Digestibility of nutrients of male Dorper sheep weaned at different ages

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Abstract

The nutrient digestibility is an important aspect to measure the feed efficiency of feed given to the animals. Therefore, this study was conducted to evaluate the nutrient digestibility of male Dorper sheep at different weaning ages. A total of 27 new-born Dorper lambs (average body weight, 3.06±0.74 kg) were randomly divided into three equal (n=9) experimental groups namely, Group 1, Group 2 and Group 3, weaned at day 30, 60 and 90, respectively. Creep feed (ME, 12 MJ/kg and CP, 18%) and grower feeds (ME, 10 MJ/kg and CP, 14%) were fed at 3.5% of their mean body weight before and after weaning, respectively. Digestibility trials for Group 1, 2 and 3 were conducted 10 d before the animals reached 30, 60 and 90 d of age, respectively. The digestibility trial was repeated at 10 d before the animal reached the age of 270 d. Three animals were selected from each group for digestibility trial and the animals were individually housed in metabolism cage. There was no significant ($P>0.05$) difference in digestibility of DM, CP, CF, EE and NFE among the treatment groups at pre-weaning and post-weaning stages. However, numerically weaning at 30 d of age was higher in nutrient digestibility at pre-weaning stage than weaning at 60 and 90 d of age. For post-weaning stage, all groups showed no significant difference in nutrient digestibility. As a conclusion, this study shows that the weaning age does not significantly influence the nutrient digestibility of male Dorper sheep.

Key words: digestibility, weaning, Dorper sheep.

Introduction

The Dorper sheep which originated from South Africa was identified as a potential breed for meat production in Malaysia (Nurulhuda et al., 2013; Jasmi, 2013). Based on its suitability and adaptability to the humid tropics, this breed was selected for the Pekan Agropolitan project in South Pahang in 2009 which is expected to become one of largest hubs for Dorper sheep in the Southeast Asian Region (Ahmad, 2014). To ensure efficient production, management practices that focus on shortening the breeding production cycle are important economic factors for sheep production (Urbano et al., 2017). The tropical climate of Malaysia permits continuous breeding irrespective of seasons and one major approach to increase breeding productivity is to reduce the age of weaning, without adversely affecting lamb performance. The weaning age of Dorper lambs was reported to range between 53-138 days (Cloete et al., 2000). Nevertheless, lambs are weaned and fed on milk replacers as early as 1 to 7 days (Lanza et al., 2006; Yeom et al., 2002). However, it is important to note that different weaning ages reported were dependent on nutritional support provided to the suckling animals. Digestive adaptations of the ruminants do not develop normally if milk is the only source of food (Lane and Jesse, 1997). Poe et al. (1969) reported that exposing lambs to dry feed at an early age enhances rumen development and reduces weaning stress. Inadvertently, poor development of the digestive chambers would lead to higher weaning age (Beharka et al., 1998). This delay in weaning age would lead to economic losses as it takes a longer lamb-rearing period with delayed mating of ewes. Rumen development is influenced not only by solid food, but also the type of feed. Urbano et al. (2017) reported better rumen development when diets were composed of a combination of concentrate and hay rather than separately. Corn and soybean meal generally make up the concentrate portion of the pre-weaning diet while alfalfa (*Medicago sativa*) the source of fibre (Simeonov et al., 2015). Alfalfa is not available in the humid tropics and therefore the fibre source of the creep feed is made up of locally available forage which may influence the digestibility of creep feed. Weaning induces stress in animals leading to increased vocalizations and cortisol plasma concentrations (Maiorano et al., 2009; Ekiz et al., 2012). It is therefore important to determine the best weaning age to reduce weaning stress and ensure post-weaning health (Chai et al., 2015) based on animal environment as well as feeding conditions. Nutrient digestibility and metabolism of lambs weaned at different ages vary as gastrointestinal development is affected due to weaning stress (Zhong et al., 2014). The digestibility of feed determines the intake thereof, thus feeds high in digestibility are likely to be consumed in greater quantities (Illius and Jessop, 1996). Various factors influence the digestibility of a feed which include the composition of the feed and the ration, the method of feed preparation (e.g., grinding, chopping), supplementation of feed with enzymes and the level of feeding (McDonald et al., 2002). The aim of this study was to determine the pre and post weaning digestibility of nutrients in male Dorper lambs weaned at different ages and fed creep feed formulated with locally available resources.

Materials and Methods

Experimental Animals

A total of 27 male new born Dorper lambs were selected for this trial. At birth, all lambs were ear-tagged, weighed and the date of birth were recorded. The lambs were randomly divided into three experimental groups based on Complete Randomized Design (CRD**).** The lambs were raised with ewes and weaned at 30, 60 and 90 d, respectively, for Groups 1, 2 and 3. During the pre-weaning stage, a formulated creep feed was fed to all of the lambs. Following weaning, a common grower feed was given to the lambs throughout the growing stage until they reached 270 d of age.

Housing

All lambs in this trial were housed in 3 different pens for the 3 groups, each occupying 9 animals. The pen had square mesh floor of 2 cm x 2 cm with an area of approximately 17.652 square metres. A feeder and a drinker were provided in each pen. Fresh clean water was provided *ad-libitum* throughout the trial duration.

Feed Formulation

Two feed formulations were prepared for the trial: creep feed for pre-weaning lambs and grower feed for growing lambs (Tables 1 and 2). The creep feed contained ±12 MJ/kg ME and 18% CP whereas the grower feed had ± 10 MJ/kg ME and 14% CP. Table 3 shows the nutrient composition of the experimental diet. Diets were formulated to meet the National Research Council (NRC, 2007) recommendations.

Feeding of the Animals

Lambs were fed twice daily at 0800 h and 1500 h. Each animal was given a complete feed with an estimated DMI of about 3.5% of mean live weight (LW) per day. The health of each experimental animal was monitored daily by visual assessment.

Table 1: Composition of creep feed (% as fed).

Ingredients	(%)
Kenaf leaves (*Hibiscus cannabinus* L.)	10.0
Soya bean meal	18.0
Ground maize	64.0
Salt	1.0
Molasses	5.0
Limestone	0.5
Ammonium chloride	0.5
Vit-Mineral premix	1.0

Table 2: Composition of grower feed (% as fed).

Ingredients	(%)
Soya hull	17.0
Palm kernel cake (PKC)	34.0
Grass hay	12.0
Soya bean	1.0
Ground maize	28.0
Salt	1.0
Molasses	5.0
Limestone	1.0
Ammonium chloride	0.5
Vit-Mineral premix	0.5

Table 3: Nutrient composition of creep feed and grower feed

Nutritive Value	Creep Feed	Grower Feed
ME (MJ/kg)	12.00	10.00
CP (%)	18.00	14.00
CF (%)	5.97	13.50
EE (%)	4.01	3.42
Ash (%)	5.54	5.73
NFE (%)	58.90	56.90
TDN (%)	72.00	67.40
Ca	0.62	0.85
P	0.31	0.41
Ca:P	2.0:1	2.1:1

Digestibility Trial

Digestibility trials for Groups 1, 2 and 3 were conducted 10 d before the animals reached 30, 60 and 90 d of age, respectively. The digestibility and balance trials were repeated at 10 d before the animals reached the age of 270 d. Three animals were selected from each group for digestibility trial and the animals were individually housed in metabolic cages. The amount of feed and water given to each lamb were recorded daily for 7 consecutive d as well as the faecal and urine output. Faeces and urine voided daily per animal were weighed and recorded every morning. The dry matter of fresh faeces was determined daily upon collection, whereby 20% of the faeces collected were dried in a forced drought oven at 60 ºC for 48 h. Over 7-d period, the remainder of faeces collected were kept in a refrigerator. At the end of the seventh d, samples were thawed at room temperature. Collected faeces and urine were separately mixed and pooled over the trial period per animal. Twenty percent of the representative samples were taken and placed in polythene bags and bottles for faeces and urine, respectively, as a bulk sample for chemical analysis. Feed, faecal and urine samples were analysed for proximate and mineral analysis.

The apparent digestibility coefficient (DC) of nutrients was calculated using the following equation as described by McDonald et al. (2002):

Apparent Nutrient DC

$$= \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times 100$$

Feed Intake

Data of feed intake were recorded throughout the trial. The amount of feed offered and refused was weighed and recorded daily for each group. Feed intake was determined daily as the difference between feed offered and feed refused. Samples of feed offered (about 1.0 kg) were taken every mo and a 500-g sub-sample was used for monthly dry matter (DM) determination while the other 500 g was kept for further analysis.

Laboratory Analysis

The samples of feed offered, faeces excreted and urine collected were analysed for DM, ash, crude protein (CP), ether extract (EE), crude fibre (CF), calcium (Ca) and phosphorus (P) according to standard procedures of the AOAC (1995).

Statistical Analysis

Data were statistically analysed using SPSS Statistical Software 16.0 (SPSS Inc., Chicago, IL, USA). Values were expressed as mean±standard deviation. The normal distribution of the data was tested using Kolmogorov-Smirnov goodness-of fit test before further statistical analysis. If the data were not normally distributed, further tests were carried out using equivalent non-parametric tests. Differences in feed intake, growth performance, and apparent digestibility between the treatment groups were evaluated using one-way analysis of variance (ANOVA) and means were separated using Turkey's test. A p-value of less than 0.05 was considered to be statistically significant.

Results and Discussion

As expected, the dry matter intake (DMI) was significantly different (P<0.05) among the three groups due to the differences in age and body weight (Table 4). The apparent digestibility of DM, CP, CF, ash and P were highest in Group 1 but no significant difference was observed between Groups 2 and 3 (P>0.05). Group 2 showed the highest apparent Ether Extract (EE) digestibility (39.4±6.2%) followed by Group 3 (20.8±22.6%) whereas Group 1 recorded the lowest (11.9±0.0%). However, no significant difference was found among the three treatment groups (P>0.05). The apparent Ca digestibility had no significant difference at P<0.05 for Group 1 (0%), Group 2 (34.9**±0%)** and Group 3 (62.7**±14.0**%). Group 3 showed the highest apparent digestibility of Ca compared to other groups. The highest apparent NFE digestibility was in Group 3 (80.7±5.4%) as compared to Group 1 (59.2±53.7%) and Group 2 (73.3±14.9%) but no significant difference was observed between the treatment groups (P>0.05).

Table 4: Apparent nutrient digestibility of Dorper lambs at 10 days prior to weaning stage (Mean±SD**).**

	Treatments (Weaning age)		
Parameter[1]	Group 1 (30 d)	Group 2 (60 d)	Group 3 (90 d)
DMI, kg/lamb/day	0.0±0.0[a]	0.3±0.0[b]	0.6±0.1[b]
DM (%)	94.9±4.7	70.8±18.5	73.8±4.9
CP (%)	77.9±21.2	45.2±25.2	40.2±16.9
EE (%)	11.9±0.0	39.4±6.2	20.8±22.6
CF (%)	95.0±5.9	87.3±8.9	88.3±1.4
Ash (%)	92.3±2.7	75.1±12.1	72.0±4.6
NFE (%)	59.2±53.7	73.3±14.9	80.7±5.4
Ca (%)[2]	-	34.9±0.0	62.7±14.0
P (%)	91.1±4.6	82.0±17.2	74.1±8.5

[1]DMI:Dry matter intake, DM: Dry matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre, NFE: Nitrogen free extract, Ca: Calcium, P: Phosphorus. G1: Group 1 (weaned at 30 days), G2: Group 2 (weaned at 60 days), G3: Group 3 (control - weaned at 90 days).
Means with different letters are significantly different at P<0.05
[2]The apparent Ca digestibility for Group 1 was not determined due to inadequacy of faecal samples at the time of analysis.

The CP balance of lambs at pre-weaning stage is presented in Table 5. Group 1 showed the highest CP balance as compared to Groups 2 and 3. However, it did not differ significantly (P>0.05) among the treatment groups. Urine was analysed for CP balance. The CP balance at post weaning stages for Groups 1, 2 and 3 were 46.5±16.6%, 52.2±5.3% and 45.2±5.3%, respectively. There was no significant difference (P>0.05) in CP balance between the treatment groups (Table 5).

Table 5: Protein balance of Dorper lambs at the pre-and post-weaning stages (Mean±SD)

	Treatments[1]		
Parameter	Group 1	Group 2	Group 3
Pre-weaning			
CP balance (%)	44.3±0.0	36.0±24.5	19.6±18.9
Post-weaning			
CP balance (%)	46.5±9.6	52.2±3.1	45.2±3.0

CP: Crude protein, G1: Group 1 (weaned at 30 days), G2: Group 2 (weaned at 60 days), G3: Group 3 (control - weaned at 90 days). *ns=not significant at P<0.05.*
[1]Means with different letters are significantly different at P<0.05

Results for nutrient digestibility of lambs at the post-weaning stage are depicted in Table 6. There was no significant difference (P>0.05) in DMI among the treatment groups. Group 3 had the highest percentage of apparent digestibility of DM, CP, P and NFE. As shown in Table 6, the apparent digestibility of DM, CP, P and NFE for Group 2 was similar to Group 3. Similar result in the apparent digestibility of EE was detected for Group 1 (97.8±0.9%), Group 2 (97.7±0.8%) and Group 3 (97.2±0.8%). No significant difference in the apparent digestibility of CF and Ca was observed among the treatment groups. Group 1 recorded the highest percentage for apparent digestibility of ash (26.4±0.0%) as compared to 16.7±13.6% and 18.9±1.5% in Groups 2 and 3, respectively. However, no significant difference (P>0.05) was observed for the apparent digestibility of ash among the treatment groups.

Table 6: Apparent nutrient digestibility of Dorper lambs at the post-weaning stage (Mean ± SD).

	Treatments[1]		
Parameter	Group 1	Group 2	Group 3
DMI, kg/head/day	1.408±0.312^{ns}	1.389±0.099^{ns}	1.593±0.131^{ns}
DM (%)	51.3±15.8^{ns}	60.0±10.4^{ns}	60.0±7.8^{ns}
CP (%)	67.9±10.9^{ns}	73.1±6.0^{ns}	73.2±4.6^{ns}
EE (%)	97.8±0.9^{ns}	97.7±0.8^{ns}	97.2±0.8^{ns}
CF (%)	27.5±0.0^{ns}	23.5±22.1^{ns}	17.5±2.7^{ns}
Ash (%)	26.4±0.0^{ns}	16.7±13.6^{ns}	18.9±1.5^{ns}
NFE (%)	63.0±11.0^{ns}	67.8±8.9^{ns}	69.4±6.9^{ns}
Ca (%)	36.6±12.8^{ns}	35.6±14.9^{ns}	28.6±3.7^{ns}
P (%)	63.9±17.1^{ns}	71.5±11.6^{ns}	72.1±1.3^{ns}

DMI:Dry matter intake, DM: Dry matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre, NFE: Nitrogen free extract, Ca: Calcium, P: Phosphorus.
G1: Group 1 (weaned at 30 days), G2: Group 2 (weaned at 60 days), G3: Group 3 (control - weaned at 90 days).
[1]Means with different letters are significantly different at P<0.05

Devendra (1986) contended that increasing nutrient digestibility associated with increased absorption and digestion was more completed when the end products of digestion were the volatile fatty acids (VFA), particularly, with a lower proportion of acetic acid. VFA can be produced by rumen microbes through the fermentation of concentrate feeds (Van Houtert, 1993). The ‘rate of passage’ or speed was directly influenced by the variation in digestibility in which the feed moved through the animal’s digestive system (Davis, 2003). When the value of DMD was below 55%, it can be considered as poor digestibility (Davis, 2003). The results obtained from this study had more than 55% at both stages of weaning except for Group 1 in the post-weaning stage. The apparent digestibility of CP for Groups 2 and 3 were 73.1±6.0% and 73.2±4.6%, respectively which were comparable to Dawit (2007) who noted CP digestibility of 74% for Arsi Bale sheep fed urea treated barley straw, supplemented with vetch and alfalfa. This value was lower than that of Group 1 which recorded 67.9±10.9% for the apparent CP digestibility.

A study in Ethiopia revealed that CP digestibility of Farta sheep ranged from 11.55-78.90% for the control group fed on grass hay only and 4 different groups which were supplemented with concentrate mixture consisted of wheat bran, noug seed cake and their mixtures at different proportions (Fentie and Solomon, 2007). If the protein rich feeds were supplemented to balance low protein roughages, the activity of microorganisms was increased, consequently enabling them to degrade the crude fibre more vigorously (Ranjhan, 2001).

Conclusion

At pre-weaning stage, early weaned lambs showed better nutrient digestibility of CP, CF, ash and P except for EE and NFE. When compared to the post-weaning stage, DMI, CP, P and NFE were well digested in late weaned animals except for EE, CF and ash. In protein balance analysis, early weaned animals displayed the highest value during the pre-weaning stage but intermediate group of animals (weaned at 60 d) recorded highest value during the post-weaning stage.

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