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Effects of Nutrient Flushing on Production and Reproductive Performance of Teddy Goats (*Capra hircus*)

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Key words
Flushing, Birth weight, Body weight gain, Teddy goat

ABSTRACT

A study was conducted to assess the effect of flushing on reproduction performance (kidding type and fertility percentage) and production performance (birth weight, weaning weight of offspring and health of does). Eighty teddy does were randomly divided into two groups (n=40) viz T_1 and T_2 as control group and test group, respectively. Flushing ration 250 g and 500 g with crude protein 17.5 % and metabolizable energy 2.9 Mcal/kg was offered to does for one month prior and post breeding season (15 September-30 October). Does were weighed at the start of breeding season T_2 (BW=29.18±0.21kg) and T_1 (BW=28.93±0.53kg), respectively. All the does were sent for grazing of jantar fodder for four hours daily and were sheltered during the rest time in different pens with separate feeding during the whole experimental period. *Ad libitum* supply of fresh clean drinking water was made available round the clock. Exposed does were mated naturally and bucks were inducted to the exposed does for 30 minutes at morning and evening daily for teasing purpose to identify does in estrus, while separate them for breeding with enlisted buck. Mean values of Fertility rate and kidding rate in T_1 and T_2 were 75% vs 85% and 150% vs 176 % ($p<0.01$) showing significantly higher rate is in T_2 group. The birth weight and weaning weight of the kids in T_1 and T_2 group were 1.56±0.02 kg vs 1.87±0.04 kg and 9.0±0.21 kg vs 10.45±0.18 kg, respectively showing better results in group (T_2). Effect of flushing on type of birth was observed significant at Chi-square value of 9.138 p-value of 0.010 showing higher number of twin and triplet birth in test group. Furthermore, the study of growth of kids revealed a better Average daily gains in T_2 than in T_1 indicating the long term carryover effect of flushing on the body weight gains of teddy goat kids.

INTRODUCTION

Pakistan is blessed with a huge population of livestock including cattle, buffalo, goat and sheep approximately 184.4 million heads (Pakistan Economics Survey, 2017). Livestock is well adapted to subtropical environment, tolerant to endemic diseases and efficient converters of poor quality forages into valuable products like milk, meat, skin, hides, bone and blood (Younas and Yaqoob, 2005). There is an utmost need to increase the livestock production potential to fulfill the growing demands of ever increasing population for livestock products (Celik, 2019).

Pakistan stands at 3rd number with 72.4 million goat population after China and India, and is continuously increasing since the past 15 years producing 701 thousand tons of mutton in the previous year (GoP, 2017). The success of a sheep and goat business depends on the number of lambs and kids raised, weaned, and marketed each year. The percentage of ewes and does conceived early

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in the breeding season, the lambing/kidding and weaning percentages are some of the most important factors influencing profits in the sheep and goat business. In other words, production is equal to reproduction. Like sheeps, goats also have potential for multiple ovulations, but this ability may be reduced by insufficient nutrition supplied. Nutrition directly influences fertility through mechanisms such as the development of oocytes, egg-laying, and fetal survival. It indirectly affects such behavior through blood metabolites and hormones (Robinson *et al.,* 2006). Economically speaking, fertility and reproductive behavior are considered as the most prominent characteristics in livestock breeding. Moreover, they are regarded as the most important determining factors for the efficiency of livestock breeding, conservation of species and genetic advances (Ahmad Fazel *et al.,* 2014).

Since nutritional requirements vary throughout the reproductive cycle, strategic feed supplementation can also be an important tool to improve reproductive efficiency. Nutrition is generally recognized as a significant regulator of reproduction (Smith and Akinbamijo, 2000) and improvement in the nutritional status of the does particularly preceding mating (flushing) is known to increase fertility in small ruminants due to dynamic effects of nutrition on ovulation rate (Kusina *et al.,* 2001). Flushing ration usually contains high proteinaceous and high calorific values. This ration is offered to animals one month prior and post breeding season by which does not only fortify the nutritional deficiencies but also improve the fertility percentage, more does will be exposed to bucks and increase the kidding percentage. Flushing has also been reported to increase the body condition and weights of does, it does not only improve at mating (static effects) but also during their post-partum period (Titi *et al.,* 2008).

Pakistan has 25 recognized indigenous breeds of goat (Hasnain, 1985; Kuthu *et al*., 2013), and goats are thought as the chief source of income for Pakistan via production of meat, milk and skin (Zubair *et al.,* 2016). Population of teddy goats (*Capra hircus*) in Pakistan is 13.2 million heads (GOP, 2014). Among different breeds of goat, teddy goat also stands among famous breeds of goats in Pakistan. Home tract of teddy goat is Punjab province but it is also found in Azad Kashmir and northern parts of Pakistan due to docile in nature, small size, easy handling, and low feed intake. Teddy goats considered to have advantage upon all local breeds of goats to thrive in severe weather conditions of different environments (Kuthu *et al*., 2013). In tropical and subtropical areas of Pakistan, most of the teddy goats do not follow seasonal breeding pattern and breed round the year. This increase the difficulties of management in commercial flocks and high kid mortality have been observed during severe seasons. The progressive farmers have adopted hormonal therapies and controlled breeding pattern for specific seasons (once a year) for convenience in management. Small ruminants breed throughout the year, which result in overall poor survival of dams and kids, reduced reproductive and productive performances especially during late pregnancy and resulting kidding fall into periods with insufficient forage availability (Karikari and Blasu, 2009). Hence, breeding strategy is potentially advantageous both in terms of improved reproductive activity of the does and the growth performance of kids. So, present project was designed with objectives of accelerating reproductive activity of teddy goats and growth performance of kids. Here, we investigated the effect of flushing on production and reproduction performance in teddy goat, *Capra hircus*.

MATERIALS AND METHODS

The study was carried out at Livestock Production and Research Institute (LPRI), Bahadurnagar, Okara, Pakistan, that is situated at latitude 30° 48′ 4.97″ (North) and longitude 73° 26′ 54 (East), at an altitude of *105 m* (344 ft) above the mean sea level with area of 199km^2, average temperature 24.5°C. The least rainfall is about 2mm during October, with higher precipitation (Av 85mm) is in July.

A total of 80 healthy breedable teddy does (Av. age of 2-3 years) and a live body weight of 29±1 kg were randomly divided into two groups (T_1 and T_2) of 40 in each group. These animals grazed available fodder of berseem and jantar in nearby field area for four hours (9 am to 13 pm) daily then stall feeding with chopped fodder was provided in wooden feeding mangers available in the shed. All animal husbandry practices were adopted in routine. Availability of common salt was made ensured in the feeding mangers. Flushing ration was formulated (Table I) with crude protein 17.5% and metabolizable energy 2.8 Mcal/kg. Breeding season starting from 15 September to 30 October was selected for teasing of both groups of goats. This concentrate was offered @ 250 g and 500 g daily one month prior and post breeding season (15 August to 30 November) to T_1 and T_2 groups at morning time and fodder was provided ad libitum. On the commencement of breeding season (from 15 September), mating plan of experimental does was designed. Teasing of all exposed does was practiced for half an hour at morning and evening daily to identify the does showing estrus by making proper arrangements to avoid natural mating. Estral does were separated, marked and inseminated with bucks. Animal showing heat signs at morning were mated at same time and repeated at evening also with same buck and vice

versa. All non-pregnant animals were isolated and pregnant flock of both groups were provided half kilogram of ration named as goat ration (composition is given in Table I) one month prior and post kidding. All necessary arrangements and bedding were provided at kidding time, the birth weights of new born kids were recorded. Starter ration (composition given in Table I) and hay of Lucerne was also provided after 15 days of birth to kids to accelerate the growth. As parasitic diseases in animals cause production losses and several critical issues (Mehmood *et al.,* 2017; Zaman *et al.,* 2017; Ijaz *et al.,* 2018). So, all the animals were dewormed after every four months. Live weights of kids and their dams were recorded at fortnightly basis upto weaning (120 days). Following parameters were recorded in the current study.

Table I. Ingredient and chemical composition of Kid Starter Ration, Goat ration and flushing ration.

Ingredients (%)	Kid starter	Flushing ration	Goat ration
Maize grain (crushed)	22	30	14
Rape seed meal	-	5	-
Canola meal	2	5	2
Soya bean meal	9	-	4
Rape seed cake	7	-	5
Barley	3	-	-
Soya husk	6	5	12
Palm kernel cake	6	5	6
Gluten 60%	5	-	-
Gluten 30%	8	10	18
Wheat bran	22	25	24
Molasses cane	8	13	13
Min.mix + premix	2	2	2
Total	100	100	100
Chemical composition			
CP%	19.35	17.5	16.4
TDN%	76.00	76.35	73.2
Fat%	3.56	3.58	3.71
Fibre	6.67	4.79	6.2
Energy (ME, MCal/kg)	2.72	2.82	2.78
Ash%	7.10	6.52	6.90

The values are expressed as % age of dry matter unless otherwise stated. T_1 denote control group whereas T_2 denote the tested group. CP%, crude protein percentage; TDN%, Total digestible nutrient percentage; ME, metabolizable energy, (Mcal/kg DM)

Body weight of does at different physiological state at the start of trial, before flushing, at start of breeding season and at kidding were recorded. Type of birth *i.e.,* single, twin and triplet births were recorded to calculate their percentage. Conception rate, pregnancy rate and kidding percentages were calculated by following formulae:

$$\text{Conception Rate} = \frac{\text{Total number of does showed estrus}}{\text{Total number of does exposed to buck}} \times 100$$

$$\text{Pregnancy Rate} = \frac{\text{Total number of pregnant does}}{\text{Total number of does exposed to buck}} \times 100$$

$$\text{Kidding Percentage} = \frac{\text{Total number of kids born}}{\text{Total number of pregnant does}} \times 100$$

Birth weight of kids at birth were recorded and after then fortnightly basis until weaning.

Data of weight of dam (at breeding and at kidding), birth weight and weaning weight of kids were analyzed by using Student's t test at 5% probability (Snedecor and Cochran 1994) in MINITAB (version 16.1.1.0) and data of type of birth and pregnancy and kidding rate percentages of teddy goats were analyzed by chi-square test.

Table II. Effect of flushing on different parameters.

Parameter	Group	Mean	SE Mean	p-value
Weight of dam before a month of breeding (kg)	T_1	29.18	0.21	0.648
	T_2	28.93	0.53	
Weight of dam at breeding (kg)	T_1	29.52	0.14	0.001
	T_2	31.84	0.59	
Weight of dam at kidding (kg)	T_1	32.46	0.18	0.000
	T_2	37.08	0.63	
Birth weight of kids(kg)	T_1	1.560	0.027	0.000
	T_2	1.870	0.040	
Weaning weight of kids (kg)	T_1	9.00	0.21	0.000
	T_2	10.45	0.18	
Weight gain up to weaning(kg)	T_1	7.44	0.20	0.000
	T_2	8.58	0.18	
Av. daily weight gain (g)	T_1	49.00	0.29	0.000
	T_2	55.91	0.41	

T_1 denote control group where as T_2 denote the tested group. g and Kg represents gram and kilogram. All values are mean ± SEM.

RESULTS AND DISCUSSION

Table II shows effects of flushing ration on live weight of does at different physiological stages (at breeding and kidding). It has been observed that there

was a non-significant difference (p value=0.648) of live body weight of does before start of trial. But it has been observed that there was a significant ($p<0.05$) increase of live body weight of does in T_2 group (31.84±0.59 kg) than (29.52±0.14 kg) in group T_1 when flushing ration was provided which may be due to fortification of depleted body reserves and body score. The results of present study showed that the does fed on flushing ration @ 500 g gained higher body weight (2.32kg) as compare to does in control group. This gain in live body weight may due to positive energy balance. Results of present study are in line with Kia *et al.* (2011) who studied that increase in live body weight in three different breeds of sheep when given high (130 % of the metabolizable energy for maintenance) and moderate (70 % of the metabolizable energy for maintenance) nutritional supplementation for 6 weeks before mating with grazing on low-nutritive pasture. Naqvi *et al.* (2011) maintained sheep on pasture with low quality dry herbage along with nutritional supplementation and reported that during period of flushing nutritionally deprive ewes gained weight in an efficient and rapid way. Naqvi *et al.* (2016) reviewed the relationship between reproduction and nutrition, Furthermore, there is several nutritionally associated signals work as messengers fundamental in reproduction process (Hess *et al.,* 2005).

Table III. Reproductive performances of does.

Parameters	T_2	T_1	Chi-Square	p-value
Pregnancy rate (%)	85 % (34/40)	75 % (30/40)	1.23	0.001
Kidding rate (%)	176 % (60/34)	150 % (45/30)	1.31	0.001

T_1 denote control group whereas T_2 denote the tested group.

Table III shows significant ($\chi^2=1.23$, $p<0.05$) increase of pregnancy rates of does in T_2 group 176% vs T_1 group 150% when flushing ration was provided. It may be due to better health condition. There is an increase of 26% fertility in T_2 group of goat. Similarly, there was a significant ($\chi^2=1.31$, $p<0.05$) increase of fertility of does in T_2 group 85 % vs 75 % in T_1 group when flushing ration was provided which may be due to multiple ova shed in goat when flushing ration is given. There is an increase of 10 % in kidding rate when flushing ration was given at higher level. Muthuramalingam *et al.* (2014) observed similar findings of single, twin and triplet percentage 6.6 (2/30), 46.6 (16/30) and 40 (12/30) respectively in goat. Chaturvedi *et al.* (2000) reported that the conception rate was higher (79%) in flushed ewes as compared to that of non-flushed (66.7%). The percentage of kidding was higher in group T_2 might be attributed to their higher body weight gain than in the group T_1. The more percentage of ewes lambed was also reported (Anilkumar *et al.,* 2003) in ewes which weighed heavier at breeding (92.86 %) than in ewes weighed less at breeding (86.36%). Findings of present study are in agreement to that of Kulkarni *et al*. (2014) who observed that there was an increase of 10% in kidding rates in Osmanabadi goats when given extra supplementation of 250g/doe/day as compared to goats kept on farmer feeding practices. Prasad *et al.* (2016) also supported the findings of entire study and observed that kidding rate was higher (20%) in nutritionally flushed Malabari goats. Reproductive efficiency increased by flushing which boost the ovarian activities i.e., increase in folliculogenesis and higher ovulation rate. Nevertheless, it has been suggested that ovarian responses are dependent on availability of nutrients (De Santiago-Miramontes *et al.,* 2011). There are many factors, i.e., duration of flushing, quality and quantity of feed, condition score of animal and breeding season had an effect on ovulation and finally meant by number of kid produced (Hafez *et al.,* 2011). Moreover, De Santiago-Miramontes *et al.* (2009) described that activity of estrus and ovulation rate can be stimulated by a moderate to high and constant body condition. Rivas-Muñoz *et al.,* (2010) found that high protein diet can increase ovulation rate in ewes than high-energy ration. Naqvi *et al.* (2011) reported that feed supplementation or nutritional flushing before mating increases ovulation rates and lambing percentage in many sheep breeds. Acero-Camelo *et al.* (2008) did flushing of Merino breeds of sheep for three weeks and reported that 23% higher lambing rate. Chaturvedi *et al.* (2000) reported that the conception rate was higher (79.2%) in flushed ewes as compared to that of non-flushed (66.7%).

Table IV shows effect of flushing on birth type. There were higher twins and triplets percentage in T_2 group than T_1 group ($\chi^2=9.138$, $p<0.05$). This might be due to fact that flushing has effect on super ovulation of does. Consequently, more the ova produced more will be the twining and triplet percentage in goat. This indicates that flushing has influence on fecundity of teddy goats. The results are similar to those of Gunn *et al*. (1992), Kulkarni *et al*. (2014) and Prasad *et al*. (2016) who reported an increase in number of off-springs by flushing prior of does prior breeding. The twin and triplet birth in the Group T_2 was a clear indication of increased ovulation rate. The occurrence of higher ovulation rate might be correlated with higher body weight gain due to the increased level of concentrate supplementation. An increase of approximately 2 % ovulation rate for every kilogram increase in live weight at mating was recorded in Corriedale, Merino and Romney marsh ewes (Fraser and Stamp, 1987). The number of ova or eggs shed at normal estrus in ewes

Table IV. Effect of flushing on birth type of teddy goat kids.

Parameters	Variable		Groups		Total	Chi-square value	P value
			T_2	T_1			
Type of birth	Single	Count	9	15	24	9.138**	0.010
		% within groups	15.0	20.0	17.27		
	Twins	Count	42	30	72		
		% within groups	70.0	80.0	74.54		
	Triplet	Count	9	0	9		
		% within groups	15.0	0.0	8.18		
	Total	Count	60	45	105		
		% within groups	100	100	100		

T_1 denote control group where as T_2 denote the tested group.

can vary from one to as many as 9 to 10 (Owen, 1976). The increase twinning in concentrate supplemented group T_2 might be due to the higher body weight gain resulting into increased ovulation rate. The increase in litter size (due to twin birth and triplets) as a result of increased body weight due to concentrate supplementation in Horro ewes was also recorded (Galmessa and Prasad, 2002).

Significant differences among control and tested groups on birth weight of kids have been observed. The birth weight of the kids was higher ($p<0.01$) in T_2 (1.87±0.04 kg) than in T_1 (1.56±0.02 kg) as mentioned in Table **II**. The birth weight of kids born which were flushed was significantly higher ($p<0.05$) than that of control group indicating that good nutrition plane of the does prior to breeding can significantly improve the birth weight their kids. It was revealed that supplementation with 500 g of concentrate in group T_2 was beneficial with respect to birth weight of the kids, as the kids with higher birth weight has the higher prospects of survivability and also related with the future growth of the kids. Our findings are in line with Chaturvedi *et al*. (2006) who studied that there is an higher birth weight of lambs (3.47 kg) born from ewes received the concentrate diet @ of 1.5% of their body weight. Present findings were in agreement to Prasad *et al*. (2016) who reported that there was an increase of (1.08 kg) birth weight of Malabari kids due to flushing of does.

A significant difference among control and tested groups has been observed on weaning weight of the kids with the prevision of flushing ration to their dams. The weaning weight of the kids was higher ($p<0.01$) in T_2 (10.45±0.18 kg) than in T_1 (9.0±0.21 kg) (Table IV). Weight gain was calculated (weaning weight – birth weight). Av. daily weight gain of kids in T_2 (55.91±0.41g) observed was higher ($p<0.01$) than in group T_1 (49.00±0.29g). The findings are analogous to Idris *et al*. (2011) who reported a significant increase in the average. daily gain of lambs before weaning due to flushing of ewes prior to breeding. Our findings were similar to Prasad *et al*. (2016), who reported that there was higher gain (1.78 kg) of weight on weaning of eight week of Malabari kids. It can be concluded that the difference in the mean body weight is only because of the difference in the initial body weight. This indicates long-term carry over effect of flushing on the future body weight gains of kids.

CONCLUSION

From the results of current study, it can be concluded that the flushing has significant influence on the live weight and reproductive performance of teddy does as well as production performance of their kids.

Statement of conflict of interest

The authors declare no conflict of interest.

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