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RESEARCH ARTICLE

The effects of creep feed and commercial concentrates on growth performance of pre-weaning dorper lambs

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ABSTRACT

The study aims to evaluate the effects of creep feed and commercial concentrates on the growth performance of pre-weaning Dorper lambs in accelerated lambing production. The Dorper lambs were selected based on breeding cohorts bred in January 2023, where 48 lambs were born with a mean birth weight of 4.11±0.2 kg. The lambs were divided into three groups and randomly assigned to the treatments. The experiment started when the lambs were ten (10) days old until reached day 90. Three dietary treatments, namely creep feed (CF) as control, commercial concentrate A (CA), and concentrate B (CB) with crude protein (CP) at 18.25%, 14.73%, and 13.05%, respectively. The treatments were assumed to be isocaloric feed. The feed given was calculated, and the lambs had free access to water and were permitted to suckle ewes (ad libitum). A GLM procedure was performed to determine the effects of feed and sexes, which are significant for growth traits. The results were that only male lambs fed with CF were significantly higher ($p<0.05$) on the weaning weight (28.10±1.2 kg) and average daily gain (ADG) (258.08±13.8 g/day) compared with other treatments. However, there is no significant difference ($p<0.05$) for male and female lambs fed with CA and CB. Therefore, the present finding suggested that the CF could increase the weaning weight and ADG over a short period for male Dorper lambs.

1. INTRODUCTION

In 2022, the small ruminant population in Malaysia were recorded at 329,710 goats and 135,560 sheep (DVS, 2023). Sheep are getting more attention from farmers due to the productivity and market demand for lamb breeds and meat (lamb and mutton), where the slaughter percentage increased by 20% in 2022 (DVS, 2023). Various exotic sheep breeds such as Dorper, Santa Ines, Barbados Blackbelly, and Marado Nova have been imported and are currently being raised in this country to satisfy the demand. Among these exotic breeds, Dorper is an imported meat-type sheep breed that was earliest introduced into this country circa 2010 (Norhayati et al., 2018). Notably, Dorper lamb breeds command a high price, with the weaned lamb (>3 months) priced at about RM850-1000/head, depending on the phenotypic characteristics. The rearing of this breed became popular due to its desirable traits such as hardiness, high carcass yield, docility, early maturation, and high pregnancy rates (Cloete et al., 2014; Kao et al., 2022). Weight is an important parameter to assess, taking precedence over other economic traits like coat and head colours. For example, in Projek Agropolitan Pekan, Pahang, Malaysia, the lambs were primarily reared for breeding and premium cuts. Therefore, it is important to ensure that the pre-weaning lambs achieve the desired weight before weaning to meet market demands. Commonly, three-month-old lambs can attain a weight of around 18-25 kg.

Deficient nutrient intake can impede overall animal performance, particularly in growing lambs, where a sufficient protein supply is important for optimal microbial growth and protein synthesis (Panadi et al., 2022). An essential component of animal feed is crude protein (CP), which plays a pivotal role in supporting the growth of animals. Currently, feeds with high CP content are expensive, especially for commercial concentrates or pellets, where the CP level correlates with the price. However, feed intake efficiency may determine the cost of farming the livestock. The protein requirements vary at different production stages, where most research is concerned with growing lambs. Previous studies have reported specific CP requirements for various lamb breeds, like Santa Ines, Suffolk, Dorper, and Merino. These requirements have been identified as 20%, 17.5%, 18%, and 23.7%, respectively (da Rocha et al., 2004). Thus, previous studies indicate the importance of tailoring feed compositions

to address the distinct nutritional needs of lambs at different stages of growth and development.

Creep feeding is a management approach involving the supplementation of suckled lambs while they are still grazing alongside their mothers. It has demonstrated several advantages in lamb production systems, particularly in subtropical regions (Poli et al., 2020). Previous research indicated that creep feeding can effectively reduce gastrointestinal nematode infestation in lambs (de Melo et al., 2017). An earlier study by Faulkner et al. (1994) revealed that increased creep feed intake led to enhanced lamb weight gain before weaning. Moreover, findings from Bhatt et al. (2009) highlighted that creep feeding improves pre-weaning growth and rumen fermentation in lambs.

The practice of creep feeding becomes economically viable for twin or triplet suckled lambs when pasture quality and quantity decline or when the growth potential of lambs is not sufficiently met with milk and natural forage (Brand & Brundyn, 2015). However, the production of creep feed in Malaysia is too scarce, coupled with the need for special formulation and costly manufacturing processes. Hence, local farmers can only feed their livestock with commercial concentrates from the market shelf. Certainly, the existing commercial concentrates are not formulated to feed the pre-weaning lambs, where the content of CP is tailored for breeders and may contain high copper content. Therefore, this study evaluated the effect of creep feed and commercial concentrates utilisation as pre-weaning lamb feed on their growth performance.

2. MATERIALS AND METHODS

2.1. Study area

The experiment was conducted at Projek Agropolitan Pekan Batu 8 Lepar, Pekan, Pahang, Malaysia (N:3°32'0.708"; E: 103°6'16.487) from May to August 2023.

2.2. Ethics statement

This study has complied with the ethical guidelines provided by the Universiti Malaysia Kelantan (UMK) Animal Care and Use Committee (ACUC).

2.3. Experimental design and animal management

The Dorper lambs were selected from breeding cohorts bred in January 2023. In May 2023, lambs (n=48) were born with a mean birth weight of 4.11±0.2 kg. The birth weight of lambs was weighed using a digital weighing balance within 24 hours postnatal. All the postnatal management includes ensuring the lambs receive colostrum (within 48 h postnatal) and applying the iodine spray to the navel. The lambs were kept with the ewes in separate compartments (3 x 6 m) (Figure 1) in a large pen (20 x 10 m).

Figure 1: The concentrate was provided separately from the ewes

The lambs were divided into three groups and randomly assigned to the treatments. The experimental phase commenced when the lambs were ten (10) days old. Three dietary treatments, namely creep feed (CF) as control, concentrate A (CA) and concentrate B (CB). Creep feed was formulated internally for this farm, and the commercial concentrates were chosen because they are widely used in commercial farms in Malaysia. The lambs were allowed to suckle at all times until weaning. During feeding time, the lambs were moved into separate areas and fed to prevent the lambs from consuming their mother's feed and vice versa. The lambs were fed with the Napier grass chopped (age 45 days) at about 2 cm length, and the ratio between forage and concentrate during pre-weaning stages was maintained at 70:30. The feed intake of lambs was calculated at 3.5% of body weight and adjusted every month. Furthermore, the feed was offered at 9.00 a.m. and 3.00 p.m. and the lambs had access to water ad libitum. Daily feed intake was calculated as the difference between the amount of feed offered and refused. Both feed samples were collected and analysed to determine daily DMI.

The birth date, birth weight (24 hours postnatal), gender, age of ewes, and litter size were recorded. Subsequently, lambs were weighed using a weighing balance at age 30 days (BW30), 60 days (BW60), and weaning weight at 90 days (BW90). The weighing activities were done in the morning before feeding, and antistress was provided during the post-weighing session to reduce stress. Pre-weaning average daily gain (ADG) was calculated by determining the difference between the initial and final weight, divided by the experimental period.

2.4. Chemical analysis

The chemical analysis was conducted at the University Malaysia Kelantan, Jeli Campus, Kelantan. All the feed samples were prepared and analysed in triplicate. The chemical composition (%) of the grass and pellet samples was documented in Tables 1 and 2, respectively. Dry matter (DM) was dried overnight at 103°C using a ventilated oven. Crude protein was evaluated by determining the total nitrogen content using the combustion method at 950°C (Dumas principle). The ether extract method using the Soxtex system was used to analyse the crude lipid. Fibertec was used to filtrate the crude fibre, and a furnace was used to incinerate it at 550°C to measure the total ash. Gross energy was estimated using a bomb calorimeter system and expressed in MJ/kg. Finally, inductively coupled plasma optical emission spectrometry (ICP-OES) was used to measure the calcium (Ca), phosphorus (P), and copper (Cu) content in the pellet. The chemical composition of the forage fed to the lambs is shown in Table 1. Subsequently, Table 2 indicates the treatment, creep feed and two commercial pellets at different CP levels fed to the lambs in pre-weaning. The CP (%) of CF, CA, and CB were 18.25,14.73,13.05%, respectively. Then, the total dry matter intake (DMI), including that from the forage and concentrate, was calculated, respectively. For this study, only crude protein intake (CPI) was estimated.

Table 1: Chemical composition (mean ± standard error) of forage diet.

Parameters	Napier
Dry Matter (DM)	19.37±0.5
Crude Protein (CP) (%)	9.06±0.3
Ether Extract (EE) (%)	2.05±0.3
Crude Fibre (CF) (%)	35.7±0.3
Ash (%)	5.86±0.2

Table 2: Chemical composition (mean ± standard error) of creep feed (CF), concentrate A (CA), and concentrate B (CB).

Parameters	Creep feed (CF)	Concentrate A (CA)	Concentrate (CB)
Dry Matter (DM)	92.16±0.6	91.70±0.5	91.65±0.5
Crude Protein (CP) (%)	18.25±0.5	14.73±0.6	13.05±0.2
Ether Extract (EE) (%)	2.50±0.4	2.37±0.3	2.26±0.3
Crude Fibre (CF) (%)	17.21±0.2	22.80±0.4	25.61±0.6
Ash (%)	13.27±0.2	10.99±0.3	12.0±0.3
Gross Energy (MJ/kg)	16.32±0.0	15.55±0.5	15.83±0.5
Calcium (ppm)	7,518.33±568.0	7,097.00±165.6	7,103.67±79.24
Phosphorus (ppm)	4,448.33±509.1	2,951.00±75.9	3,311.00±27.0
Copper (Cu) (ppm)	8.12±0.0	15.14±0.1	15.18±0.1

2.5. Data collection and analysis

The lamb growth performance data were analysed using the general linear model procedure (Teklebrhan et al., 2014). The model considered fixed effects of the lamb, specifically the lamb gender and feed given. Variables showing no significant difference in two-way interactions were excluded from the analysis. Tukey's multiple-range tests used SPSS statistical software (Version 24) to compare means.

3. RESULT AND DISCUSSION

This study assessed the impact of using creep feed and commercial concentrates (breeders) as a pre-weaning Dorper lamb diet on growth performance. Table 3 shows the growth performance of pre-weaning lambs where the birth weight was not significantly different among treatments. The Dorper lambs, with birth weights ranging from 2.5 to 5 kg, exhibited a larger size than the local or other imported breeds of sheep (Teklebrhan et al., 2014; Gebreyowhens et al., 2017). In a recent study, the birth weight was weighed at a mean of 4.11±0.2 kg, irrespective of gender. Although male lambs in the present study recorded greater birth weights than females, male lambs had higher live weights than females. In the current experiment, male lambs have a bigger birth weight than females, and the difference was not statistically significant. This result was consistent with earlier research by Abebe et al. (2015), which demonstrated that the male Dorper lambs in Ethiopia were noticeably larger than females. The birth weight is a significant indicator of the lamb's size, vigour, and health during early postnatal development and significantly influences later growth. Similar findings were demonstrated in previous studies where higher birth weight and pre-weaning growth of Boer and black Bengal kids were found in males, indicating sex influences (Syahirah et al., 2016; Perveen et al., 2019). A recent finding shows that lambs' weight increased within ten days, and weight on that day was used as initial body weight ($p>0.05$) for the experiment. Furthermore, feeding CF with 20% CP has significantly increased the growth of lambs regardless of gender in both pre-weaning and post-weaning periods reared in Malaysian conditions (Panadi et al., 2021).

The influence of sex on the lamb's growth has been extensively researched. Studies have shown that sexual dimorphism significantly influences pre-weaning growth performance, with male lambs exhibiting a faster growth rate and more significant weight at equivalent ages compared to females (Abebe et al., 2015; Ghafouri-Kesbi & Notter, 2016). The weight of the lambs was weighed on day 30 (BW30), and the live weight of these lambs was found not to be significantly different (Table 3). Recent findings found that the lamb's live weight started to vary at day 60 until weaning, where the

BW60 and weaning weight (kg) of pre-weaning male lambs fed with CF show were significantly higher ($p<0.05$) compared to CA and CB treatments. Finally, live weight at weaning weight (BW90) showed that the male lambs fed CF had significantly higher ($p<0.05$).

The average daily gains (ADG) of lambs were higher in males, but were significantly higher when fed CF. Simultaneously, the ADG (g/day) of pre-weaning male lambs in CF was significantly higher ($p<0.05$) (258.08±13.8 g/day), but the lambs in CA and CB were not affected significantly ($p<0.05$). Previous research also noted that male lambs had higher live weights and average daily gain (ADG) at 60,120,180, and 240 days (Berhanu & Aynalem, 2009). Furthermore, the larger weight of males compared to females at six months could be due to hormonal differences in their endocrinological and physiological functions. Aligned with recent findings, previous studies revealed that the growth rate of pre-weaning kids was statistically significantly influenced by variation of sex (Gatew et al., 2019; Elmaz et al., 2020). Yaqoob et al. (2004) reported significantly heavier male lambs than females at birth weight, contradicting a recent study. Hence, recent findings collectively emphasise the significant influence of sex on the birth weight, growth and development of lambs.

In this current research, ewes were selected from two-year age clusters, and all lambs were born as singletons from second parity. This incidence is associated with the Dorper breed not being the best breed for producing twin lambs. Furthermore, the litter size also greatly impacts the growth performance of the lambs, as explained by an earlier study (Lv et al. 2015). Previous studies explored the litter size effect on ewe and lamb performances in an intensive management system, concluding that litter size influenced the body condition score (BCS) of ewes and lambs' birth weight (Syahirah et al., 2016; Sarvinda et al., 2022). Nevertheless, recent findings suggested that the ewe age, parity, and litter size did not significantly influence the growth performance traits of lambs. Hence, due to maternal factors that may be similar, emphasising proper nutrition contributes to better growth for the lambs.

The ADG obtained in pre-weaning lambs subjected to varied diets may be attributed to the protein amount and amino acid available in the small intestine, where the protein and glucose assimilated through the small intestine are more efficient, resulting in better ruminal fermentation (da Rocha et al., 2004). Additionally, it has been observed that creep-fed lambs and kids exhibit higher average daily weight gain, weaning weights, and improved carcass traits compared to those not receiving creep feed (Hayes et al., 2019). The diet's high crude protein (CP) is absorbed in the small intestine, elucidating the high ADG and better feed efficiency. On the other hand, a previous study suggested that to fulfil the lamb requirements, feed with 20-23% of CP is required for better lamb growth (Panadi et al., 2021). A CP content lower than 14% significantly slowed the lamb growth response reported by a previous study (Rios-Rincon et al., 2014; Panadi et al., 2021). Those findings agreed with recent findings where the use of CB with CP% at 13% had shown a slow response on ADG. On the other hand, Al-Sherwany and Alkass (2021) suggested that lambs fed ad libitum exhibited significantly higher ADG compared with those reared on a restricted diet.

Table 3: Growth performance of pre-weaning Dorper lambs fed creep feed (CF), concentrate A (CA), and concentrate B (CB).

Parameters	Treatments (mean±S.E)					
	CF		CA		CB	
Sex	♂	♀	♂	♀	♂	♀
Birth weight (kg)	4.21±0.0	4.10±0.0	4.17±0.1	4.13±0.1	4.22±0.1	4.09±0.1
Initial body weight (kg)	6.45±0.2	6.28±0.1	6.26±0.3	6.19±0.2	6.44±0.1	5.97±0.1
BW 30	16.78±0.3	15.75±0.6	14.68±0.4	15.51±0.3	14.36±0.6	14.21±0.4
BW 60	23.06±1.1^{a}	19.87±0.8^{b}	18.75±1.1^{b}	18.34±1.1^{b}	18.74±1.3^{b}	18.02±1.2^{b}
Weaning weight (kg) (BW90)	28.10± 1.2^{a}	23.97 ±1.1^{bc}	23.73±1.0^{bc}	21.60 ±1.3^{bc}	22.94± 0.4^{bc}	20.60± 0.3^{c}
ADG (g/day)	258.08±13.8^{a}	230.22±12.9^{bc}	222.22±12.9^{bc}	213.29±15.6^{b}	219.99±11.4^{bc}	198.43±3.7^{c}

$^{a, b, c}$ Different superscripts within the row indicate significant differences ($P < 0.05$)

In this study, Table 4 shows the dry matter intake (DMI) (g/day) and crude protein intake (CPI) (g/day) estimated from all treatments. Different percentages of CP provided by concentrates influenced the feed intake (forage and concentrate). The introduction of creep feed can significantly enhance DMI, such as in previous studies where the creep feed diet with varying levels of CP showed a linear increase in DMI as the protein content rose (Panadi et al., 2021). For example, lambs received a diet with 20% CP had a DMI of approximately 1059.92 g/day compared to 605.30 g/day for those on a 14% CP diet. Similar to recent findings, the total DMI taken by pre-weaning lambs is significantly higher (578.81 g/day) compared to a lower percentage of the CP diet. Furthermore, the feed intake can also be different due to the influence of feeding regimes. In a recent study, the pre-weaning lambs received milk and concentrates that may affect the DMI. Lambs on a combined feeding regime, such as grazing with supplementation of concentrate and milk replacer, showed significantly higher DMI than those on a control diet of just grazing (Bhatt et al., 2009).

Table 4: Dry Matter Intake (DMI) (g/day) and Crude Protein Intake (CPI) (g/day) of pre-weaning Dorper lambs.

Parameters	Treatments		
	CF	CA	CB
DMI of Napier (g/day)	421.29±36.1	-	-
DMI of concentrate (g/day)	157.52±31.7[a]	147.93 ±29.9[b]	146.85 ±13.2[b]
Total DMI	578.81±70.25[a]	551.25±69.36[b]	535.5±58.31[b]
Total CP intake (g/day)	99.76±22. 06[a]	94.54±16. 68[b]	92.31±25.25[b]

[ab] Different superscript within the row indicates the significant difference ($p<0.05$). DMI: Dry matter intake, CP: Crude protein

Lambs have rumens that are physically and metabolically undeveloped and resemble those of monogastric animals at birth (Liu et al., 2022). Milk enters the abomasum through the oesophagal groove to be digested and is then absorbed in the small intestine to maintain and meet the nutritional needs for growth (Abdelsattar et al., 2023). Feeding milk replacers to lambs during the pre-weaning phase is important for developing the rumen and can improve creep feed intake (Chai et al., 2015). The timing of creep feeding can also influence lamb growth and development. Agwa et al. (2016) reported a significant improvement in lamb ADG when the creep feed was fed at four weeks of age.

The copper (Cu) function in ruminants is essential to their health and well-being. Previous research has shown that dietary copper levels can influence serum lipid profiles and growth performance in goat kids (Huang et al., 2014; Zhang et al., 2023). Copper toxicity in sheep is a significant concern in the livestock industry (Autukaitė et al., 2021). Sheep are particularly susceptible to copper toxicity due to their liver cells having a high affinity for Cu and excreting it into the bile at a very low rate, leading to the accumulation of copper in the liver over time (Vonk et al., 2011). Chronic copper poisoning can lead to acute death in ruminants, including sheep (Srinivasan et al., 2021). Certain breeds of sheep, such as the Texel and Merino, are more susceptible to copper poisoning (Autukaitė et al., 2021).

Additionally, inclusion of certain feed ingredients, such as palm kernel cake (PKC), in sheep rations can increase the risk of copper toxicity (Saeed et al., 2021). Monitoring and controlling their copper intake are important to prevent copper toxicity in sheep. Commercial pellets usually contain PKC, where the level of copper is higher than the safe level for sheep consumption. In a recent study, the copper level in the pellet was significantly higher in the treatment of CA, and CB (> 10 ppm) may not be safe for prolonged use. The accumulation of copper in the liver can lead to chronic health effects and even death. Although Cu is an essential element for many biological processes, it becomes toxic excessively (Wolschendorf et al., 2011). Pechova et al. (2012) suggested that selenium supplementation in pregnant goats has influenced the concentration of copper in the blood serum of kids. Therefore, a recent study may indicate the multifaceted nature of serum copper levels and the need to consider various factors when evaluating copper content in the serum of pre-weaning lambs

4. CONCLUSION

This study demonstrated that the pre-weaning growth performance of Dorper lambs was influenced by feed and sex differences. The inclusion of protein percentage from 13-19% in concentrates may have a significant effect, as CF is highly recommended for feeding male lambs for accelerated farming. Overall, creep feeding is rewarding to use in lamb production systems. However, the creep feed's composition and its introduction timing should be carefully considered to optimise its effectiveness.

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