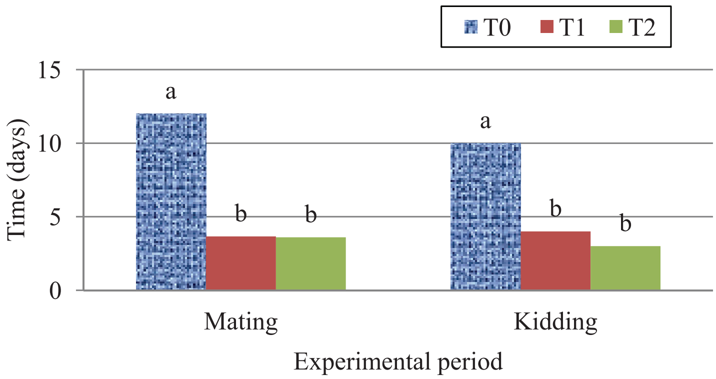

Figure 5 Mean variation in mating and kidding days (Day 0 = first mated and first kidded goats of all animals) for three different concentrate supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily). Columns within each parameter with different letters (a, b) are statistically significant ($P < 0.05$).

Table 3 Gestation length and parturition parameters of goats with three different concentrated feed supplement treatments (T0 = no concentrate, T1 = 200 g per goat daily, T2 = 400 g per goat daily)..

Parameter	Treatment			P-value
	T_0	T_1	T_2	
Gestation length (days)	135 ± 0.0	138 ± 2.3	136 ± 1.8	NS
Litter size (number of kids per doe)	1.0	1.0	1.0	NS
Kids birth weight (kg)	1.5 ± 0.01^c	1.8 ± 0.07^b	2.1 ± 0.08^a	0.0002
post partum Dam weight (kg)	17.4 ± 0.64^c	21.2 ± 0.83^b	25.3 ± 0.71^a	<0.0001

$^{a, b, c}$ = Values in the same row with different superscripts differ significantly at $P < 0.001$ level. NS= Not significant ($P > 0.05$).

In the current experiment, supplementation of concentrate before the breeding season enhanced the growth performance of the goats resulting in higher BW and BCS in the mating and parturition periods. Estrus, mating and kidding days of Woyto-Guji goats were also significantly affected concomitant with the changes in body weight and body condition of the goats. The BCS observed in the mating period in the current study was 2.5, 2.9 and 3.4 for the T_0, T_1 and T_2 treatment groups, respectively. It has been reported that goats should have a BCS (on a 5 point scale) of 2.5–4.0 for healthy reproductive functions (Villaquiran *et al.*, 2004), above 2 to maintain pregnancy (Mellado *et al.*, 2004) and 2.5–3 for the optimal ovulation rate (Iiker *et al.*, 2010). However, in the current study, body size differences may have also contributed to the variation in reproductive activities observed between the treatment groups.

In the current study, when the concentrate was discontinued after the mating period, the BW of the supplemented groups (T_1 and T_2) declined at a rate faster than the control (T_0). This could be the reason for the lack of significance in the BCS values between the treatment groups at day 90 of pregnancy even though at this period the supplemented (T_1 and T_2) groups had higher body weights than the control (T_0). This indicates that concentrate supplementation prior to the breeding period alone does not sustain the body condition of goats throughout pregnancy. However, with the resumption of the concentrate supplement after 90 d of pregnancy, the supplemented goats (T_1 and T_2 groups) regained body weight, having higher BW and BCS at the end of pregnancy and at parturition compared to the control, but without a significant difference in the BCS between the supplemented T_1 and T_2 groups.

The increase in the proportion of goats showing estrus in the current study can be associated with the higher BCS of supplemented goats (Bizelis *et al.*, 1990; Mukasa-Mugerwa, 1991; Meza-Herrera *et al.*, 2008). Dietary energy restriction/under nutrition during pre-breeding has been reported to affect negatively the proportion of goats showing estrus (Mani *et al.*, 1996; Kusina *et al.*, 2001).

The goats in the current study kidded starting from the end of September to early October. In southwestern Ethiopia, September to October is also the major kidding period for goats (Pastoral Community Development Project, 2008). The hot dry season occurs from December to February during which high mortality of animals has been reported (Pastoral Community Development Project, 2008). The variation in mating and kidding days observed in the current study is associated with the higher growth rate of goats since faster growth is related with higher BW and enhanced reproductive performance, that is, earlier attainment of sexual maturity and more intense estrus activity and earlier lambing or kidding when mated (Dyrmundsson, 1981; Boulanouar *et al.*, 1995). Earlier sexual maturity by 19 d has been reported for Moroccan indigenous goats with improved feeding (Chentouf *et al.*, 2011). In the dry tropical region of Africa, the benefit of early mating and kidding of goats is crucial in terms of ensuring high survival rates in kids and success in the *post partum* reproductive performance of goats (Hary, 2002).

The increase in pregnancy and kidding rates and the lower abortion rates in the concentrate supplemented groups compared to the control in this study could be due to improvement in the body weight and body condition of the goats. Ocak *et al.* (2006) also observed similar results with respect to pregnancy and kidding rates. Feed supplementation was also reported to sustain pregnancy during the dry season in Begait and Abergelle goats of Ethiopia (Berhane and Eik, 2006).

The higher kid birth weight and *post partum* body weight of goats observed in the concentrate supplemented groups would enhance the survival of kids and the performance of the does later in the *post partum* period (Berhane and Eik, 2006). However, in the current experiment, the variation in gestation period and litter size was not significant between the dietary treatments, although the level of nutrition and mating weights were reported to affect the gestation period and litter size in goats (Amoah *et al.,* 1996; Ali *et al.*, 2009).

The goats used in the current study were in their first parity and they were also purchased from pastoral herds where inadequate feed and water supply is common due to a marked seasonal variation in rainfall distribution (Admasu *et al.*, 2010). Thus, in spite of the concentrate supplement, this may have contributed to the lack of difference in the litter sizes of the goats since it has been reported that the parity of the dam (Devendra and Burns, 1983) and a reduced growth rate early in life influences the litter size (adult fecundity and fertility) in small ruminants (Mellado *et al.*, 2006; Gardner *et al.*, 2009). However, FARM-Africa (1996) reported 83% single, 16% twin and 1% triplet births for Woyto-Guji goat flocks in southwest Ethiopia. It has been also reported that litter size varies between 1.08 and 1.75 with an average of 1.38 for tropical breeds (Devendra and Burns, 1983).

CONCLUSION

In arid and semiarid areas of Ethiopia, recurrent drought and poor nutrition as a result of inadequate feeding are the major limiting factors for goat production. The results of the current study demonstrate that growth, pregnancy and the kidding rate of Woyto-Guji goats were significantly improved with concentrate supplementation. The higher body weight of kids and goats observed *post partum* with concentrate supplementation would enhance the survival of kids and the reproductive performance of goats later in the *post partum* period. The concentrate supplement prior to the breeding season may also offer benefits in promoting early mating and kidding of Woyto-Guji goats before the subsequent hot dry season of southwest Ethiopia.

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