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Productive Response of Pelibuey Sheep to Supplementation in the Stretching Season in the Dry Tropic

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Abstract

Sheep meat production in the dry tropics of Mexico is low in the dry season, due to lack of forage, therefore, strategic supplementation is important to avoid weight loss in animals; The research was carried out from August 15 to December 15, 2020 in order to evaluate the productive response of pelibuey sheep in confinement, fed with pangola grass hay (GH), plains grass silage (PGS) and supplemented with commercial feed (CF) in the dry season. 16 sheep of the same weight and age were used, four treatments were evaluated in them, in a completely random design; the treatments were four levels of supplement 0, 0.1, 0.2 and 0.3 kg of AC fed with HP and PGS. Sheep were dewormed at the beginning of the experiment and housed in individual cages. The variables were: dry matter intake, daily weight gain (DWG) and DM digestibility. DM consumption was different ($P < 0.01$), the lowest consumption was 0.364 kg in treatment 1 (T1), with a maximum of 0.684 kg in T4; WDG was different ($P < 0.01$), with a lower value of 0.044 kg·day^{-1} in T1 and a higher value of 0.112 kg in T4. The apparent digestibility of the dry matter showed a difference ($P < 0.01$) which varied from 45.52 to 59.15% for T1 and T4, respectively. DM intake, WL gain, and DM digestibility increased with increasing supplement level at the levels studied.

Keywords

Intake, Weight Gain, Sheep, Digestibility

1. Introduction

In Mexico, the tropical region comprises approximately 56 million ha, representing 28% of the national territory; Most of this surface, which comprises 16%, is lo-

cated in the tropics with a warm subhumid climate and 12% corresponds to a warm humid climate [1]. The sheep inventory in the state of Oaxaca was 515, 782 heads and in the rural development district coast of 3, 249; with a slaughter percentage of 16.9 in relation to the total number of sheep in the state and 17.3% in the coastal development district, with a carcass meat yield of 17.8 and 17.7 kg at the state level and the Oaxacan coast, respectively [2].

In regions with a warm climate the cattle feed on native forage, stubbles, grain and sometimes supplemente with legume pods in the tropics [3] [4], animal production is low, a situation caused by the seasonality of rainfall which, in periods of low water where the availability of native forages decreases drastically, in turn, generates variations in the growth, production and quality of the forage, used for feeding livestock, which causes that the animals do not consume the quantity or quality of food required for maintenance and production, having losses in weight gain and milk production [5] [6]. In most ruminant producing tropical areas, they suffer nutritional stress either temporarily or permanently the most common deficiency in forages is energy; However, it has been mentioned that one of the main problems, limiting the productivity of cattle, under grazing conditions, is the protein deficiency in the forage, particularly in the dry season, since 22% to 49% of the Tropical forages are deficient in this nutrient [7] [8].

A viable alternative to improve animal production is strategic supplementation, the objective of which is to provide the animals with nutrients that forage does not provide in sufficient quantities [9], which can increase weight gain, decrease mortality, accelerate puberty and improve the percentage of calving, among other benefits; It has been shown that supplementation to ruminants both in grazing and in stables in the dry season, improves the productive parameters of animal production systems [10], profitability and quality of life of producers [11]. Therefore, this research was carried out with the objective of evaluating the productive behavior of pelibuey sheep under confinement conditions, fed with pangola grass hay, llanero grass silage and supplemented with commercial feed in the dry season, in San José Estancia Grande, Oaxaca, México.

2. Materials and Methods

The research was carried out at the Technological Institute of Pinotepa, in the academic unit in San José Estancia Grande, Oaxaca, Mexico, located at 16˚22' north latitude and 98˚13' west longitude, at 70 meters above sea level [2], with a warm subhumid climate, with rains of 800 mm in summer and an average annual temperature of 26.9˚C [12]. Pangola grass hay, llanero silage and four supplement levels 0, 0.1, 0.2 and 0.3 kg·animal^{-1}·day^{-1} was used as the base feed for all treatments; treatments were T1: pangola grass hay + llanero silage without suplementation; T2: pangola grass hay + llanero silage + 0.1 kg commercial feed; T3: pangola grass hay + llanero silage + 0.2 kg commercial feed and T4: pangola grass hay + llanero silage + 0.3 kg commercial feed.

The sheep were dewormed the next day they arrived at the experiment site in-

ternally with Albendaphorte to the 2.5% Co from the Animal Health and Welfare laboratory, taken twice every 20 days, the dose used was 1.5 ml per 10 kg of live weight, and externally bathed with 12.5% Bovitraz of Amitraz from Bayer laboratory, the doses used was 2.0 ml by litter water twice every 10 days and housed in individual cages, in which they randomly received the evaluated treatments. The feeding management consisted in offering daily a known quantity of plains silage (*Andropogon gayanus*) with 6% crude protein and 47.2% of dry matter digestibility and, at noon, it was offered the commercial Purina supplement with 12% crude protein and, finally ad libitum, pangola hay (*Digitaria decumbens* Stemp) 5.2% crude protein and 45.5% of dry matter digestibility was assigned; silage and hay rejects were weighed daily; the sheeps were weighed every eight days throughout the experimental period. The supplement was weighed daily on an Ohaus brand granataria scale and was offered individually to each sheep in plastic buckets during the hottest hours of 2:00 p.m.

The variables measured were daily dry matter intake, which was determined by adding the dry matter consumed from silage, pangola hay and the supplement, the daily weight gain was obtained by dividing the accumulated weight gain throughout the experimental period between the time that it is hard and, the apparent digestibility of the dry matter was determined using the technique of total collection of faeces.

To study the effect of the treatments on the live weight gain of the sheep, the consumption of dry matter and the apparent digestibility of the dry matter, were analyzed statisticament by analysis of variance for a completely random design, using the PROC GLM procedure the SAS [13] program and the treatments means were compared using the Tukey test ($\alpha = 0.05$). To analyze the type of response exhibited by weight gain, due to the effect of supplementation levels imposed by the studied treatments, the orthogonal polynomial technique and regression techniques were used. The analysis in Table 1 is given by the company PURINA (2019).

3. Results and Discussions

Dry matter consumption (DMC)

The average DMC in response to the effect of the studied treatments are con-

Table 1. Nutritional composition of commercial food used as supplement.

Nutrient	Unit of measure (%)
Humidity	12.00 Maximum
Proteín	12.00 Minimum
Fat	2.00 Minimum
Fiber	26.00 Maximum
Ashes	20.00 Maximum
Nitrogen-free Extrac	23.00 Per diference
Calcium	4.60 Maximum
Fosphorus	0.40 Minimum

centrated in Table 2, whose analysis shows highly significant differences ($P < 0.01$) between treatments, with a lower daily consumption of 0.364 kg per sheep in treatment 1 and a higher consumption of 0.684 kg occurred in T4.

Treatment 1 was different ($P < 0.05$) to the dry matter (DM) consumption observed in treatments 2, 3 and 4 and, represented 77.4%, 62.7% and 53.4% of the consumption achieved in these last treatments, respectively; Similarly, the treatments in which the sheep were supplemented T2, T3 and T4 were different from each other ($P < 0.01$), the consumption achieved in T4 being higher ($P < 0.05$) in 45.5% and 17.9% than the intakes observed in treatments 2 and 3, respectively, in general the treatments in which the sheep were supplemented on average were higher ($P < 0.05$) in 58.7% than the consumption obtained in T1.

In general terms, by increasing the level of supplement to sheep, the consumption of dry matter increased significantly, however these consumptions are lower than those reported by [14] who on average observed consumption of 1.11 kg DM per sheep·day^{-1}, when substitute sugarcane molasses for Algarrobo *Ceratonia siliqua* pods in sheep rations at three levels, these differences may be due to the fact that the sheep used were heavier and the rations were made up of better quality ingredients; in the same way, they are different from those reported by [15] who report values ranging from 1.19 to 1.3 kg DM·sheep^{-1}·day^{-1}, in the same climate and place. However, they are similarly to the values reported by [16] whose DM intakes ranged from 0.55 to 0.76 kg·animal^{-1}·day^{-1}.

The low dry matter intakes observed in this research may be due in part, to the fact that both the pangola grass hay and the plains grass silage had already matured, that is, when the content of cell walls presents a high value, low concentration protein and energy and low dry matter digestibility value. The observed behavior of the consumption of dry matter may be due to the fact that by adding a greater quantity of commercial food as a supplement, this improves the digestibility of the dry matter consumed, thereby increasing the rate of passage of what is ingested and, as a consequence, it allows the animal to have a higher

Table 2. Daily dry matter consumption of pelibuey sheep supplemented with commercial feed in the dry season, in San José Estancia Grande, Oaxaca, Mexico.

Treatments	Consumtion (Kg DM·animal^{-1})	EEM*
T1	0.364^{a**}	0.023
T2	0.470^{b}	0.025
T3	0.580^{c}	0.025
T4	0.684^{d}	0.027
Average	**0.524**	

*Standard error of the mean; **Means with different literals in the column are different Tukey ($P < 0.05$); T1: Control treatment of pangola grass hay and plains grass silage; T2: 0.1 kg of supplement per sheep per day, pangola hay and flat grass silage; T3: 0.2 kg of supplement per sheep per day, pangola grass hay and llanero silage and T4: 0.3 kg of commercial supplement per sheep per day, pangola grass hay and llanero silage.

DM consumption.

Daily weight gain

The analysis of variance carried out for this variable showed a highly significant difference ($P < 0.01$), where the highest weight gains 0.112 kg were observed in T4, and the lowest gain 0.044 kg·animal^{-1} day^{-1} in T1. The average daily weight gains are concentrated in Table 3, in which it is observed that treatment 1 was different ($P < 0.01$) from treatments 2, 3 and 4, in the same way, treatment 2 showed differences ($P < 0.01$) to treatments 3 and 4, similarly, T3 and T4 presented differences ($P < 0.01$) in this variable, due to the effect of treatments.

The weight gain achieved in T1 represented 69.8, 52.4 and 39.3% of the gain obtained in treatments 2, 3 and 4, respectively. Treatment 2 was superior ($P < 0.01$) 43.2% to treatment 1, treatments 3 and 4 exceeded ($P < 0.01$) 90.9 and 154.5% respectively to T1 and, on average, the treatments in which a supplement was used were superior in 96.2% to treatment 1. On the other hand, T3 was 33.3% higher ($P < 0.01$) than T2, and T4 surpassed T3 by 33.3%. In general terms, it is observed that as the supplement to sheep was increased, the daily weight gain increased, this increase was sustained to the extent that a higher level of supplementary food was offered to the animals.

Although the daily weight gain in sheep increased, these were low, this possibly could be due to the fact that both the pangola grass hay and the llanero grass silage, did not have the adequate quality to contribute in quantity the nutrients (protein and energy) that the sheep required to produce a better weight gain, this can be strongly related to the low values of apparent digestibility of the dry matter of the evaluated treatments.

These values of daily weight gain are lower than those found by [14] who on average reports gain of 0.138 kg·sheep^{-1}, said difference may be due to a higher quality of the rations evaluated; In the same way, the weight gain in this research was lower than that reported by [15], whose value ranged from 0.185 to 0.19 kg·animal^{-1}·day^{-1}, when replacing cane molasses with Algarrobo pods (*Ceratonia*

Table 3. Daily weight gain of pelibuey sheep fed with pangola grass hay, llanero grass silage and commercial feed in the dry season, in San José Estancia Grande, Oaxaca, Mexico.

Treatments	Weight gain (Kg)	EEM*
T1	0.044^{a**}	0.002
T2	0.063^{b}	0.003
T3	0.084^{c}	0.003
T4	0.112^{d}	0.003
Average	**0.076**	

*Standard error of the mean; **Means with different literals in the column are different Tukey ($P < 0.05$); T1: Control treatment of pangola grass hay and plains grass silage; T2: 0.1 kg of supplement per sheep per day, pangola hay and flat grass silage; T3: 0.2 kg of supplement per sheep per day, pangola grass hay and llanero silage and T4: 0.3 kg of commercial supplement per sheep per day, pangola grass hay and llanero silage.

siliqua); however, they are similar to those reported by [16] whose values ranged from 0.076 to 0.111 kg per·animal^{-1} day^{1}, when evaluating rations containing different proportions of parota pods (*Enterolobium cyclocarpum*) in young lambs.

The behavior exhibited of the daily weight gain, as a result of the treatments evaluated in this research, may be due to the fact that, by offering supplementary feed in increasing quantities to the sheep, the protein and energy intake was improved, thereby favored a better daily weight gain, in response to a higher consumption of feed per day, as can be seen in Table 1, and possibly to a better apparent digestibility of the dry matter consumed by the sheep, in the treatments studied.

Productive response to supplementation

In Figure 1 it is observed that the type of response exhibited by weight gain, due to the net supplementation effect, is linear, since when the sheep were offered 0.1 kg of DM of the commercial supplement, formulated for sheep, they gained 0.02 kg LW·day^{-1}, on the other hand, by increasing the amount of supplement to 0.2 kg·animal^{-1}·day^{-1}, the sheep managed to gain 0.04 kg·day^{-1}, in the same way by increasing the supplement level to 0.3 kg·sheep^{-1}·day^{-1} the sheep gained 0.068 kg of live weight. The equation that represents this phenomenon is WDG = −0.01206 + 0.7247X, with a coefficient of determination of r^2 = 0.955, for the dry season.

In this graph, in general terms a linear response is observed, where by increasing the amount of supplement in the treatments, the response of the sheep was to increase the daily weight gain, however, these observed responses are low, which may be due to the fact that the diet offered to the sheep consisted of a large proportion of pangola grass hay, which presented a DM digestibility of 45.5%, therefore, the contribution of nutrients such as protein and energy by the forage was low, which implies that the retention time of the intake in the rumen reticulum was longer, which negatively influenced the response of the sheep in weight gain.

This type of WG response to supplementation in the dry season coincides with that found by [14] [17], when evaluating supplementation levels in sheep in stables during the dry season and, with that reported by [2] for the dry season,

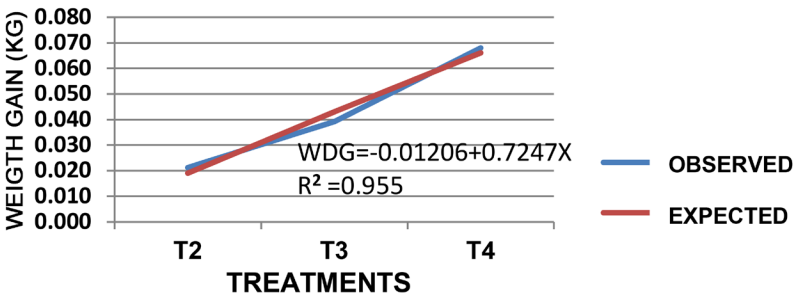

Figure 1. Productive response of pelibuey sheep, to protein energy supplementation, in confinement in the dry season, in San José Estancia Grande, Oaxaca, Mexico.

under dry tropic conditions for grazing calves in a pangola meadow by substituting commercial feed for cacahuananche flour (*Gliricidia sepium*).

Apparent dry matter digestibility (ADMD)

The mean values of the ADMD are presented in Table 4, in which it can be seen that the lowest digestibility value 45.5% was presented in treatment 1 and the highest 59.15% in treatment 4. A significant difference was found ($P < 0.05$) between treatments 1 and 4, with treatments 2, 3 and 4 being equal ($P > 0.05$) in digestibility.

The behavior of this variable may be due to the fact that, by increasing the level of supplement in the treatment, this caused a positive effect on the ADMD consumed, since it improved substantially, which allowed increasing the consumption of daily DM Table 2 and, improved the daily weight gain Table 3. However, despite an improvement in the ADMD, it is unquestionable that these digestibility values do not allow high DM intakes and, consequently, there are low daily weight gain.

These results coincide with those recorded by [14], which fluctuate from 44% to 56.1% when evaluating with sheep, three levels of substitution of cane molasses for carob pods in the diets, in the same way with what was found by [18], who report DM digestibility values ADMD that varied from 47% to 57%, by increasing the levels of supplementation to young bulls in stables, fed with pangola grass hay and llanero grass silage, the highest level of supplementation produced the best ADMD value.

4. Conclusion

According to the conditions in which the experiment was carried out and the results obtained, it can be concluded that supplementation with commercial feed at the levels used in this research, to pelibuey sheep fed with pangola grass hay and plains grass silage, improved the consumption of dry matter, the daily weight

Table 4. Apparent digestibility of daily dry matter consumed by pelibuey sheep fed with pangola grass hay, plains grass silage and commercial feed in the dry season, in San José Estancia Grande, Oaxaca, Mexico.

Treatments	Digestibility (%)	EEM*
T1	45.52^{b**}	1.22
T2	48.00^{ab}	1.54
T3	50.18^{ab}	1.25
T4	59.15^{a}	1.95
Average	**50.71**	

*Standard error of the mean; **Means with different literals in the column are different Tukey ($P < 0.05$); T1: Control treatment of pangola grass hay and plains grass silage; T2: 0.1 kg of supplement per sheep per day, pangola hay and flat grass silage; T3: 0.2 kg of supplement per sheep per day, pangola grass hay and llanero silage and T4: 0.3 kg of commercial supplement per sheep per day, pangola grass hay and llanero silage.

gains and the digestibility of the dry matter of the evaluated treatments and, the productive response of the sheep increased, as the level of supplement in the treatments increased, the response being linear.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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