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IMPACT OF DIFFERING CONCENTRATE INCLUSION LEVELS ON THE GROWTH PERFORMANCE OF WEANED LAMBS

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Article Info

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Abstract

In Trinidad and Tobago, the productivity of small ruminant livestock faces several challenges, including inadequate reproductive strategies, genetic stock, and veterinary services. However, the most critical factor limiting productivity is the poor feed supply and feeding system, given that the available feed resources mainly consist of natural pastures and crop residues. These feed sources are characterized by high fibrous content, lignin levels, and low nutritive value. Animals consuming low-quality feed deplete their fat reserves to meet nutrient requirements, resulting in reduced fat storage, particularly during dry forage growth periods and extended underfeeding.

Livestock's live weight and nutritional status significantly impact production efficiency metrics like feed conversion ratio (FCR) and average daily gain (ADG). Most dry forages and roughages in the region have crude protein (CP) content below 7%, making it challenging to meet microbial requirements without protein-rich supplementation. Feeding poor-quality forage alone cannot even fulfill maintenance requirements for livestock. Therefore, improving the feeding system for small ruminants becomes imperative, with a focus on supplementing grass with high-energy feeds.

One promising approach to enhance the nutritive value of crop residues involves strategic supplementation with energy and protein-rich sources, promoting voluntary feed intake, digestibility, and utilization. This study underscores the importance of such supplementation strategies to address the pressing issue of low small ruminant productivity in Trinidad and Tobago.

Introduction

Poor reproductive strategies, inadequate genetic stock, the lack of veterinary services and inadequate quantity and quality of feed can be listed as the causes for low productivity of small ruminant livestock in Trinidad and Tobago. Among these limiting factors, poor feed supply and feeding system is the most critical as the feed resources in

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Trinidad are comprised largely of natural pasture and residues of different crops. McDonald et al. (2002) indicated that all the straws, and related by-products are extremely fibrous, most of them have high levels of lignin and all are of low nutritive value. It was reported that animals fed low quality feed use their fat body reserve in order to fulfill their nutrient requirement which in turn leads to decreased fat storage in their body and as a result mobilization of body fat reserves will start. This is pronounced during dry periods of forage growth and prolonged underfeeding Kirton et al. (1995). Kirton et al. (1995) reported that live weight and nutritional status of animals can influence their production efficiency factors; such as feed conversion ratio (FCR) and average daily gain (ADG). Most dry forages and roughages possess a crude protein (CP) content of less than 7 % which indicates microbial requirement can hardly be satisfied unless supplemented with feeds rich in protein (VanSoest et al., 1994). When fed alone, poor quality forage are unable to provide even the maintenance requirement of livestock (Rege, 1999). Continued feeding of low quality feed stuffs like lignified grass and fibrous crop residues will not result in increases in the rate of live weight gain and enhance performance of weaned lambs. Therefore, it is important to consider the improvement of the feeding system for small ruminants. In this case, the use of supplementation of grass with high energy feeds need due attention.

One possible method of improving the nutritive values of crop residues is through the strategic supplementation with energy and protein rich sources that has the capacity to promote voluntary feed intake, digestibility and subsequent utilization (Nega and Melaku, 2009).

Hence, there is a need to search for alternative feeding methods, which could supplement poor quality roughage feeds to enhance productivity of livestock in the tropics. Some researchers have indicated that lambs supplemented with different levels of concentrate mixture were able to accommodate relatively better lean flesh than lambs fed wheat straw alone. This finding was in line with many other studies, (Asnakew, 2005; Mulu, 2005; Simret, 2005; and Zemichael, 2007). Payne and Wilson (1999) also reported that dressing percentage increases with increasing the proportions of concentrate in the ration. Sandros (1993) reported that grazing lambs supplemented with concentrate had significantly higher slaughter weight, hot carcass weight, and dressing percentage than the non-supplemented lambs. Apparent nutrient digestibility of dry matter (DM) and organic matter (OM) of the basal diet was significantly increased by 14.2% of dry matter (DM) due to supplementation. In line with this result Khanal et al. (1999) reported that there was a 13.3% increment in apparent dry matter (DM) digestibility for sheep supplemented with concentrate mixtures.

The demand for fresh lamb meat in the local market has increased over the last decade even with a decline in local production. Local producers have developed a feeding system where poor quality grass is supplemented with heavy amounts of concentrate to fatten lambs. Feeding accounts for 70 – 80 % of production cost. Escalating feed prices coupled with our present economic climate have forced local producers to adjust the utilization of concentrate feeds. This study was therefore designed to investigate an appropriate concentrate inclusion rate that could positively impact the performance parameters of growing lambs in the most cost effective manner.

Materials and methods

Experimental animals, feeds and management

This study was conducted at the Eastern Caribbean Institute of Agriculture and Forestry Farm, located in Caroni North Bank Road Centeno. The trial's method and procedures were accepted by the Ethics Committee of the University of Trinidad and Tobago. A total of 21 female Barbados Black Belly lambs, weighing an average of 15 to 19 kg was used to evaluate the effect of dietary inclusion of a commercial concentrate (Ruminant mix) on growth performance. Lambs were treated against internal parasites before commencement of the experiment. Seven lambs each of a group of 21 were randomly allotted to each of three dietary treatment groups, that is; Treatment 1: inclusion @ 2 % body weight, Treatment 2: inclusion @ 2.5 % and Treatment 3: inclusion @ 3 % body weight. Animals were subjected to the experimental diets for an adaptation period of 12 days before the commencement of the experiment. The amount of feed offered each time to the lambs were recorded daily. Refusals and wastage were weighed on the following morning. The total weight of the feed offered, adjusted for refusal and wastage, provided an estimate of the average feed consumed by each group per day throughout the study. The animals had free access to water and the volume of water offered each time was recorded daily and the remaining was recorded on the following morning. All of the lambs were fed a basal diet of mixed grass harvested from the farm. Daily water intake, corrected for losses, provided an estimate of the average water intake per day for each group. Animals were weighed on a weekly basis before offering fresh feed. Samples of feed were collected biweekly for proximate analyses (AOAC, 1995).

Chemical Analyses

The DM content was measured by placing 1 g of sample in a porcelain crucible in an oven set at 100°C overnight. The loss in weight was used as a measure of moisture content. Organic matter was determined by igniting 1 g of sample in a muffle furnace at 550 ºC and estimated as the loss in weight of sample. Nitrogen content was determined by using the Kjeldahl method (AOAC 1995, method no.990.03) and was converted to crude protein by multiplying percentage N content by 6.25. Ether extract was determined in accordance with the Soxhlet extract method using petroleum ether as the extract agent (AOAC, 1995). Ash content was determined by incinerating the samples in a muffle furnace at 550 °C (AOAC, 1995).

Carcass analysis

At the end of the experiment, 3 animals were selected from each of the treatments and starved overnight, while having access to water. Live weights at slaughter and dressed carcass weights were recorded.

Economic efficiency

This was evaluated as the feed cost for each pound of weight that was gained by the lambs. Hence, efficiency was calculated as the ratio between income (price of weight gain) and the cost of feed consumed (**feed cost ÷ weight gain**).

Measurements

The following measurements were recorded after calculation: average daily gain (ADG, g/d) was calculated as (**final BW-initial BW/days on feed**); intake was calculated(**feed offered – feed refused**); feed conversion ratio (FCR) was calculated by dividing **DMI/weight gain**; water consumption per unit feed intake (l/kg) was calculated as total water intake/dry matter intake (**TWI/DMI**); weight gain – the total weight an animal has gained for a given period of time(**ending weight – starting weight**); dressing percentage was calculated as (**hot carcass weight/live weight * 100**).

Statistical analysis

Data was analyzed using the General Linear Model procedures of MINITAB (2004). Significant differences among treatment means for dietary effect on growth parameters was analyzed using the least significant difference (LSD) method. Significance was declared at $p<0.05$.

Results

The chemical components of the commercial concentrate (ruminant mix) and mixed grass fed to growing lambs is presented in Table I. There was no difference ($p>0.05$) in dry matter (DM) (901 & 914 g/kg DM) and organic matter (OM) (886 & 891 g/kg DM) content between mixed grass samples and the commercial concentrate. Ash content was higher ($p<0.05$) in the mixed grass samples (104 g/kg DM) when compared to the commercial concentrate (79 g/kg DM).

Table I Chemical composition of feeds used for feeding lambs at ECIAF (g/kg DM)

Sample	DM g/kg	OM g/kg	Ash g/kg	CP g/kg	EE g/kg	CF g/kg	NFE g/kg
Mixed grass	901a	886a	104a	75.4^{a}	18.1^{a}	385a	418a
Ruminant mix	914a	891a	79b	135b	24.7^{b}	50.2^{b}	637b
SEM	0.18	0.10	0.09	0.22	0.32	1.55	3.09

DM: Dry matter, OM: Organic matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre, NFE: Nitrogen Free Extract

Calculated according to (AOAC 1995)

Crude protein (CP) levels were highest ($p<0.05$) in the commercial concentrate (135 g/kg DM) and lowest ($p<0.05$) in the mixed grass (75.4 g/kg DM). Similarly, ether extract (EE) was higher ($p<0.05$) in the commercial concentrate (24.7 g/kg DM) when compared to the mixed grass (18.1 g/kg DM). Crude fibre (CF) values were higher ($p<0.05$) in mixed grass samples (385 g/kg DM) when compared to the commercial concentrate (50.2 g/kg DM). In contrast, nitrogen free extract (NFE) was higher ($p<0.05$) in the commercial concentrate (637 g/kg DM) when compared to mixed grass (418 g/kg DM)

The effect of different levels of concentrate supplementation on feed intake, water intake, average daily gain (ADG), feed conversion ratio (FCR) and weight gain of ewe lambs is presented in Table II. Feed intake was highest ($p<0.05$) among lambs supplemented at 3 % (5.85 kg) of their body weight. However, there was no significant difference ($p>0.05$) between the groups supplemented at 2 % (4.11 kg) and 2.5 % (4.72 kg) of their body weight. Similarly, there was no difference ($p>0.05$) in water intake between the groups supplemented at 2 % (12.9 L) and 2.5 % (12.9 L). However, water intake was highest ($p<0.05$) among animals supplemented at 3 % (15.3 L) of their body weight (Table II).

Table II Effect of supplementation on the performance parameters of ewe lambs

Treatment	Feed intake (kg)	Water intake (L)	ADG (kg)	FCR (kg)	Weight gain (kg)
2%	4.11^{a}	12.9^{a}	0.56^{a}	7.52^{a}	14.4^{a}
2.5%	4.72^{a}	12.9^{a}	0.56^{a}	8.50^{b}	16.3ab
3%	5.85^{b}	15.3^{b}	0.70^{b}	8.28^{b}	20.6^{c}
SEM	0.189	1.044	0.021	0.210	1.662

^{abc}Means in the same column within a parameter with different superscripts differ significantly; $p<0.05$. ADG: Average daily gain, FCR: Feed conversion ratio, SEM: Standard error of mean

Average daily gain (ADG) was highest ($p<0.05$) among ewes supplemented at 3 % (0.70 kg) of their body weight. There was no difference ($p>0.05$) in average daily gains (ADG) between the groups supplemented at 2 % (0.56 kg) and 2.5 % (0.56 kg) respectively.

Feed conversion ratio (FCR) was significantly lower among animals supplemented at 2 % (7.52 kg) when compared to animals supplemented at 2.5 % (8.50 kg) and 3 % (8.28 kg) of their body weight respectively. Weight gain was significantly higher ($p<0.05$) among ewes supplemented at 3 % body weight in comparison to ewes supplemented at 2 % (14.4 kg) and 2.5 % (16.3 kg) respectively (Table II).

The effect of concentrate supplementation on final weight, feed cost per pound of gain, dressing percentage and mortality of ewe lambs is illustrated in Table III. Final weight gained was significantly lower ($p<0.05$) among lambs supplemented at 2 % (34.8 kg) when compared to those supplemented at 2.5 % (46.4 kg) and 3 % (44.8 kg) of their body weight.

Table III Effect of supplementation on weight, cost/gain and dressing percentage of ewe lambs

Treatment	Final weight (kg)	Feed cost/lb of gain ($TT)	Dressing percent (%)	Mortality (%)
2%	34.8^{a}	8.18^{a}	46a	0
2.5%	46.4^{b}	9.52^{a}	45.7^{a}	0

3%	44.8^b	7.71ab	42.9^b	0
SEM	1.662	1.133	0.524	

[abc]Means in the same column within a parameter with different superscripts differ significantly; p<0.05. SEM: Standard error of mean

Ewes supplemented at 3 % of their body had a lower (p<0.05) feed cost per pound of gain ($7.71) when compared to those supplemented at 2.5 % ($ 9.52). Dressing percentage was also lowest (p<0.05) among ewes supplemented at 3 % of their body weight (42.9 %) when compared to ewes supplemented at 2 % (46 %) and 2.5 % (45.7 %) respectively. There was no difference (p>0.05) in mortality of lambs across the groups (Table III).

Discussion

Grass forages in Trinidad and Tobago do not provide adequate protein to support the growing needs of lambs. This study emphasized the need to support local grass pastures with some level of concentrate.The crude protein (CP) levels of the mixed grass (CP 75.4 g/kg DM) as seen in Table I, would prove inadequate for fattening lambs as their CP requirement ranges from 130 to 160 g/kg DM (NRC, 2001). This mixed grass can be classified as a low quality forage. According to Obeidat et al. (2019), low quality forages are deficient in crude protein (less than 8% crude protein; CP), low in soluble sugars and starches, and are made up of natural pastures or crop residues. Supplementing the mixed grass with the National Feed Mills (NFM) Ruminant mix (CP 135 g/kg DM, Table I) have shown that the combination is more than capable of meeting the CP needs of these animals. The crude fibre (CF) content of the mixed grass is relatively high (385 g/kg DM, Tables I) which can lead to reduced intake due to gut fill. Additionally, high levels of fibre in the diet can result in decreased digestibility of dry matter thus limiting the supply of energy required for animal productivity. The crude fat (Ether extract) levels appear to be low (18-23 g/kg DM, Table I) for the mixed grass and the commercial concentrate. These levels may be adequate for rumen health as high levels of dietary fat (> 5 %) can negatively impact rumen microbes which can result in reduced degradability and dry matter intake owing to their inactivity.

Feed intake was highest (p<0.05) among lambs supplemented at 3 % (5.85 kg) of their body weight. This is in agreement with Hossain et al. (2003), Yagoub & Babiker (2008) and Sayed (2009) who reported that the level of energy significantly influenced daily feed intake of lambs, suggesting that nutrient digestibility increases with increased supplementation. Obeidat et al. (2019) concluded thatlambs supplemented with crude protein (CP) will have greater feed intake and growth compared to the non-supplemented lambs grazing low-quality forages.Water intake was highest (p<0.05) among animals supplemented at 3 % (15.3 L) of their body weight (Table II). It is possible that as digestibility increases there is a greater demand for water to conduct metabolic processes.This study illustrated that aaverage daily gain (ADG) was highest (p<0.05) among ewes supplemented at 3 % (0.70 kg) of their body weight. This supports the findings of (Asnakew, 2005) who indicated better gains in animals supplemented at high levels.Similarly, this finding agreed with that reported by Ebrahimiet al. (2007). They concluded that lambs fed on energy dense rations recorded higher significant average daily gain than that of lambs 66 on medium and low energy diets. Also, average daily gain was highest in goat kids fed high-energy diet and lowest in goats fed low energy diets (Hossain et al., 2003).

Increasing the levels of energy may facilitate the proliferation of more fermentable metabolizable energy (ME) for rumen microorganisms resulting in enhance microbial protein synthesis and increased amounts of protein available to the animal.

Final weight gained was significantly lower (p<0.05) among lambs supplemented at 2 % (34.8 kg) when compared to those supplemented at 2.5 % (46.4 kg) and 3 % (44.8 kg) of their body weight. This suggest that animals supplemented at higher levels are more efficient at utilizing feeds made available. Chegeniet al. (2019) and Manera et al. (2014) reported that the average daily gain (ADG) and the body weight (BW) gain of different sheep breeds were enhanced by those consuming higher levels of protein supplements.

Dressing percentage was also lowest (p<0.05) among ewes supplemented at 3 % of their body weight (42.9 %) when compared to ewes supplemented at 2 % (46 %) and 2.5 % (45.7 %) respectively. This does not support the findings of Payne and Wilson (1999) who reported that dressing percentage increases with increasing the proportions of concentrate in the ration. However, the dressing percentages of this study fell within the range of those reported by Macedo, Siqueira and Martins (1999). They concluded that the carcass yield of sheep may vary from 40 to 50%. The carcass yield obtained in this study was higher than those reported by Furusho-Garcia et al. (2010) (39.46%) in a study involving Santa Inês sheep slaughtered at an average weight of 38 kg. Ewes supplemented at 3 % of their body had a lower ($p<0.05$) feed cost per pound of gain ($7.71) when compared to those supplemented at 2.5 % ($ 9.52). The higher economic efficiency for lambs fed on high-energy diet compared with other supplemented groups could be attributed to increasing energy levels in lamb's diet. High energy diets are known to result in increased growth performance, adequate digestibility of nutrients and carcass yield of lambs (Sayed, 2009). Moreover, supplementing low-quality forage in ruminant diets with quality crude protein can reduce feeding expenses while maintaining or enhancing animal performance, voluntary feed intake and the digestibility of nutrients (Huston et al., 1999 and Currier et al., 2004).

Conclusions

Generally, the present study demonstrated that supplementation of growing lambs with varied levels of concentrate on grass basal diets can improve feed intake, average daily gain, efficiency of feed conversion, weight gain and cost/lb of gain. Moreover, it was concluded that inclusion of concentrates at 3 % of lamb body weight resulted in better feed intake, daily gain, feed conversion efficiency and body weight of growing lambs compared to other rates of inclusion and could be recommended in practice. Further work should be conducted in an effort to establish an optimum inclusion rate.

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Conflicts of Interest: The authors declare that there is no conflict of interest regarding this study.

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