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Reproductive Performance of Multiparous Ewes with Different Flushing Ration Management

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ABSTRACT

This study evaluated the reproductive performance of multiparous ewes under various flush management strategies. A total of 16 multiparous ewes were utilized in a 4 x 4 randomized group design. The treatments included P1: no flushing; P2: flushing before and after mating; P3: flushing before and after mating and at mid-pregnancy; P4: flushing before and after mating, at mid-pregnancy, and at the end of pregnancy. The observed variables included the percentage of pregnancy, number of embryos, embryo diameter, amnion diameter, embryo durability, number of offspring, and duration of pregnancy. The findings indicated that the management of flushing rations affected both the pregnancy rate and the amniotic diameter. No significant differences were observed between treatments regarding the number and diameter of embryos, gestation length, number of offspring, and embryo lifespan (P>0.05). This study concluded that managing flushing rations affects reproductive performance regarding pregnancy rate and amniotic diameter.

Keywords: local sheep, reproductive performance, diet flushing

ABSTRAK

Penelitian ini bertujuan mengevaluasi performa reproduksi induk domba lokal multipara dengan manajemen *flushing* yang berbeda. Penelitian menggunakan 16 ekor domba betina multipara dengan Rancangan Acak Kelompok 4 x 4. Perlakuan terdiri atas P1 = Tanpa ransum *flushing*, P2 = ransum *flushing* sebelum dan setelah kawin, P3 = ransum flushing sebelum dan setelah kawin serta tengah kebuntingan, P4 = Ransum flushing sebelum dan setelah kawin, tengah serta akhir kebuntingan. Peubah yang diamati adalah persentase kebuntingan, jumlah embrio, diameter embrio, diameter amnion, daya tahan embrio, jumlah anak, dan lama kebuntingan. Hasil penelitian menunjukkan manajemen ransum *flushing* memengaruhi angka kebuntingan dan diameter amnion. Jumlah dan diameter embrio, lama kebuntingan, jumlah anak, dan daya tahan embrio tidak berbeda antar perlakuan (P>0.05). Penelitian ini menyimpulkan manajemen ransum *flushing* memengaruhi performa reproduksi pada angka kebuntingan dan diameter amnion.

Kata kunci: domba lokal, performa reproduksi, ransum flushing

INTRODUCTION

Local ewes in Indonesia have successfully adapted to the tropical climate and exhibit prolific genetic traits, specifically the capacity to give birth to multiple lambs per pregnancy. The prolific genetic traits enhance population growth for farmers; however, their expression is often limited by insufficient nutrient intake among the ewes. Lamb mortality rates are notably high, at 18.75% (Astuti et al. 2008), attributed to ewes consuming solely pasture during pregnancy. Insufficient nutrient intake in ewes impacts the body condition score (BCS), resulting in competition among fetuses for nutrients (Astuti et al. 2022). Enhancing feed quality is crucial for supporting pregnant ewes and maximizing reproductive success.

Flushing feed management is one way to improve the feed quality for ewes. Flushing rations enhance livestock conditions by providing high-quality feed, which prepares them more effectively for reproduction (Rohmah et al. 2017). The administration of protein-rich flushing feed can improve BCS before mating, increase the number of follicles, and support embryo growth (Aidismen et al. 2018). The administration of flushing feed during pregnancy enhances BCS by providing additional energy and protein that support fetal growth and prepare for lactation (Tesfaye et al. 2023).

The administration of flushing at the end of pregnancy may enhance fetal development and increase birth weight (Tesfaye et al. 2023). The study by Nurlatifah et al. (2020) on female sheep, which were fed a flushing diet for three weeks that included sunflower oil and lemuru fish oil at the beginning and end of pregnancy, indicated an increase in fat consumption. This increase may contribute to prostaglandin biosynthesis, essential for fertilization and the birthing processes in livestock. Research on flushing ration management is typically limited to periods before and after mating and at the conclusion of pregnancy. Therefore, additional studies are necessary to identify the optimal timing for flushing management.

Aidismen et al. (2018) indicate that flushing management can be implemented prior to mating, during the mid-pregnancy phase, and at the end of pregnancy. Additional research is required to assess various flushing management practices before and after mating, during mid-pregnancy, and at the end of pregnancy, as their impact on reproductive performance remains unclear. This study evaluates the impact of flushing diet management before and after mating, during pregnancy, and at the end of pregnancy on the reproductive performance of multiparous ewes.

MATERIALS AND METHOD

The procedures in this study were approved by the Animal Ethics Committee of the Faculty of Veterinary Medicine, IPB University, No. 119 - 2018 IPB.

Research Livestock

This study involved 16 multiparous female sheep, aged approximately 16 to 20 months, with an average body weight of 29.77 ± 5.87 kg and a coefficient of variation of 19.71%. The sheep were organized into four treatment groups, each with four replicates. Body weight was classified into four categories: very light, light, medium, and heavy. The sheep were housed in separate pens, each containing feeders and water containers.

Research Rations

The ration was given as fresh napier grass (*Pennisetum purpureum*) and concentrated. The concentrate consisted of soybean meal, cassava, pollard, lemuru fish oil, palm oil, molasses, $CaCO_3$, premix, and salt. This study utilized two types of concentrates: flushing concentrate and control concentrate. Table 1 presents the composition of the flushing and control rations expressed as 100% dry matter.

Livestock Maintenance

The sheep were randomly placed in individual pens grouped according to body weight. Ration adaptation was carried out for one week. The rations were divided into control rations and flushing rations (Table 2). The flushing rations were administered for a duration of four weeks during each feeding period (Figure 1). Rations were fed three times daily: morning before forage (7:00 AM), noon (11:00 AM), and afternoon (2:00 PM). Forage was provided three times daily: morning (10:00 AM), noon (1:00 PM), and afternoon (3:00 PM). Drinking water was provided *ad libitum*. The ration comprises 3.5% of body weight based on dry matter, with 30% forage and 70% concentrate. Sheep were weighed once a month to adjust the ration amount. The ration was adjusted as body weight increases.

The remaining ration was calculated daily from the ration left in the feeders and scattered around the cages. The control ration was given during maintenance except during the flushing ration period for each treatment. The treatments given are as follows:

P1 = Without flushing
P2 = Flushing ration before and after mating
P3 = P2 + during pregnancy
P4 = P3 + at the end of pregnancy

Estrus and Mating Synchronization

Estrus synchronization was performed by injecting the hormone prostaglandin (PGF2α) noroprost® at 2 mg per animal IM. The injection method used was the

Table 1 Composition of treatment concentrate based on dry matter

Feed Ingredients (%)	Treatment Concentrate	
	Control	Flushing
Soybean meal	25.00	28.00
Pollard	28.29	24.00
Cassava bagasse (*Onggok*)	34.00	28.30
Lemuru fish oil	-	5.00
Coconut oil	-	2.00
Molasses	10.00	10.00
CaCO3	1.00	1.00
Premix*	1.00	1.00
Salt	0.71	0.70

* Each 1 kg contains vitamin A = 3,000,000 IU, vitamin D3 = 600,000 IU, vitamin E = 500 mg, vitamin B1, B2, B6, B12 each 4,000, 2,000, 2,000, 1,000 mg, niacin = 2,000 mg, Ca-d pantothenate = 2,000 mg, folic acid = 25 mg, biotin = 100 mg, ferrous = 500 mg, Mn = 1,000 mg, Mg = 12,000 mg, Zn = 100 mg, iodine = 80 mg, sodium chloride = 10,000 mg, sodium bicarbonate = 300,000 mg, herbal = 50,000 mg, probiotics = 50,000 mg, monensin = 500 mg, and amino acids = 100,000 mg.

Table 2 Nutrient composition based on dry matter

Feed Ingredients (%)	Concentrate		Pennisetum purpureum
	Control	Flushing	
Dry matter[a]	81.15	82.68	16.36
Ash[a]	6.47	7.39	13.93
Crude protein[a]	18.64	18.76	9.38
Crude fat[a]	0.83	7.97	1.96
Crude fiber[a]	10.26	8.05	30.95
NFE (Nitrogen Free Extract)[a]	63.80	57.83	43.78
TDN	74.70[1)]	83.08[1)]	55.83[2)]

[a] Laboratory Analysis Results from the Center for Biological Resources and Biotechnology Research, Bogor Agricultural University, 2021. BETN = nitrogen-free extract, TDN = total digestible energy. 1) TDN formula for forage = 70.6 + (0.259 x %PK) + (1.01 x %LK) -(0.76 × %SK) + (0.0991 × %BETN), 2) TDN formula for concentrates = 2.79 + (1.17 × %PK) + (1.74 × %LK) - (0.295 × %SK) + (0.81 × %BETN) (Sutardi 1980).

Figure 1 Flushing ration management flowchart

double injection with an interval of 11 days (Hafez and Hafez 2000). One day after the second injection, the ewes were grouped with rams at a ratio of 1:4 in group pens for seven days to allow natural mating.

Pregnancy Detection

Pregnancy detection was conducted on day 25 post-mating by assessing the quantity and dimensions of embryos, and the size of the amniotic sac. Pregnancy detection was conducted using an ALOKA SSD-500 ultrasound machine (ALOKA Co. Ltd., Japan) equipped with a 7.5 MHz linear probe (ALOKA Co. Ltd., Japan). The linear probe was enhanced with a 30 cm handle to facilitate rectal examinations for observing the embryo and amnion. The probe was coated with gel before insertion into the rectum to minimize irritation of the rectal mucosa and serve as a medium for transmitting ultrasonic waves. The probe was inserted into the ventral rectum and advanced toward the urinary bladder, continuing to the anterior region to capture an image of the reproductive organs. The diameter of the embryo and amnion was measured based on its longitudinal axis. The embryo and amniotic diameter measurements were performed using an internal caliper from the ultrasound image.

The pregnancy rate was determined by dividing the number of pregnant ewes by the total number of ewes mated in a single treatment, then multiplying by 100%. The gestation period was calculated from the day the ewe completes mating until she gives birth. The litter size was determined by counting the number of offspring per birth from multiple delivered ewes. Embryo viability was determined by dividing the number of offspring born by the number of embryos observed during the ultrasound, then multiplying by 100%.

Data Analysis

This study employed a randomized block design (RBD) featuring four treatments and four groups for replication. The data were analyzed statistically through ANOVA, and mean differences were assessed using Duncan's multiple range test. The pregnancy rate data were analyzed descriptively. Data processing in this study used Microsoft Excel and SPSS version 25.

RESULTS

Sheep receiving a 100% flushing diet achieved a 100% pregnancy rate, whereas control sheep not on a flushing diet had a pregnancy rate of only 75%. The gestation period in multiparous ewes receiving the control and flushing diets showed no significant difference (P>0.05). The gestation period in multiparous ewes ranged from 141 to 144 days. No significant differences were observed in the number and diameter of embryos among multiparous ewes on varying flushing diets (P>0.05). The number of embryos ranged from 2.25 ± 0.48 to 2.75 ± 0.37. The embryo diameter ranged from 1.13 ± 0.04 to 1.41 ± 0.06 mm.

The amnion diameter of multiparous ewes receiving a flushing diet was significantly larger (P<0.05) compared to those not receiving such a diet. The findings indicate no significant difference (P>0.05) in litter size among multiparous ewes receiving a flushing diet. The average litter size observed in this study varied between 2.00 and 2.50 lambs per ewe. The findings indicated that embryo survival rates in the control (P1) and P4 groups exceeded 100%. Nonetheless, P2 and P3 achieved only 80% and 72%, respectively (Table 3).

All ewes in both the control and flushing diet management groups exhibited an increase in body weight. Initially, the average body weight of the sheep was 29.77±5.87 kg. Following the study, the average body weights for groups P1, P2, P3, and P4 were recorded as 50.33 ± 12.22 kg, 52.50 ± 5.89 kg, 57.00 ± 4.51 kg, and 58.80 ± 13.03 kg, respectively. The birth weight of the lambs varied from 1.93 ± 1.94 kg to 2.63 ± 0.32 kg (Table 3). The results showed no significant difference in birth weight of the lambs relative to the mother's weight (P>0.05). The birth weight of offspring in relation to the dam in this study varied from 0.04 to 0.05. The results of the study showed that the dam's weight relative to litter size was significantly different (P<0.05). The maternal weight in multiparous ewes with flushing ration management was higher relative to litter size, ranging from 23.55 to 28.50, compared to 21.60 in those without flushing ration.

DISCUSSION

Ewes provided with a flushing diet exhibited a higher pregnancy rate compared to the control group. This indicates that a flushing diet could increase the pregnancy rate in sheep. A flushing diet given before and after mating may enhance oocyte quality and create optimal uterine conditions for conception. This is consistent with the study by Aidismen et al. (2018), which found that pregnancy in ewes fed a flushing diet with different protein sources before mating, during mating, and up to one month post-mating resulted in 100% pregnancy. Etawa crossbred goats fed a flushing diet with plant and animal oil sources at the beginning and end of pregnancy and before parturition also

Table 3 The effect of ration management flushing on the reproductive performance of multiparous ewes

Variable	Treatment			
	P1	P2	P3	P4
Pregnancy rate (%)	75	100	100	100
Gestation period (days)	144 ± 4.04	141 ± 0.96	142 ± 1.89	141 ± 2.71
Number of embryos	2.25 ± 0.48	2.50 ± 0.24	2.75 ± 0.37	2.0 ± 0.31
Embryo diameter (mm)	1.13 ± 0.04	1.35 ± 0.09	1.41 ± 0.06	1.34 ± 0.13
Amniotic sac diameter (mm)	2.57 ± 0.20^{b}	3.29 ± 0.13^{a}	3.47 ± 0.22^{a}	3.05 ± 0.26^{ab}
Litter Size	2.33 ± 0.88	2.00 ± 0.40	2.00 ± 0.00	2.5 ± 0.50
Embryo survival rate (%)	103.7	80	72	125
Ewes weight at parturition (kg)	50.33 ± 12.22	52.50 ± 5.89	57.00 ± 4.51	58.80 ± 13.03
Birth weight of offspring (kg)	2.01 ± 1.04	1.93 ± 1.94	2.63 ± 0.32	2.30 ± 0.49
Birth weight of offspring per ewes weight (%)	3.98 ± 2.71	4.08 ± 1.19	4.64 ± 0.62	4.17 ± 1.52
Ewes weight per litter size	21.57 ± 5.24^{b}	26.25 ± 2.95^{ab}	28.50 ± 3.24^{a}	23.52 ± 5.21^{ab}

P1 = No flushing ration, P2 = Flushing ration before and after mating, P3 = Flushing before and after mating, and in the middle of gestation, P4 = Flushing before and after mating, in the middle, and at the end of gestation. Numbers followed by different letters in the same row indicate significant differences (P<0.05).

achieved a 100% pregnancy rate (Astuti et al. 2020).

The pregnancy rate of multiparous ewes subjected to flushing management yielded favorable outcomes. The provision of flushing rations prior to and following mating facilitated optimal follicle implantation in the uterine wall (Kia and Safdar, 2015). Flushing rations influence the hypothalamus, prompting the pituitary gland to release FSH, essential for follicle maturation, and activating LH to facilitate ovulation (Aidismen et al., 2018). The gestation length observed in this study was consistent and fell within the normal range for sheep. The gestation length varies by sheep breed; for instance, Dorper and Awassi sheep have gestation periods of 133.67 ± 4.105 days and 131.1 ± 5.79 days, respectively (Jwana, 2024). Ewes that deliver multiple offspring experience shorter gestation periods (Li and Brown 2016). The implementation of a flushing diet in the study did not influence gestation length, nor was there a difference in the number of lambs born.

This study conducted pregnancy examinations (PKB) using ultrasound. The number and diameter of embryos were generally greater in the flushing ration management group; however, high individual variation resulted in no statistically significant difference. The amnion diameter of multiparous ewes receiving a flushing diet was significantly larger (P<0.05) than that of ewes not receiving such a diet. The amniotic fluid is the fluid within the embryonic sac surrounding the embryo during pregnancy. It typically forms 12 days after fertilization and consists of two membranes: the amnion and the chorion. The size of the amniotic diameter is related to the amount of fluid it contains, which protects the embryo from shocks. Sawado et al. (2024) reported that adequate fat intake could help maintain healthy lipid composition in the amniotic sac to support fetal cell membrane health. The amniotic sac diameter is positively correlated with the embryo diameter. A larger diameter is necessary to support fetal health. Omega-3 content in the flushing diet can influence the function and structure of the chorionic layer in the amniotic sac, thereby increasing the amniotic sac diameter (Middleton et al. 2018). Li *et al.* (2023) reported that odd-chain saturated fatty acids have a positive relationship with fetal weight and head circumference. However, this was not proven in this study, as the newborns had no significant differences in weight.

The number of embryos detected by ultrasound in this study ranged from 2.25 ± 0.48 to 2.75 ± 0.37, with embryo diameter ranging from 1.13 ± 0.04 to 1.41 ± 0.06 mm. The number of embryos detected was found to be different from the number of offspring born. This was evident from the embryo survival rate, calculated by dividing the number of offspring born by the number of embryos detected by ultrasound during pregnancy examination. The study showed that embryo viability in the control (P1) and P4 groups was over 100%. However, P2 and P3 were only 80% and 72% (Table 3). This suggests that not all embryos were identified during PKB via ultrasound. Sheep, as small ruminants, are challenging to palpate rectally. The modified ultrasound probe, equipped with a rod

for deeper insertion, could not detect all embryos. Sihombing (2020) reported that embryo viability in ewes fed a flushing diet containing lemuru and palm oil ranged from 80.00% to 90.90%.

The number of offspring produced in this study was only 2 to 2.5, with no significant difference between treatments. These results are consistent with Khotijah's (2014) report, which stated that the number of offspring produced from a diet rich in linoleic acid from sunflower oil ranged from 2.00 to 2.40. Astuti et al. (2020) investigated flushing management at the onset and conclusion of pregnancy using a 5% lemuru oil flushing diet, which yielded an average litter size of 1.80. Although the litter size did not differ, the offspring born to dams fed the flushing diet appeared healthier and more active. According to Abdelrahman et al. (2023), omega-3 fatty acids can enhance fetal growth, making the fetus more prepared for birth. This study demonstrated that while the pregnancy rate increased, the number of offspring produced remained unchanged. This condition is attributed to embryo growth until parturition being influenced by various factors, including embryo viability, maternal age, and maternal nutrition (Stewart, 2021).

Birth weight of offspring ranged from 1.93 ± 1.94 to 2.63 ± 0.32 kg, indicating that ration flushing did not affect birth weight, number, and sex of offspring in the ewe's womb. Prenatal growth of prolific livestock is influenced by the number of fetuses in the uterus. A high number of fetuses causes insufficient feed intake by the ewe, resulting in smaller offspring. The lack of difference in birth weight is likely due to individual responses from each ewe. All ewes experienced an increase in body weight. Initially, the average body weight of the ewes was 29.77 ± 5.87 kg. Following the study, the average body weights for groups P1, P2, P3, and P4 were recorded as 50.33 ± 12.22 kg, 52.50 ± 5.89 kg, 57.00 ± 4.51 kg, and 58.80 ± 13.03 kg, respectively. This suggests that supplementary feed in the form of concentrate, whether standard (control) or from the flushing feed management treatment, could improve body condition. These female sheep are expected to have better reproductive performance in subsequent developments.

CONCLUSION

Flushing ration management could increase pregnancy rates and amniotic diameter. Further research with a larger number of livestock and further evaluation of reproductive performance are needed to observe subsequent estrous cycles. *"The authors state no conflicts of interest with the parties involved in this study".*

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