Revista MVZ Córdoba
ISSN: 0122-0268
ISSN: 1909-0544
revistamvz@gmail.com
Universidad de Córdoba
Colombia

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Cárdenas M, José; Duarte A, Pablo; Mena A, Dahaivis; Ramos T, Olivier
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Revista MVZ Córdoba, vol. 23, no. 2, 2018
Universidad de Córdoba, Colombia
Available in: http://www.redalyc.org/articulo.oa?id=69356053002
DOI: https://doi.org/10.21897/rmvz.1333

Original

Requirements and energy efficiency of Pelibuey and Katahdin non pregnant, non lactating ewes in Yucatan, Mexico

Requerimientos y eficiencia energética de ovejas Pelibuey y Katahdin no gestantes, no lactantes en Yucatán, México

José Cárdenas M
Instituto Tecnológico de Tizimín, México
valcarme@hotmail.com

Pablo Duarte A
Instituto Tecnológico de Tizimín, México
valcarme@hotmail.com

Dahaivis Mena A
Instituto Tecnológico de Tizimín, México
valcarme@hotmail.com

Olivier Ramos T
Instituto Tecnológico de Tizimín, México
valcarme@hotmail.com

DOI: https://doi.org/10.21897/rmvz.1333
Redalyc: http://www.redalyc.org/articulo.oa?id=69356053002

Received: 03 April 2017
Accepted: 02 October 2017

Abstract:

Objective. To estimate metabolizable energy requirements for maintenance (MEm), energy efficiency of weight gain (EEWG) and fat thickness, in Pelibuey and Katahdin ewes in Yucatan, Mexico. **Material and method**. Eight non pregnant, non lactating, multiparous ewes, were feed at three intake levels with a diet containing 2.0 Mcal/Kg-1 of ME and 11 % of CP. Feed intake was measured daily, ewes weight and thickness of subcutaneous fat (SF) were determined every 14 days. The EMm was estimated by regressing values of live weight against metabolizable energy intake (MEI), EEWG was estimate as gram of weight gain per Mcal of MEI. **Results**. There were no differences between breeds in MEm (97±4 and 110±4 kcal/Kg0.75, for Pelibuey and Katahdin) and EEWG (58±8 and 63±8 g/Mcal of MEI, for Pelibuey and Katahdin); differences were found in SF (6.1±0.2 and 4.9±0.2 mm, for Pelibuey and Katahdin). **Conclusions.** The energy requirements for maintenance were similar in Pelibuey and Katahdin ewes in Yucatan, Mexico.

Keywords: Intake, weight increment, fat, production, ewes.

Resumen:

Objetivo. Estimar los requerimientos de energía metabolizable para el mantenimiento (MEm), le eficiencia energética del incremento de peso (EEWG) y el grosor de grasa, en ovejas Pelibuey y Katahdin en Yucatán, México. **Materiales y método**. Ocho ovejas multíparas no gestantes, no lactantes, fueron alimentadas a tres niveles de consumo con una dieta que contenía 2.0 Mcal/kg-1 de EM y 11% de PC. El consumo de alimento fue medido diariamente, el peso de ovejas y el grosor de grasa subcutánea (SF) se determinó cada 14 días. La MEm fue estimada por regresión de los valores de peso vivo contra el consumo de EM (MEI), la EEWG fue estimada como los gramos de ganancia de peso por Mcal de MEI. **Resultados.** No existieron diferencias entre razas en EMm (97±4 y 110±4 kcal/Kg0.75, para Pelibuey y Katahdin respectivamente) y EEWG (58±8 y 63±8 g/Mcal de MEI, para Pelibuey y Katahdin respectivamente); se encontraron diferencias en SF (6.1±0.2 y 4.9±0.2 mm, para Pelibuey y Katahdin respectivamente). **Conclusiones**. Los requerimientos de energía para mantenimiento fueron similares en las ovejas Pelibuey y Katahdin en Yucatán, México.

Palabras clave: consumo, incremento de peso, grasa, producción, ovejas.

INTRODUCTION

The sheep production in Yucatan is constrained by low quality and availability of grasses and forages through the year, affecting reproduction and growth of animals (1).

The Pelibuey is the predominant sheep breed in Mexican tropics and Yucatan peninsula (2), its potential has been improved through selection and crossbreeding programs with other tropically adapted breeds as Katahdin (3), nevertheless nutritional requirements of these hair sheep have not been revised at all (4).

The energy requirements of sheep vary with genotype, sex, age, physiological condition, physical activity, and environmental temperature (5); in ruminants, a high amount of metabolizable energy use (>50%) goes to maintain parent population and over 70% of whole-energy expenditure can be associated with maintenance (6), the metabolizable energy used for maintenance the breeding herd has enough magnitude to influence animal production (7), the knowledge of these requirements for different breeds and genotypes is of great importance to adjust maternal biological types to the environment (8).

The objective was to estimate metabolizable energy requirements for maintenance (MEm), energy efficiency of weight gain (EEWG) and fat deposition, in Pelibuey and Katahdin ewes in Yucatan, Mexico.

MATERIALS AND METHODS

Site Study. The study was carried out at the sheep production unit of Instituto Tecnologico de Tizimin, in Yucatan, Mexico. The region is located at 17 masl, climate is AW, warm, subhumid, with an annual temperature varying from 24.5 to 27.5°C, rainfall of 900 to 1100 mm and a rain season between June and October (9).

Feed intake, changes of live weight and fat deposition were measured in Pelibuey and Katahdin ewes during three periods of feeding, using a experimental diet on three feed levels, with the objective of estimate requirements of metabolizable energy for maintenance (MEm) and energy efficiency of weight gain (EEWG).

Animals and feeding. Eight non pregnant, non lactating, multiparous ewes (3 to 5 calving), with average live weight and standard deviation of 31 ± 2 kg, were assigned to individual corrals with feeder, free access to water and assessed in a complete randomized design with a 2x3 factorial arrangement, two pure breeds (Pelibuey and Katahdin, four repetitions per breed) and three feed levels (100, 120 kilocalories [kcal] of ME kg0.75 and ad libitum), after adaptation to diet the ewes were feed during three consecutive periods of 28 days each.

The diet was formulated to contain 2.0 megacalories (Mcal) per Kg-1 of ME and 11% of crude protein (CP), it was composed of 50% chopped Pannicum maximum hay and 50% of a concentrate based on corn (40%), wheat (40%) and soybean meal (20%).

Measurements. Animals were adapted to conditions of feeding and management for 21 days prior to any measurement. Feed intake was measured every morning (07:00) by offered-rejected daily food weighing, to determine dry matter intake (DMI) and ME intake (MEI), the ration were adjusted by ewe live weight every 14 days.

Ewes were weighed by morning every 14 days with a previous 16 hours feed and water withdraws, to assess live weight changes (LWC). Thickness of subcutaneous fat (SF) was measured at beginning and after weighing by ultrasound between 12th and 13th dorsal vertebra, using a fathometer.

Chemical analysis of feedstuffs and feces. Daily samples of offered and refused food were taken twice a week. Fresh feces samples were taken per ewe, using plastic bags direct from rectus by morning on days 6, 13, 20 and 27 of each experimental period. Feed and feces samples were oven dried at 60°C for 48 h to determine DM content, subsequently dry material were ground to pass a 1 mm sieve and analyzed to determine the percentage of acid-insoluble ashes, as well as crude protein (CP), neutral detergent fiber

(NDF), acid detergent fiber (ADF), ash and gross energy (GE, Mcal/kg DM) in feed (10). The chemical composition of the diet per feed level is presented in table 1. Variation in diet values for all nutritional indicators were less than 8%, there were not differences in diet despite feed level (p≥0.05).

TABLE 1
Table 1. Chemical composition (DM basis) per feed level of experimental diet for ewes in Yucatan, Mexico.

Feed level	CP (%)	NDF (%)	ADF (%)	EE (%)	Ash (%)	GE (% DM)
Ad libitum	11.4	50.7	27.0	1.3	5.9	4.0
120 kcal/kg0.75	10.2	52.4	30.2	1.2	5.9	3.7
100 kcal/kg0.75	11.5	50.1	26.3	1.3	5.6	3.5
Mean	11.0	51.1	27.8	1.3	5.8	3.7
CV	6.4	2.4	7.6	7.0	3.0	5.5

CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; EE= ether extract; GE= gross energy; DM= dry matter; kcal= kilocalories; kg0.75= kilograms of metabolic weight; CV= coefficient of variation.

Dry matter digestibility and ME content. The DM digestibility (DMD) of experimental ration for ewe at each feeding level was estimated, using the percentage acid-insoluble ashes (AIA) in feed and feces as an internal marker, using the following equation (11):

DMD(%)= 100-100 ([(%AIA in feed)/(%AIA in feces) x (%AIA in feces)/(%AIA in Feed)])

Diet gross energy digestibility (GED) was computed as GED (%) = 0.981 DMD – 1.08, digestible energy (DE) in feed was estimated as DE (Mcal/kg DM) = GE * (GED/100) and ME (Mcal/kg DM) content was valued as 82% of DE (5).

Maintenance requirements and energy efficiency. The ME requirement for maintenance (MEm) was considered, as the amount of ME consumed by ewe which induces zero change in live weight and was calculated by regressing values of CLW against MEI (Y = B0 + B1 * x), expressed as kcal of ME per kg metabolic body weight per day (kcal/Kg0.75/d-1). Energy efficiency of weight gain (EEWG) was estimated as the grams of weight increase per Mcal of MEI (g/Mcal MEI) (12).

Efficiency of utilization of ME for maintenance (km) and weight gain (kg) were estimated by equations km = 0.35 qm + 0.503 and kg = 0.78 qm + 0.006, where qm is the metabolizability of diet, proportion of ME in GE (13).

Statistical analysis. A simple statistical model was used to analyze the effect of ewe breed, feeding level and interaction, the variables were analyzed by general linear model procedure of statistical computational software SAS, the interaction was excluded because was not significative (p≥0.05), means in each factor were compared with the multiple range test (minimum significant difference).

RESULTS

The results of measurements in live weight change, dry matter consumption, metabolizable energy intake, digestibility and subcutaneous fat thickness in Pelibuey and Katahdin sheep are shown in table 2.

TABLE 2

Table 2. Breed and feed level means of dry matter intake, DM digestibility, metabolizable energy intake, live weight change and subcutaneous fat of Pelibuey and Katahdin ewes in Yucatan, Mexico.

		LWC (g/d-1)	DMI (g/kg0.75)	MEI (kcal/kg0.75)	DMD (%)	SF (mm)
Breed	Pelibuey	110	68	123	60.0	6.1a
	Katahdin	119	66	120	59.6	4.9b
	SE	11	0.9	2	0.5	0.2
Feed level	Ad libitum	123a	85a	154a	59.4	6.1a
	120 kcal/kg0.75	107a	64b	115b	59.3	5.8a
	100 kcal/kg0.75	- 59b	53c	96c	60.6	4.6b
	SE	19	1.2	2	0.6	0.2

abc different letters in same variation factor and variable indicates statistical difference (p<0.05); DMI = dry matter intake; DMD = DM digestibility; MEI = metabolizable energy intake; LWC = live weight change; SF = subcutaneous fat; Mcal = megacalories; kcal = kilocalories; kg0.75 = kilograms of metabolic weight; SE = standard error of estimation.

The average initial and final live weights for ewes were 30.7 ±2.2 and 38.9 ±4.0 kg; there were no differences ($p \geq 0.05$) between breeds (31±2 and 32±4 kg of initial weight for Pelibuey and Katahdin; 38±4 and 40±3 kg of final weight for Pelibuey and Katahdin).

The feed consumption behavior was influenced by feed level ($p \leq 0.05$), average DMI and MEI was 67 ±14 g/kg0.75 and 122 ±21 kcal/kg0.75, there were no statistical differences ($p \geq 0.05$) for breed factor.

There were statistic differences between breeds ($p \leq 0.05$) for subcutaneous fat. The feed level affected ($p \leq 0.05$) dry matter intake, energy intake, live weight and subcutaneous fat thickness.

The regression equations to estimate maintenance energy requirements, efficiency of ME utilization for maintenance (km), gain (kg) and energy efficiency of weight gain of Pelibuey and Katahdin ewes in Yucatan, Mexico, are presented in table 3.

TABLE 3

Table 3. Energy requirements for maintenance, efficiency of ME utilization and energy efficiency for weight gain in Pelibuey and Katahdin ewes in Yucatan.

Breed	Regression equation	R	SE	MEm (kcal/kg0.75)	CV(%)	km(%)	kg(%)	EEWG (g/Mcal)
Pelibuey	Y = 103.817 + 0.267367 LWC	0.71	19.1	97.3	9.8	0.67	0.39	58.2
Katahdin	Y = 113.189 + 0.151998 LWC	0.72	18.8	109.5	5.7	0.67	0.38	63.2

R= correlation coefficient; SE= standard error of estimation; LWC= live weight change; MEm= metabolizable energy requirement for maintenance; CV= coefficient of variation; km = efficiency of ME utilization for maintenance; kg = energy efficiency of ME utilization for gain; EEWG = energy efficiency of weight gain.

There were no effect of breed or feed level ($p \geq 0.05$) on parameters of energy requirements and efficiency, nevertheless Katahdin ewes had 12.5 and 8.6% higher metabolizable energy requirements for maintenance (MEm) and energy efficiency for weight gain (EEWG) than Pelibuey.

DISCUSSION

As expected, the live weight was affected by feed level ($p \leq 0.05$) but it was similar between breeds (115 ± 6 g/d-1 LWC, CV = 6%). Wildeus et al (14) have reported coefficients of variation of 19.9 % between hair sheep ($p \leq 0.001$), despite to growth rates and mature body weight breed differences. Pelibuey and Katahdin ewes in Yucatan seem to have similar increase rates and mature body weight.

The feed consumption was similar in both ewe breed ($p \geq 0.05$), Canton et al (15) observed this behavior in the same region, they recorded similar DMI ($p \geq 0.05$) between growing crossbreeding hair sheep (198 ±8 g/kg0.75 DMI, CV=4.1%) On the other hand, Silva et al (16) quantified about 12.5 % less average DMI and observed differences ($p \leq 0.05$) between Morada Nova and Santa Inês ewes in Brazil (59 ± 15 g/kg0.75 DMI, CV=21%). The Pelibuey and Katahdin ewes in Yucatan have similar consumption behavior; this could have implications on nutritional requirements and efficiency of use of energy from feedstuff.

There was no effect of breed or feed level on diet digestibility, the average DMD was 59.8 ± 2.6% (CV=3.0%), this results contrast with Silva et al (17) who reported 59.9 and 62.0 % of DMD to wool and hair sheep respectively ($p \leq 0.05$). The results indicate that Pelibuey and Katahdin sheep have similar capacities to draw upon feedstuff to obtain metabolizable energy (ME) at any feed level situation.

There was no effect of feed level on subcutaneous fat ($p \geq 0.05$) in ewes, in contrast with Chay et al (18), who found a significative increment in body fat (7 to 10%) of Pelibuey ewes in Yucatan, Mexico. There were differences by breed factor in subcutaneous fat thickness ($p \leq 0.05$), Pelibuey ewes accumulated 25% more fat than Katahdin, feed level had significative effect ($p \leq 0.05$) in fat accumulation as well. This inclination that has been noticed by Partida et al (19), they found a variation coefficient of 7.3% between Pelibuey and Pelibuey x Suffolk/Dorset sheep in carcass fat ($p \leq 0.05$). Hernandez et al (20) validated this fact in sheep biotypes; they measured significative differences ($p \leq 0.05$) in subcutaneous fat thickness (2.5±0.05 and 2.3±0.04 mm for Pelibuey and wool sheep) and concluded that sheep from rustic and proliferous groups such as Pelibuey tend to accumulate more fat than other specialized breeds. Fat reserves in hair sheep such as Pelibuey and Katahdin ewes would represent an advantage in dry season in Yucatan sheep system; this energy reservoir can be used for maintenance and lactation with an efficiency of 74 to 84% (5).

The MEm average was 103.4±9.9 kcal/kg0.75 and was in the range for cattle in sheep (100 to 110 kcal/kg0.75) suggested by NRC (5). In Mexico there are reports of high coefficients for MEm for hair sheep (117 to 143 kcal/kg0.75, r2 = 0.42), even higher than wool breeds (21). Pelibuey and Katahdin sheep MEm measurements in Yucatan, are in the range (85.9 to 112.8 kcal/kg0.75) of the another studies about Pelibuey crosses (Pelibuey x Rambouillet/Dorper/Han/Santa Inês) in the world (22,23).

The values of ME use efficiency for maintenance and gain (km, kg) were similar to evaluations made for sheep in different regions and nutritional systems. The km has been ranged from 0.64 to 0.67 by different sources (24); kg is widely ranged from 0.3 to 0.6 by AFRC (25), but results are close to Galvani et al (23) observations (kg=0.36±3.7). The average EEWG was 60.7±14.3 g/Mcal MEI and there are no precedents of measurements about this indicator, but results are near of cattle studies (EEWG = 72.9±10.4 g/Mcal MEI) carried out in Yucatan (11).

In conclusion, the energy requirements for maintenance (MEm) are similar in Pelibuey and Katahdin non-pregnant, non-lactating, multiparous ewes in Yucatan systems. The ME is used with similar efficiency for weight gain in Pelibuey and Katahdin ewes in Yucatan. There are differences in subcutaneous fat thickness between Pelibuey and Katahdin ewes in Yucatan. Fat reserves in Pelibuey and Katahdin ewes would represent an advantage for dry season in Yucatan systems; it can be use for maintenance and lactation with high efficiency.

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