AGRO PRODUCTIVIDAD

Colegio de Postgraduados

Economic evaluation and productive performance of lambs finished with concentrate and corn stover

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Citation: Martínez-Martínez, R., Godoy-Pelayo, O., Vicente-Pérez, R., Moreno-Hernández, A., Macías-Cruz, U., Cárdenas-Flores, F. J., Grifaldo-Alcántara, P.F., & Gómez-Vázquez, A. (2022). Economic evaluation and productive performance of lambs finished with concentrate and corn stover. *Agro Productividad*. https://doi.org/10.32854/agrop.v15i7.2326

Academic Editors: Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

Received: February 04, 2022.
Accepted: July 15, 2022.
Published on-line: August 08, 2022.

Agro Productividad, 15(7). July. 2022. pp: 111-117.

ABSTRACT

Objective: To evaluate the effect of two concentrates and corn stover in the productive performance and economic impact of finishing hair lambs in pens.

Design/Methodology/Approach: Twenty hair lambs (Dorper×Katahdin) with an initial live weight of 33.3±2.9 kg were grouped into ten blocks (two lambs per block) and then were randomly assigned to two treatments: T1) commercial concentrate + corn stover and T2) experimental concentrate + corn stover (with an 80:20 ratio). The total weight gain (TWG), average daily gain (ADG), dry matter intake (DMI), feed conversion (FC), feeding costs, gross value of TWG, gross profit margin and economics of feed efficiency (EE) were evaluated. An analysis of variance was performed under a completely randomized block design. The means were compared with the Tukey test (α=0.05).

Results: There were no differences in TWG, ADG, FC, and DMI (P>0.05). T1 has higher costs (US$41.91) per ton of feed. Production costs of diets and feeding were lower for T2, which also showed the best economic feed efficiency (EE=26.6%).

Study Limitations/Implications: Their availability throughout the year is the advantage of using agro-industrial and agricultural by-products (*e.g.*, corn stover) in total mixed diets to finish ovines.

Findings/Conclusions: Lambs finishing is profitable when the producer formulates and prepares his own diet, reducing feeding production costs without affecting productive variables.

Keywords: Hair sheep, feedlot finishing, economic impact.

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INTRODUCTION

In Mexico, the largest sheep meat production is obtained from extensive and semi-extensive systems, where average daily gain is low (120-150 g d^{-1}) and the lamb mortality rate is high (30-40%) (González-Garduño *et al.*, 2013). Consequently, lambs finished under this system take longer to get to market, although the production cost is relatively low. In recent years, taking into account the competitive price and the high demand for sheep meat, producers —mainly from central and northern Mexico— have chosen to finish lambs in intensive systems: the grain-based total mixed diets provided to lambs allows them to fulfill their genetic potential for growth (Mendoza-Martínez *et al.*, 2007). These systems have then made it possible to reduce fattening periods by improving dry matter intake, average daily gain, and feed efficiency. However, production costs undergo a considerable increase, since they require facilities and total mixed diets (Macedo and Castellanos, 2004).

The feed used in intensive systems to fatten sheep includes total mixed diets or commercial concentrates combined with 20-30% forage. Alfalfa is generally used as forage, due to its year-long availability, particularly in central-northern Mexico (Muñoz-Osorio *et al.*, 2016; Rodríguez-Hernández *et al.*, 2019). The cost of commercial concentrates has become increasingly high and expensive for producers; however, approximately 50% of sheep farmers still depends on them (Muñoz-Osorio *et al.*, 2015). One strategy to reduce feeding costs is having producers formulate and prepare their own diets, based on regionally available supplies, combined with corn stover as a source of fiber. Although Guerra-Medina *et al.* (2015), Sun *et al.* (2018) and others have already researched the nutritional feasibility of using concentrates with corn stover in the diet of fattening sheep, there is scarce information available about the economic impact of implementing this nutritional strategy for sheep fattening. Therefore, it is necessary to carry out an economic analysis of sheep fattening with total mixed diets that include corn stover. Thus, the objective of this study was to evaluate the use of two concentrates with corn stover on the productive performance and economic impact of finishing hair lambs in pens.

MATERIALS AND METHODS

Location and description of the study area. The research was conducted from July to August 2019, at the "Mezquitalito" ranch, located in the municipality of Autlán de Navarro, Jalisco (212° SW latitude, 19° 45' 55" N and 104° 19' 55" W, at 890 m.a.s.l.). The climate of the region is predominantly semi-dry, with most of the rains concentrated in summer and an average annual temperature of 23.5 °C (García, 2004).

Animals and handling. Twenty F1 hair lambs (Dorper×Katahdin, 33.3±2.9 kg LW) were used. In average they were 3.5-months old. Prior to the start of the experiment, the lambs received an antiparasitic prophylactic treatment (200 mcg Ivermectin/kg LW, subcutaneous route; Ivermectin, Sanfer Laboratory, Mexico City, Mexico) and vitamins (1 ml of A-D-E, intramuscular route; Vigantol, Bayer, Mexico City). The animals were housed in individual pens that included a feeder and a drinker (*ad libitum* water). The lambs adapted to the experimental diets 10 days before the performance test. The evaluation was made in the following 30 days.

Treatments. At the beginning of the test, the lambs were grouped into ten blocks, each with two lambs with similar initial LW (blocking factor). Subsequently, two treatments were randomly assigned to each block: T1) commercial concentrate + corn stover (n=10) and T2) experimental concentrate + corn stover (n=10) at an 80:20 ratio. The experimental diet was formulated (2.8 Mcal of ME kg^{-1} DM and 15% CP) in order to obtain a 300 g d^{-1} gain (NRC, 2007). Table 1 shows the ingredients and chemical composition of the experimental diets.

Evaluated variables. Productive performance: Initial (day 1) and final (day 31) weight (kg) was recorded before the morning feeding. Additionally, the weight of food offered and rejected the previous day was recorded every day, in order to calculate the dry matter intake (DMI). The amount of feed offered on the first day of the test was 1.5 kg/lamb; subsequently the amount was adjusted daily, taking into consideration an approximate rejection rate of 10%. The availability of clean water and the health status of the animals were checked

Table 1. Ingredients and chemical composition of the experimental diets.

Ingredients, kg t^{-1}	T1	T2
Maxiengorda[1]	800	-
Ground corn	-	570
Soybean meal	-	100
Wheat bran	-	80
Vegetable oil	-	20
Minerals	-	20
Urea	-	10
Corn stover	200	200
Chemical composition (%)		
Dry matter	90.0	90.7
Crude protein	13.0	15.0
Fat	4.9	5.3
Fiber	14.4	9.9
Ashes	4.0	3.1
Acid detergent fiber	13.0	12.6
Neutral detergent fiber	25.4	24.3
Total digestible nutrient, TDN	76.5	77.1
Energy from de diet (Mcal kg^{-1})		
Digestible energy, DE	3.4	3.4
Metabolizable energy, ME	2.8	2.8
Net energy for maintenance, NEm	1.8	1.8
Net energy for growth, NEg	1.2	1.2

[1]Sorghum, yellow corn, soybean meal, canola meal, corn gluten, molasses, flavoring, vitamins (A, D, E), minerals (calcium, cobalt, phosphorus, iron, manganese, potassium, and zinc), and antioxidant (B.H.T.); TDN=91.0246−0.571588*NDF (Cappelle *et al.*, 2001); DE=TDN×0.044 (NRC, 1985); ME=0.82×DE (NRC, 1985); NEm=1.37×ME−0.14ME^2+0.01ME^3−1.12 (NRC, 1985); NEg=1.42×ME−0.17ME^2+0.012ME^3−1.65 (NRC, 1985).

daily. The total weight gain (TWG, kg) was calculated based on the difference between the final weight and the initial weight; meanwhile, average daily gain (ADG, g d^{-1}) was obtained by dividing TWG between the number of days of the test. The consumption of DM (DMI, kg d^{-1}) was calculated based on the difference between the food offered and rejected each day and finally it was multiplied by the DM% of the food. Feed conversion (FC) was calculated as the DMI:ADG ratio.

Economic impact: All the supply costs that were used to formulate the diet and the live lamb price per kilogram in the market were gathered. The data were reported in US dollars (US$), considering an exchange rate of 1 US$=$20.2321 Mexican pesos. The experimental diets' production costs (US$ t^{-1} MS) were calculated multiplying the price (US$/ t^{-1} MS) of the ingredients by the amount (t^{-1}) used in each diet, adding the total at the end. Subsequently, some of the economic parameters described below were estimated using the methodology proposed by Mahrous *et al.* (2021). The feed cost was estimated multiplying the diet cost times the total DMI in the period, while the gross value per TWG was determined multiplying the total gain in the period times the kg price of live lamb (US$2.1). The gross profit margin was calculated as the difference of the TWG gross value and the feed cost. Finally, the economics of feed efficiency (EE) was obtained dividing the percentage of the gross profit margin by the feed cost.

Statistical analysis. An analysis of variance was performed with a randomized complete block design using the PROC GLM of the SAS statistical package (SAS, 2011). The means were compared using a Tukey test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Table 2 shows the productive performance results: there were no differences between treatments ($P > 0.05$). Sheep ADG was 250 g d^{-1}, similar to the results reported in hair sheep (Muñoz-Osorio *et al.*, 2016), but lower (300 g d^{-1}) than the expectations (NRC 2007). On the one hand, Guerra-Medina *et al.* (2015) reported a 301 g d^{-1} ADG in Katahdin×Dorper lambs that consumed concentrates with 15% of corn stover; however, they consumed a similar amount of energy and protein (1.2 Mcal kg^{-1} of ME and 13.3% of CP) than the diets in this study. On the other hand, Vicente-Pérez *et al.* (2020) reported a 343 g d^{-1} ADG in Katahdin lambs that consumed the same experimental concentrate

Table 2. Productive performance of lambs finished with concentrates and corn stover.

	T1	T2	S.E.M.	P
Number of lambs (n)	10	10	-	-
Initial weight, kg	34.39	34.21	0.31	0.57
Final weight, kg	42.17	41.37	0.83	0.36
Total weight gain, kg	7.78	7.16	0.76	0.43
Average daily gain, g d^{-1}	259	239	25.50	0.43
Dry matter intake, kg d^{-1}	1.47	1.31	0.09	0.11
Feed conversion, kg kg^{-1}	5.93	5.93	0.43	0.99

T1=Commercial concentrate - corn stover (80% - 20%); T2=Experimental concentrate - corn stover (80%-20%); S.E.M.=Standard error of the mean.

than T1, but with 20% pine sawdust as fiber source. Additionally, the feed conversions of both treatments were higher than in sheep exploited in southeastern Mexico. This is an important variable for the profitability of fattening. Munoz-Osorio *et al.* (2015) reported feed conversions of 5.0 (in raised pens) and 3.2 (in ground-level pens) in intensive feedlot systems. In both systems the lambs were fed commercial-brand or farm-made feeds combined with tropical grasses.

Table 3 shows the production costs of the experimental diets. The costs of T1 increased by US$41.91 per ton of feed. Therefore, T2 is a viable option to finish sheep in the same time, at a lower diet cost. The high cost of grains and cereals has put the subsistence of production systems at risk —a risk that intensifies when the producer depends on commercial brand foods. A study in Yucatan reported that 47% of the producers fatten their lambs with commercial feed, while the rest prepare their own diets and a few others buy their feed from informal suppliers (Muñoz-Osorio *et al.*, 2015). In this sense, this study reached economically important results: producers are encouraged to seek advice and prepare their own diets with locally available supplies.

Table 4 shows feed costs, gross value per weight gain, gross profit margin and economic feed efficiency per fattening lamb finished with concentrates and corn stover. The gross

Table 3. Production costs (US$ t^{-1} DM) of experimental diets for lambs finished with concentrates and corn stover.

Ingredients	Price, (US$ t^{-1} MS)	T1		T2	
		Quantity (t^{-1})	Cost (US$)	Quantity (t^{-1})	Cost (US$)
Corn stover	176.45	0.2	35.29	0.2	35.29
Maxiengorda	386.51	0.8	309.21	-	-
Concentrate	334.12	-	-	0.8	267.30
TOTAL	-	1.0	344.50	1.0	302.29

T1=Commercial concentrate-corn stover (80%-20%); T2=Experimental concentrate-corn stover (80%-20%).

Table 4. Gross profit margin and economic feed efficiency obtained in hair lambs finished with concentrates and corn stover.

Items	T1	T2	S.E.M.	P
Cost of feed, US$ kg^{-1} DM	0.34	0.30	-	-
Total DM intake, kg $animal^{-1}$	44.23	39.33	2.79	0.11
Total DM intake cost (US$ $animal^{-1}$)	15.24	11.90	0.90	<0.01
Market price, US$ kg^{-1} live body weight	2.1	2.1	-	-
Profit of total weight gain[1] (US$ $animal^{-1}$)	16.53	15.22	1.62	0.43
Gross profit margin[2] (US$ $animal^{-1}$)	1.30	3.32	1.09	0.09
Economics of feed efficiency[3] (%)	7.56	26.56	7.96	0.04

T1=Commercial concentrate-corn stover (80%- 20%); T2=Experimental concentrate-corn stover (80%-20%); [1]US$ of total weight gain/animal; [2]Difference between profit of total weight gain and total DM intake cost (Mahrous *et al.*, 2021); [3]Gross profit margin/Total DM intake cost × 100 (Mahrous *et al.*, 2021); S.E.M.=Standard error of mean.

value for live weight gain (P=0.43) and gross profit margin (P=0.09) were not affected by the concentrate source of the diet. However, feed cost (P<0.01) and economic feed efficiency (P≤0.04) improved with T2. Finishing lambs with a commercial concentrate and corn stover (T1) is US$3.34 more expensive than with diets based on concentrates available in the region and corn stover (T2). T1 obtained a higher income per kilogram of live weight gained than T2 (US$16.53 *vs.* US$15.18); however, as a consequence of its higher feed costs, the gross profit margin per finished lamb was US$2.02 lower. Finally, based on its economics of feed efficiency, T2 is more profitable (EE=26.6%) and consequently much better than T1 (EE=7.6%). Therefore, the evidence suggests that finishing hair lambs with the T2 diet proposed in this study is feasible.

Rebollar *et al.* (2015) mention that the purchase of animals and feed are headings that require the greatest investments among all production costs in a feedlot. Duarte and Olmedo (2013) mention that, when concentrates are used in diets, the fattening time shortens, total DM intake increases, and feed conversion improves. In addition, the Net Profit increases as the variable costs (*e.g.*, feed costs) are reduced without affecting production parameters. Meanwhile, Muñoz-Osorio *et al.* (2015) determined that most producers sell their lambs at live lamb prices (91.18%), because it represents the main source of economic income in their system; their results match the findings of this study, which took into consideration the price for the sale of live animals.

Herrera-Toscano and Carmenate-Figueredo (2018) suggest that selecting local resources to feed lambs reduces production costs, particularly of forages (*e.g.*, leguminous trees and agricultural by-products). Likewise, Gutierrez *et al.* (2014) indicate that using agricultural by-products (*e.g.*, sugarcane tips) in total mixed diets for lambs improves the production parameters and economic profitability of these production systems.

CONCLUSIONS

The use of concentrate made from locally available supplies and corn stover (80:20 ratio) for lamb finishing improves the profitability of the fattening, as a result of the lower production cost of the diet, without facing the negative effects on the weight gain of commercial concentrates.

REFERENCES

Cappelle, E.R., Filho, S.C.V., Da Silva, J.F.C., Cecon, P.R., (2001) Estimativas do valor energético a partir de características químicas e bromatológicas dos alimentos. *Revista Brasileira de Zootecnia. 30*(6), 1837-1856. Doi: 10.1590/S1516-35982001000700022

Duarte, R.A., Olmedo, D.O. (2013). Efecto de la suplementación en el desempeño productivo de corderos destetados mantenidos sobre pastura natural. *Investigación Agraria, 4*(2), 10-14.

García, E. (2004). Modificaciones al sistema de clasificación climática de Köppen. 5ª. (Ed.). Instituto de Geografia. Universidad Nacional Autónoma de México (UNAM). México, DF. 91p.

González-Garduño, R., Blardony-Ricardez, K., Ramos-Juárez, J. A., Ramírez-Hernández, B., Sosa, R., Gaona-Ponce, M. (2013). Rentabilidad de la producción de carne de ovinos Katahdin × Pelibuey con tres tipos de alimentación. *Avances en Investigación Agropecuaria, 17*(1), 135-148.

Guerra-Medina, C.E., Montañez-Valdez, O.D., Ley-De Coss, A., Reyes-Gutiérrez, J.A., Gómez-Peña, J.E., Martínez-Tinajero, J.J., Pinto-Ruiz, R. (2015). Fuentes alternas de fibra en dietas integrales para ovinos en engorda intensiva. *Quehacer Cientifico Chiapas, 10*(1), 3-8.

Gutiérrez, D., Guerra, Y.G., González, P.Á., Elías, A., García, R., Stuart, R., Sarduy, L. (2014). Utilización de la caña de azúcar en mezclas integrales frescas para la alimentación de corderos. *Revista Centro Azúcar, 41*(3), 64-77.

Herrera-Toscano, J.A., Carmenate-Figueredo, O. (2018). Selección de recursos locales para la alimentación de ovinos en el municipio Las Tunas, Cuba. *Pastos y Forrajes. 41*(3), 176-182.

Macedo, R., Castellanos, Y. (2004). Rentabilidad de un sistema intensivo de producción ovino en el trópico. *Avances en investigación agropecuaria, 8*(3), 1-9.

Mahrous, A.A., El-Tahan, A.A.H., Hafez, Y.H., El-Shora, M.A., Olafadehan, O.A., Hamdon, H. (2021). Effect of date palm (*Phoenix dactyfera* L.) leaves on productive performance of growing lambs. *Tropical Animal Health and Production, 53*(1). 1-8. Doi: 10.1007/s11250-020-02493-2.

Mendoza-Martínez, G.D., Pérez, F.X.P., Mella, M.R., Delgadillo, M.A.M., Rangel, H.L., Gama, R.B. (2007). Evaluación de alimentos integrales para el engorde intensivo de ovinos. *Revista Científica, 17*(1), 72-82.

Muñoz-Osorio, G.A., Aguilar-Caballero, A.J., Sarmiento-Franco, L.A., Wurzinger, M., Cámara-Sarmiento, R. (2016). Technologies and strategies for improve hair lamb fattening systems in a tropical region: A review. *Rev Ecosist Rec Agropec. 3*(8):267-277.

Muñoz-Osorio, G. A., Aguilar-Caballero, A. J., Sarmiento-Franco, L. A., Wurzinger, M., Cámara-Sarmiento, R. (2015). Descripción de los sistemas intensivos de engorda de corderos en Yucatán, México. *Nova scientia. 7*(15), 207-226.

Nutrient Requirements of Domestic Animals (NRDA). 1985. Nutrient Requirements of Sheep. 6th ed. National Academy Press. Washington, D.C., USA.

National Research Council. (NRC). 2007. Nutrient Requirements of Small Ruminants: Sheep, Goat, Cervids, and New World Camelids. National Academies Press. Washington, D.C., USA.

Rebollar, S., Rubio, R. R., Reyes, L. A., Cruz, U. M., Alvarez, F. D., Calderón, A. C., Navarro, S. S. (2015). Análisis económico del uso de clorhidrato de zilpaterol en la alimentación de corderas. *Investigación y Ciencia. 23*(64). 5-10.

Rodríguez-Hernández, K., Maldonado-Jáquez, J.A., Granados-Rivera, L.D., Sánchez-Duarte, J.I., Domínguez-Martínez, P.A., Torres-Hernández, G., Argüelles-Verdugo, E.A. (2019). Finishing lambs using an integral feed under a restricted-feeding program in an intensive production system in Northern Mexico. *Austral journal of Veterinary Sciences, 51*(3), 105-111. Doi: 10.4067/s0719-81322019000300105

SAS. (Statistical Analysis Sistem). System for Windows. (2011). SAS User´s Guide Statistics, SAS Inst. Inc. Cary Noth Carolina. EE. UU.

Sun, L., Yin, Q., Gentu, G., Xue, Y., Hou, M., Liu, L., Jia, Y. (2018). Feeding forage mixtures of alfalfa hay and maize stover optimizes growth performance and carcass characteristics of lambs. *Animal Science Journal, 89*(2), 359-366.

Vicente-Pérez, R., Macías-Cruz, U., Mancilla, M.R., Vicente, R., García, E.O., Martínez, R., Avendaño-Reyes, L, Montañez O.D. (2020). Suplementación de clorhidrato de zilpaterol en corderos finalizados con dieta sin fibra de forraje. *Revista Mexicana de Ciencias Pecuarias, 11*(3), 638-650.