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RESEARCH ARTICLE

Effect of estrus synchronization with prostaglandin (PGF2α) hormone on reproductive performances of Bonga sheep ewes flushed with different local forages in Kaffa zone, Ethiopia

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Abstract

This study was conducted in Adiyo and Telo districts of Kaffa zone, aiming to evaluate the performances of Bonga sheep and their response to estrus synchronization flushed with indigenous feeds under different management conditions. Eight representative kebeles were purposively selected based on CBBPs and sheep population presence. From each kebele, the farmers with ewes were registered and 200 respondents were randomly assigned using Kothari, (2004). In the current study LI 9.4 ± 0.18 months, DO 20.2 ± 0.13 days and LS 1.4 ± 0.04 were obtained and LI was shorter (8.5 ± 0.22 months) in CBBP than 10.5 ± 0.28 months in non-participants. The BWT, WWT and 6 MWT were 3.8 ± 0.06, 16.0 ± 0.10 and 27.8 ± 0.33 kg and the values for PrWDG and PoWDG were136.0 gm/day and 133.0 ± 0.02 gm/day respectively. In the experimental study the onset and duration of estrus were 45.9 ± 2, 43.1 ± 2.37 and 48.0 ± 2.61; 45.6 ± 1.55 hours in short and long flushed ewes accordingly. Estrus response, conception, lambing rate and LS were 68, 70.59, 72.22%, 1.38 and 84, 83.3, 90% and 1.42 for short and long flushing sequentially. Flushing with indigenous feeds in long-term flushing presented better results regarding the positive manifestation of estrus, conception lambing rate, liter size and onset, and duration of estrus. Therefore, long term (28 days) flushing was an effective strategy to increase ewes' reproductive performance.

Keywords: Bonga sheep, Ewe flushing, Reproductive performance, Indigenous feed.

Introduction

In Ethiopia small ruminants account on average for 40% of the cash income and 19% of the total value of subsistence food derived from all livestock production (Mengesha, 2012). There are about 42.9 million heads of sheep, among which 70% of them are females and 30% are males (CSA, 2020/21). The sheep production system is ineffective due to different constraints such as shortage of feed and water, disease occurrence, parasite infestation, lack of genetic improvement, lack of market access and information (Eshetu *et al.,* 2018). Uncontrolled mating practices, which are mostly caused by conventional free grazing management methods, have a substantial detrimental influence on insufficient genetic resources and sheep productivity (Tezera, 2015). Due to this, farmers must be driven to maintain selective and productive breeds that can be achieved through the use of a regulated breeding program.

Nutrition influences fertility through mechanisms such as oocyte development, egg laying and fetal survival via blood metabolites and hormones (Ahmad and Hossein 2014). The main factors affecting sheep fertility, reproductively, and productivity are energy and protein sources in the diets (McDonald *et al.,* 2010).

According to Michael (2018), flushing causes ewes to ovulate. Flushing and supplementing actions are essential for meeting feed nutritional requirements and are also vital for improving reproductive success. It can help ewes to get more nourishment during the breeding season. Flushing the ewes can help in ovulation, conception, and embryonic implantation rates. It also improves the breed's reproductive performance by increasing the proportion of females who show estrus, increasing lambing rates by 10 to 20% and changing the breed's reproductive performance (Muluken and Jane, (2020) and Michael, (2018).

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Estrus synchronization has great roles in the reproductive process as it adjust breeding season, more ewes become on heat at the same time and easy of insemination to get offspring at the same time, to manage pregnant ewes easily (Mekuriaw *et al.,*2015 and Mueller *et al.,* 2019). Estrus synchronization and artificial insemination are not used in this industry, which is a major contributing factor to sheep's lower reproductive and productive performance (Begum *et al.,* 2014). This new technology was practiced in a few CBBP participants but not expanded as the potential of sheep (Muluken and Jane, 2020; Mekuriaw *et al.,* 2015). In addition to the technological difficulty, outdated management practices also have an impact on sheep productive performance (Mehmood *et al.,* 2011). The farmers feed these locally available feeds, but their nutrient compositions and potential on ewes' reproductive performance were not studied in the study area. Such challenges make to explore the use of reproductive technologies (estrus synchronization with artificial insemination and locally available feed for breeding. To overcome the above challenges and obtain the desired benefit from this breed, sheep productivity must be improved through reproductive technologies and proper management for the stock. The objective of the current study was to evaluate the reproductive as performances of Bonga sheep with estrus synchronization flushed with locally available feeds under different management conditions in Kaffa zone, Southwestern peoples regional state.

Material and Methods

Adiyo District

The study district is bordered on the north by the Gojeb River which separates it from the Oromia Region Telo on the South, Decha and Gimbo on the West and on the east by the Konta zone direction. Agro-ecologically Adiyo district consists of dega (highland), Woinadega (mid-altitude) and kola (lowland). It is located in 36° 47′E longitude and 7° 26′ N latitude with altitude ranging from 1250 to 3500 masl. Its maximum and minimum annual temperature is 36 and 38°C, respectively. Its rainfall ranges from 1800 mm to ≥ 2200, distributed from March to May and July to mid-October. The total domestic livestock population in the area is estimated to be about 2,593,202 out of which 819,879 (31.6%) is sheep population (KZFEO, 2020). The study was conducted in Boka-shuta CBBP based on its sheep population and its performance.

Materials used in the Study

The materials used in the study were measuring balance, plastic dish, saline water, contrast-phase microscopes which is made in Germany, slide, peppete, insemination sheath, glove, artificial vagina, ultrasound (Handheld Wireless Mini tub GmbH; Tiefenbach, Germany), ultrasound jelly, PGF2α hormone (Enzaprost®; France with manufacture date of 02/2020 and expired date of 02/2023 injectable solution with 50 ml, straw, conical graduated tube (to store the ejaculated semen from artificial vagina) and digital thermometer.

Animals Selection and Their Management

In this experimental study, 170 non-pregnant were identified purposively, among which 100 were selected from 100 CBBP participants using stepwise multistage sampling techniques. Non-pregnancy was detected by using CBBP data records and ultrasound (Handheld Wireless Mini tub GmbH; Tiefenbach, Germany). All experimental ewes were tagged for identification purposes. The experimental ewes were checked for health status and vaccinated against common infectious diseases, provided for internal parasites albendazole (300 mg at 1 bolus/30 kg body weight, Ashish life Science Pvt.Ltd., India), and were vaccinated against Ovine Pasteurellosis and Sheep and Goat Pox (National Veterinary Institute, Debre Zeit, Ethiopia).

The ewes were injected with 1-mL of PGF2α hormone in each flushing round to initiate the ewes in estrus. That means ewes were injected two rounds starting from the beginning of the experiment which means 50 ewes assigned in short flushing were injected with PGF2α at first (1^{st}) and eleventh (11^{th}) days and then inseminated at the fourteenth (14^{th}) days of flushing. In case of long flushing, 50 ewes also injected with PGF2α at 1^{st} and 28^{th} days of the experiment. The protocols used for this study was double injection for both short and long flushing.

Feed Preparation and Feeding Procedures

The feeds used in this experiment were *Pennisetum glaucifolium* hay, *Bsella alba* (*Nopho*), *Thunbergia alata boj. ex.simson (Imamo), Pentas schimperiana vatke (Nachbuto),* and concentrate mix with basal diet of *ad libtum* Table 1. The experimental feeds were harvested and collected from the farmers around the study area. The feeds were dried in the shade to reduce moisture. Commercial mixed concentrates was purchased from Addis Ababa oil and milling factory. The feed finally offered to the experimental ewes. Adequate supplies of the experimental feeds were stored daily for use during the whole study period. All ewes were fed on the experimental feeds for adaptation for 21 days (Assefu, 2012) before commencement of the actual experiment. As soon as the adaptation period ended, experimental feeds were given for flushing with an *adlibtum* of hay.

Experimental Design and Treatments

The experiment was conducted by using a randomized complete block design (RCBD) with five treatments Table 1. Ewes were blocked based on their parity as parity (1, 2, 3, 4 and ≥5) into five blocks consisting of 20 ewes in each block and the same parity with in treatment group. The parity of these ewes was obtained from Boka Shuta CBBP. Ewes within

Table 1: Experimental treatment

Treatment	Basal diet grass	*PGH (gm)*	*BA(gm)*	*TA(gm)*	*PS(gm)*	CM(gm)	N
T1	*Ad libtum*	1000		0	0	0	20
T2	*Ad libtum*	0	1000	0	0	0	20
T3	*Ad libtum*	0	0	1000	0	0	20
T4	*Ad libtum*	0	0	0	1000	0	20
T5	*Ad libtum*	0	0	0	0	500	20

the block were randomly assigned to five feed treatment groups, and the party was the same in the treatment group. The five treatments groups were: control group T1 (fed on *Pennisetum glaucifolium* hay + *ad libtum*), T2 (fed on 1000 gm *of Basella alba+ ad libtum*), and T3 (fed 1000 gm of *Thunbergia alata boj.ex*. *Simson+ ad libtum,* T4 (fed on 1000 gm of *Pentas schimperiana vatke + ad libtum*) and T5 (fed 500 gm commercial mixed concentrate +*ad libtum*) per day. The basal diet offered for experimental ewes was 1000 gram of grass hay. Experimental feeds for each treatment was offered in two equal portions twice a day at morning (from 2:30–3:00 o'clock) and afternoon (from 10:30–11:00 o'clock) in local time. Experimental ewes allowed to access water freely. Feeding was conducted for 14 days for short flushing and 28 days for long flushing (Table 1).

N=number of ewes; PGH= *pennisetum glaucifolium* hay BA=*basella alba*, TA= *thunbergia alataboj.ex simson*, PS= *pentas schimperiana vatke*, CM=commercial mix, gm= gram,

Measurements and Observations

Heat detection, semen processing, insemination and pregnancy diagnosis

After injection of prostaglandins hormone (PGF2α), ewes were observed for behavioral estrus manifestation for an hour two times daily for about 3 to 4 consecutive days. The owner of the experimental ewes was trained about how to identify estrus signs and how to manage the experimental ewes with special attention and then in each part of the study, behavioral observations were observed every day at the morning starting from 3:00 o'clock, afternoon starting from 8:00 o'clock to evening in local time. Ewes considered being in estrus when they show estrus signs such as vigorous tail-wagging, reddened and swollen vulva, clear mucus discharge, restlessness, frequent bleating and frequent adoption of urination.

Chemical analysis of experimental feeds and feed intake of ewes

Representative composite samples of feed were collected and dried in an oven to constant weight and milled to pass through a 1 mm sieve screen size and analyzed in ILR by following internationally accepted procedures of chemical composition analysis as it referred below. Determination of chemical composition DM, Ash, and CP was performed following the procedure of (AOAC, 1990). The samples was milled or ground and kept in airtight containers in the Animal Nutrition Laboratory. Acid detergent fiber (ADF), neutral detergent fiber (NDF), and acid detergent lignin (ADL) components of each ingredient was determined according to the procedures of (Van Soest and Robertson, 1985). The crude protein (CP) was estimated by multiplying N with a factor of (N* 6.25 and OM by subtracting ash from 100.

Statistical Analysis of Data

The data was collected and entered to Microsoft Office Excel 2010 computer software. The experimental data (feed intake, time to onset and duration of estrus) were subjected to general linear model (GLM) procedures of SAS 9.3 and used to compare means within treatment groups. Any significant difference among the means was separated by least significant difference (LSD). Experimental variables such as estrus response, pregnancy rate and lambing rate were expressed in percentages.

The statistical model: - $Y_{ij} = \mu + T_i + B_j + e_{ij}$

Where: Y_{ij} = response variable

μ = overall mean

$T_{i=}$ treatment (feed) effect

B_j= block effect,

e_{ij}= random error

Results And Discussion

Chemical Composition of Experimental Feed

Chemical composition of feed used in this experiment was presented in (Table 2). The CP content of the grass hay used in the present study was very low, below the maintenance requirement of the sheep (Van Soest, 1994). This implies that the *desho* grass hay (PGH) is of the poor-quality revealing the necessity of supplementary feeding for animals. The nutrient content of *Basella alba* was DM (93.80%), CP (19.20%), and ME (8.70%). The current result was in line with the report by Takele *et al.,* (2014) who reported the nutrient compositions of *V. amygdalina* were 94.24% of DM and 19.25% of CP. *T. alata* has 92.40% of DM, 22.20% CP and 8.50% ME and *Pentas schimperiana*has 91.60% DM, 15.10% CP and 9.00% ME. This result obtained for DM and CP for TA and PS was in agreement with the finding of owen and Amakiri, (2011) who reported *V. amygdalina* has 86.40% DM, 21.50% of CP. The nutrient composition difference was might be due to the nature and potential of the feeds to avail the desired nutrient composition. This result indicates *Thunbergia alata* has highest CP content followed by *B. alba* but ME was highest in *Basella alba* followed by *T. alata*. The CP content of experimental feeds *basella alba*, *T. alata* and *P. Schimperiana* was highest to the CP contents of *P. glaucifolium* hay as reported by (Hagos, 2011 and Melese, 2012) 10.90, 9.90, 9.85 and 9.89% respectively, but much higher than the values of 7.90, 7.56 and 7.20% obtained by Lemma *et al.,* (2018) and Tekleyohannes *et al.,*(2013). The variation in chemical compositions reported in different studies indicates that nutritional contents among the feeds might be due to

Table 2: Chemical composition of feed used in the experiments

	Chemical composition of experimental feeds							
Feeds	*DM*	*OM*	*CP*	*Ash*	*NDF*	*ADF*	*ADL*	*ME*
T1(PGH)	92.50	85.00	7.04	15.56	69.20	44.90	5.40	5.90
T2(BA)	93.80	88.60	19.20	3.42	49.30	32.60	9.10	9.70
T3(TA)	92.40	88.70	22.20	2.42	32.30	34.80	13.00	8.50
T4(PS)	91.60	92.40	15.10	11.18	38.70	41.50	14.60	9.00
T5(CM)	92.80	89.40	23.80	8.90	36.20	21.80	3.00	10.90

PGH= *Pennisetum glaucifolium* hay; PS=*Pentas schimperiana;* BA=*Basella alba*; TA=*Thunbergia alata*; CM= concentrate mix; DM = dry matter; CP= crude protein; NDF= neutral detergent fibre; ADF= acid detergent fiber; ADL= acid detergent lignin; OM= organic matter; DOMD = digestible organic matter in the dry matter; ME = metabolizable energy;

variations in species, variety, soil fertility, climate, and stage of maturity at cutting and post-harvest management. Also, hay preparation and storage management differences and advance in the maturity of grass from which the hay was prepared is usually associated with low CP and high NDF and ADF content. According to (NARC, 1998), the nutrient requirement of sheep, the experimental feeds have adequate nutrients to meet the requirements for breeding except the control group.

Dry Matter and Nutrient Intake of Bonga Ewes

Dry matter and nutrient intake of Bonga ewes fed hay and supplemented with different indigenous feeds and concentrate mixture was presented in (Table 3). Feed intake is the weight of feed consumed by an animal or group of animals in a given period of time during which they have free access to feed. There was highly significant (p<0.01) difference in total dry matter intake among treatments with the highest value (1030.10 g/day/ewes) recorded for T5 (CM) followed by T2 (BA) with TDMI of 1016.00 gm/day/ewes and the least values (881.50 gm/day/ewes) recorded for T1 (control group). Total daily DM intake showed an increasing trend with increasing level of ME in treated feed staffs..

Table 3: Dry matter and nutrient intake of Bonga ewes fed hay and supplemented with different indigenous feeds and concentrate mixture.

	Treatment						
Ingredients	*T1*	*T2*	*T3*	*T4*	*T5*	*MSE*	*SL*
Hay DM gm/day	881.50	347.90	426.70	399.10	531.10	-	-
Supplement gm/day	0	668.10	477.70	511.90	499.00	-	-
Total DMI gm/day	881.50^{b}	1016.00^{a}	904.40^{b}	911.00^{b}	1030.10^{a}	4.54	0.00
OM	749.20^{c}	863.05^{a}	768.90^{b}	774.40^{b}	875.50^{a}	3.85	0.01
CP	70.00^{c}	192.00^{b}	222.00^{b}	251.00^{ab}	295.00^{a}	0.32	0.00
NDF	610.00^{c}	703.00^{a}	625.90^{b}	630.60^{b}	712.70^{a}	3.14	0.01
ADF	395.90^{c}	456.20^{a}	406.10^{b}	409.00^{b}	462.60^{a}	2.04	0.01
ADL	47.60^{b}	54.90^{a}	48.80^{b}	49.20^{b}	55.60^{a}	0.24	0.01
ME	5.90^{c}	9.00^{a}	8.50^{b}	8.70^{ab}	9.40^{a}	0.02	0.00

PGH= Pennisetum glaucifolium hay; PS=Pentas chimperiana BA=Basella alba; TA=Thunbergia alata; CM= concentrate mix; DM = dry matter; CP= crude protein; NDF= neutral detergent fibre; ADF= acid detergent fiber; ADL= acid detergent lignin; OM= organic matter; ME = metabolizable energy; *** = indicates highly significant difference between treatments; mean values with different superscripts differ significantly; SL= significant level;

From the experimental feeds the highest TDMI was obtained in T2 (BA) followed bay T4 (PS) with 911.00 gm/day of TDMI as compared with T5 (CM). This result indicates T2 (BA) was comparable with T5(CM) and it can replace the concentrate mix for enhancing the reproductive performance of ewes. The best result reported for this feed was due to its good ME content, which enable the ewes to perform ewes in estrus synchronization; hence energy feed was important for flushing. As a result, BA (T2) shows best reproductive performance in this study as it compared with other experimental feeds.

Onset and Duration of Estrus in Study Area

Onset of estrus on short and long-flushed ewes

The onset and duration of estrus in study area was presented in (Table 4). In short flushed ewes, onset of estrus has highly significant (p<0.01) difference among all treatment groups and control feeds. This result was in agreement with the finding of Shamble, (2017) who reported a significant difference on onset of estrus on Begait sheep breeds in Tigray, northern Ethiopia. The significant difference was might be due to different factors like environmental conditions of the study area, the performance of the studied breed, and management provided for experimental sheep and it might be due to the variation in nutritional composition of the treatment feed. The present study result indicates T2 (BA) has best time to become onset of estrus at 37.0 ± 3.10 hours followed by T3 (TA) 46.6 ± 3.04 and T4 (PS) 62.0 ± 4.10 hours. The onset of estrus observed on ewes feed on T2 (BA) was better than (56.8 ± 6.60) hours on ewes fed on control feed T1 (PGH) and it was comparable with T5 (CM) 35.0 ± 3.00 hours. This result obtained for onset of estrus in short flushing indicates T2 (BA) has potential nutritional composition, leading the ewes to come in earlier estrus.

The result obtained in current study indicates onset of estrus for ewes feed on T2 (BA) has shorter hours than the result reported by Tezera, (2015) who found 50.10 hour onset of estrus for local sheep breed fed on local feed in south Wollo zone; Amhara region but comparable with the report of Shambel, (2017) in Tigray, northern Ethiopia who reported 33.4 ± 3.10 hours for Begait sheep breed. This difference might be due to different factors in the study area like the, environmental condition, genetic makeup of the study sheep, management practice provided for experimental sheep. *B. alba* (T2) was the right feed to get best onset of heat followed by T5 (CM) for short flushing. In long-flushed ewes there was highly significant (p<0.01) difference among treatment groups and control feeds on onset of estrus. This result was in agreement with the finding of Shamble, (2017) who reported significant difference on onset of estrus on Begait sheep breeds in Tigray, northern Ethiopia. Present study result indicates T2 (BA) has the fastest 33.0 ± 0.90 hours to become onset of estrus followed by T4 (PS) 47.1 ± 5.60 hour. Similarly, regarding the onset of estrus, results were consistent with those reported by Martínez-Ros *et al.,* (2018), who obtained onset of estrus presentation at 33.8 ± 4.00 hours. The onset of estrus observed on ewes feed on T2 (BA) was better than ewes fed on control feed T1 (PGH) with 61.0 ± 6.90 hours of onset response of estrus and it was similar with the result obtained from T5(CM) 32.6 ± 1.70 hours. The result obtained for onset of estrus in long flushing indicates T2 (BA) has the potential nutritional composition to improve the reproductive performance of ewes by fastening the time to become onset of estrus. The result obtained in current study indicates onset of estrus (heat) for ewes feed on T2 (BA) has shorter hours than the result reported by Tezera, (2015) who found 50.10 hour for local sheep breed feed on local feed in south Wollo zone; Amhara. Similarly, Hashem *et al.,* (2015) reported 50.4 ± 7.30 hour of onset of estrus for Menz and Awass crossbred sheep. This difference might be due to environmental factors in the study area, genetic potential of the study sheep, and the management practice provided for experimental sheep.

Duration of estrus on short and long flushing

In short-flushed ewes, the estrus duration has a significant (p<0.01) difference among treatments and control feeds Table 4. This was in agreement with the report of Tezera, (2015) who reported a significant difference for duration of estrus among the treatment of his study for local sheep breed in south Wollo zone, Amhara region. As noted in current study T2 (BA) has the longest (51.7 ± 5.00) hours for duration of estrus followed by T4 (PS) 49.3 ± 6.30 hours of estrus duration in experimental ewes and this result was the comparable result with T5 (CM) with 60.3 ± 4.90 hours of estrus duration. The control feed T1 (PGH) has the shortest (33.8 ± 0.90) hours of estrus duration hence it has under nutrient requirement of ME in its nutritional composition. The highest estrus duration obtained in this study was comparable with in range of estrus duration between 18.00 and 72.00 hours reported by Hashemi *et al.*, (2015). When the duration of estrus increases the chance of mating also become increases, so these treatment feeds were comparable enough with commercial mixed concentrates to attain proper breeding.

Highly significant (p < 0.01) difference was observed between treatments and control feeds on duration of heat in long flushing. This result was in agreement with the report of Tezera, (2015) who reported significant difference for duration of estrus among treatment of his study for local sheep breed in south Wollo zone, Amhara region. Current study result indicates duration of estrus was longest (47.7 ± 3.90) hours in T3 (TA) followed by T2 (BA) 45.6 ± 3.60 hours and this result was inconsistence with result obtained from control feed T5 (CM) which has 54.6 ± 1.50 hours of estrus duration on long flushing. The control feed T1 (PGH) has the lowest 36.0 ± 3.40 hours of estrus duration due to its lowest nutritional composition which facilitates best reproductive performance of ewes.

Reproductive performance of Ewes in Short and Long Flushing

Estrus response of ewes

The reproductive performance of ewes with treatment feed was presented in (Table 5). In short flushed ewes, the estrous response was higher (80.00%) in T2 (BA) than 60.00% in both T3 (TA) and T4 (PS). The estrus response obtained for T2 (BA) was lower than T5 (CM) which has 90.00% of estrus response and higher estrus response rate was observed in all the treatment groups than controlled group T1 (PGH) 50.00%. The result difference obtained in experimental feeds might be due to the nutrient composition of the feed. Hence *B. alba* has highest ME, it has good performance in ewes fertility as compared with other experimental feeds, including a control group.

Table 4: Onset and duration of estrus on short and long flushing

	Treatments						
Parameters	*T1(PGH)*	*T2(BA)*	*T3(TA)*	*T4(PS)*	*T5(CM)*	*Test*	
	Mean ± SE	*Mean ± SE*	*Mean ± SE*	*Mean ± SE*	*Mean ± SE*	*F-value*	*p-value*
Short flushing							
Onset of estrus (hour)	56.8 ± 6.60^{c}	37.0 ± 3.10^{a}	46.6 ± 3.04^{b}	62.0 ± 4.10^{cd}	35.0 ± 3.00^{a}	9.17	0.00
Duration of estrus (hour)	33.8 ± 0.90^{cd}	51.7 ± 5.00^{b}	37.3 ± 3.01^{c}	$49.3 \pm 6.30b^{c}$	60.3 ± 4.90^{a}	5.07	0.00
Long flushing							
Onset of estrus (hour)	61.0 ± 6.90^{d}	33.0 ± 0.90^{a}	50.7 ± 4.00^{c}	47.1 ± 5.60^{b}	32.6 ± 1.70^{a}	8.51	0.00
Duration of estrus (hour)	36.0 ± 3.40^{d}	45.6 ± 3.60^{b}	47.7 ± 3.90^{b}	40.4 ± 1.60^{c}	54.6 ± 1.50^{a}	6.31	0.01

N = number of total ewes; n= number of ewes in each treatment; superscript letter indicates significance differences among experimental feeds; PGH= *Pennisetum glaucifolium* hay; PS= *Pentas schimperiana* BA=*Basella alba*; TA=*Thunbergia alata*; CM= concentrate mix; mean values with different superscripts indicates significantly different;

The result obtained for estrus response in current study was higher than the report of Tezera, (2015) who found 66.60% estrus response for local sheep breeds in south Wollo zone; Amhara region and similarly Mekuriaw *et al.,* (2015) found that estrus response rate of 65.00% for Menz and Awass cross bred sheep. Contrary Nasroallah *et al.,* (2012) reported 93.30% estrus response for Barki ewes.

The estrus response rate was higher 90.00% in T2 (BA) and T4 (PS) as compared to T3 70.00% in long flushing. Low estrus response obtained in control group T1 (PGH) 60.00% was an indication of their poor nutritional status as they were under nutrient requirements. The result difference obtained in experimental feeds might be due to the nutrient composition of the feed. The highest result obtained in this study was higher than the finding of (Hashem *et al.,* 2015), who reported estrus response rate ranges 58.80% for Menz and Awass crossbred sheep. The result variation among different researcher might be due to environmental conditions, management practices of study areas or genetic potential of the study ewes. Long-flushed ewes show the highest estrus response as it compared with short-flushed ewes. So that using these experimental feeds for reproduction under long flushing was important.

Conception Rate of Ewes

In short flushing conception rate was highest (75.00%) in T2 (BA) followed by 66.60% and 50.00% in T4 (PS) and T3 (TA), respectively Table 5. The conception rate obtained for T2 (BA) was lower than 88.89% in T5 (CM) and higher than control group T1 (PGH) which has 60% conception rate. The result difference between experimental feeds was might be due to the difference in nutrient composition that they have and the efficiency of ewes to convert the feed ingredients. The result of conception rate obtained in this study for T2 (BA) was higher than the report of Shambel *et al.* (2020) who found that the conception rate of 46.58% for Ethiopian highland sheep in Amhara region. But it was lower than the finding of Shambel, (2017) who report conception rate was 83.30% for Begait ewes in Tigray, northern Ethiopia. The result variation among different researchers might be due to management, and environmental conditions of the study area. So that proper management and feeding with appropriate environment was important for ewes to conceive effectively.

In long flushed ewes the higher (88.89%) conception rate was obtained in T2 (BA) as it compared to 85.71 and 77.78% in T3 (TA) and T4 (PS), respectively. The highest conception rate observed for T2 (BA) was comparable with T5 (CM) which has conception rate of 90% in long-flushed ewes and it was higher than control group T1 (PGH).

The lower (71.43%) conception rate obtained in the control group was due to the low nutritional composition of the feeds offered for this group. It indicates it was under the ewe's nutrient requirement, which never can meet their nutrient requirements. This is the result of increased levels of nutrition on the blood concentrations of reproductive and metabolic hormones in the ewe and some of the intraovarian changes that take place in response to stimulation of nutrition.

Table 5: The reproductive traits estrus response, conception, lambing rate of ewes nutritionally flushed with indigenous forages

	Parameters (N=100)		
Treatments	*Estrous response (%)*	*Conception rate (%)*	*Lambing rate (%)*
	Short flushing		
T1(PGH)	50.00	60.00	50.00
T2(BA)	80.00	75.00	80.00
T3(TA)	60.00	50.00	50.00
T4 (PS)	60.00	66.67	50.00
T5(CM)	90.00	88.89	85.71
	Long flushing		
T1(*PGH*)	60.00	71.43	66.67
T2(BA)	90.00	88.89	85.71
T3(TA)	70.00	85.71	100.00
T4 (PS.)	90.00	77.78	83.33
T5(CM)	100.00	90.00	100.00

N= Total number of ewes; PGH= *pennisetum glaucifolium* hay; PS= *pentas Schimperiana* BA=*basella alba*; TA=*thunbergia alata*; CM= concentrate mix;

The result of conception rate obtained in this study for T2 (BA) was comparable with the finding of Shambel, (2017) who reported conception rate was 83.33% for Begait ewes in Tigray, northern Ethiopia and it was higher than 77.75% of conception rate which reported by Muluken and Jane, (2020) for the same breed. The result variation among different authors might be due to the management, environmental, and genetic potential of the studied breeds. The result variation within the same breed was an indication of the increasing performance of Bonga ewes. The conception rate in long flushing has an interesting result than short flushing. This indicates that for ewes feed long time there might be a change in their inter-ovarian and other reproductive organs that leads them to conceive higher than that in short flushing.

Lambing rate of ewes

In short flushing lambing rate obtained from this study was ranged between 50 and 85.71% in all treatment groups and higher (80.00%) in T2 (BA) than T1 (PGH), T3 (TA) and T4 (PS). This result obtained for T2 (BA) was higher than 75.60% of lambing rate observed by Koyuncu, (2010), similarly Mekuriaw *et al.,* (2015) reported 58.30% lambing rate for Menz and Awass cross sheep breeds. Contrary it was lower than the finding of Tezera (2015) who reported 90.13% of the lambing rate in south Wollo zone; Amhara region for local sheep breeds. Different factors to be considered for this result difference among different researchers might be due to external and internal factors like management of experimental feeds, management, environmental conditions, and genetic potential of the breeds Table 5.

In long-flushed ewes the highest (100%) lambing rate was observed in T3 (TA) followed by T2 (BA) and T4 (PS) with a lambing rate of 85.71 and 83.33%, respectively and it is comparable with T5 (CM) which shows 100% of lambing rate. The lambing rate was lower (66.67%) in control group T1 (PGH). This difference is might be due to the variation in nutrient composition of the experimental feeds hence it plays role on the development of fetus.

Conclusions and Recommendations

Flushing and steaming up has advantageous in correcting the nutrient deficit in natural pastures and improving the reproductive performance of sheep. Flushing with potential indigenous forage species in ewes inseminated was confirmed to have the potential to improve reproductive performance. Long-term (28 day) flushed ewes show good reproductive performance than short-term (14 days) flushed. The reproductive performance of experimental ewes in comparison of potential locally available feed and then estrus response, conception and lambing rate of the ewes in long flushed ewes show progressive result. Long-term flushing presented better results regarding the positive manifestation of estrus, conception lambing rate and onset, and duration of estrus. Therefore, long-term (28 days) flushing with *B. alba* is an efficient strategy to reduce nutrient deficiency and increase the reproductive performance of ewes.

Availability of data and materials

Data used and analyzed for this study are available from the corresponding author on reasonable request.

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Author's contribution

Habtamu Arega and Worku Masho:- designed experiment and collect, edit, analyze and interpret data. Write first draft of the manuscript. Elias Bayou and Regasa Begna:- edit the manuscript

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