Short communication

Prediction of energy requirements of Murciano-Granadina preruminant female kids using the National Research Council

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Abstract

Data collected on metabolizable energy (ME) intake and growth performance of preruminant female kids of the Murciano-Granadina breed was used to assess the accuracy of the latest U. S. National Research Council (NRC) recommendations to predict their energy requirements. Female kids were fed a milk replacer individually, according to appetite three times a day from two to five weeks of age. The mean initial body weight and average daily weight gain (± SE) were 3.31 ± 0.08 kg/d and 120 ± 3 g/d. Daily ME intake, expressed relative to metabolic body weight ($BW^{0.75}$), decreased linearly with age from 1085 to 970 kJ/kg $BW^{0.75}$/d, and there was nearly a constant ratio of ME requirements for maintenance. The observed ME intake was 5.4% higher than the ME requirements, calculated according to NRC, probably due to the energy content of the weight gain. It was concluded that the energy system model of the NRC is accurate enough to calculate the ME requirements of preruminant female kids of the Murciano-Granadina breed.

Keywords: Goats, pre-weaning period, suckling female kids, NRC
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Replacement female kids are the basis for a healthy and productive goat herd in the future. However, studies on their energy intake and growth performance are scarce. Most studies conducted on preruminant kids have focused on metabolizable energy (ME) intake and growth performance of male kids (Jagusch *et al.*, 1983; Sanz Sampelayo *et al.*, 1988; Bezabih & Pfeffer, 2003). Other studies have reported on feed intake and growth of preruminant male and female kids (Peña *et al.*, 1985; Ugur *et al.*, 2007) and on their carcass characteristics (Kutchik *et al.*, 2002; Peña *et al.*, 2009).

The U.S. National Research Council recommendations on energy requirements of suckling goats (NRC, 2007) are based on the research at Langston University (Sahlu *et al.*, 2004). A close examination of the database of the experiments used to derive the ME requirements of suckling goats (Luo *et al.*, 2004) shows (1) a wide range of body weights (BW) (mean: 7.88 ± 3.34 kg; minimum: 2.8 kg; maximum: 21.8 kg); (2) a wide age range, since the experiments lasted between 21 and 106 days; and (3) some animals were not strictly preruminants as they consumed solid feeds. In addition, gender differences were taken into account only to calculate the ME requirements for maintenance (MEm) and a common value for all sex classes was used to calculate the ME content of the weight gain.

Clearly, there is no combined data on energy intake and growth performance of preruminant female kids. Such data could be useful to evaluate how well the energy system of the NRC (2007) predicts the ME requirements of very young, strictly preruminant female kids. The aim of this study was to examine the data collected on ME intake and growth performance of preruminant female kids of the Murciano-Granadina breed, and assess the accuracy of the NRC (2007) to predict the ME requirements of female kids.

The experiment was carried out in the Animal Production building (Centre of Experimental Animals CO/5/U) of the University of Córdoba, in accordance with the Spanish normative for the protection of

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animals used for experimental purposes (RD 1201/2005). Fifteen Murciano-Granadina female kids were used. The kids were born within a 24-hour interval on a commercial farm, removed from the dams before first suckling, individually identified, fed colostrum and moved to the research facility. The experiment began when the kids were seven days old, and lasted for 35 days. All kids were vaccinated with a polyvalent vaccine (Basquin Plus CP, Laboratorios Ovejero, Leon, Spain) when they were three weeks old.

The kids were placed in 1 x 1.4 m cages with slatted floors elevated to 50 cm above the ground. The cages were in a 13 x 8 x 3 m room with a forced ventilation system (10 times the room volume per hour), by means of a suction fan with four outlets placed 25 cm above room floor level and four air inlets placed at ground level on the opposite wall, and an air conditioning system with two air inlets and thermostats able to control the temperature between 18 and 32 °C. Environment temperature was maintained at 24 – 25 °C and relative humidity was monitored daily and observed to change between 60 and 65%.

The kids were given colostrum according to appetite during the first two days; then they were abruptly changed to a milk replacer (Guyolait 50, INA, Madrid, Spain). The milk replacer was rich (>70%) in skimmed milk and whey. The chemical composition was (g/kg): dry matter (DM), 948; crude protein, 216; fat, 215; ash, 68; carbohydrates (by difference), 449. The ME content of the milk replacer was calculated as 19.8 MJ/kg DM, according to Yeom *et al.* (2002). The milk replacer was prepared in warm water (40 °C) at a concentration of 130 g/kg immediately before feeding. It was individually fed by bottle to appetite three times a day, at 08:30, 14:30 and 20:30. The exact intake was determined by weighing the bottles before and after suckling. The ME intake was calculated from the DM intake and ME content of the milk replacer. The kids were weighed once a week just before their morning suckling.

The statistical software SPSS 15.0 (SPSS Inc. Chicago, IL) was used. Linear effects of age on growth and intake traits were analyzed using the repeated measures procedure. The correlation procedure was used when appropriate. The linear regression and paired t-test were used to examine the relationship between the observed and NRC (2007) predicted ME intake. One sample t-test was used to compare the energy content of the weight gain (specified constants: 13.4 and 14.8 kJ/g weight gain). The level of significance was set at $P < 0.05$ in all the tests.

The data collected on feed and energy intake and growth performance of preruminant Murciano-Granadina female kids are shown in Table 1.

Table 1 Means and standard errors (SE) of body weight, daily weight gain, and feed and metabolizable energy intake of Murciano-Granadina preruminant female kids (n = 15) from two to five weeks of age[†]

	Age in weeks								Whole period	
	2		3		4		5			
	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE
Body weight, kg	3.31	0.08	4.17	0.10	5.02	0.11	5.84	0.12	4.59	0.13
Daily weight gain, g/d	105	4	140	6	105	6	129	4	120	3
Liquid feed intake, g/kg BW/d	313	4	291	3	253	3	243	4	275	4
Dry matter intake, g/kg BW/d	41	0.5	38	0.4	33	0.5	32	0.6	36	0.6
ME intake, kJ/kg $W^{0.75}$/d	1085	17	1070	12	975	11	970	13	1025	9

[†]Linear effect was significant ($P < 0.05$) in all the variables, except for daily weight gain.
ME - metabolizable energy.

Liquid feed and DM intake expressed relative to BW decreased ($P < 0.05$) linearly with age. This pattern was different from Allegretti *et al.* (1998) who found that liquid feed intake of Murciano-Granadina male kids increased until they were 15 days old, reached a maximum of 20 and 30 days of age, and then

decreased slightly. In our experiment, liquid feed intake between two and five weeks of age was 18% higher than that reported by Allegretti *et al.* (1998) despite the reconstituted milk replacer having the same ME content in both experiments (2.57 MJ/kg).

The daily ME intake decreased linearly ($P < 0.05$) when expressed relative to the $BW^{0.75}$. Sanz Sampelayo *et al.* (1990) found that the ME intake in preruminant Murciano-Granadina male kids, up to 30 days of age, fed milk replacer was 2.4 times the MEm requirements. Assuming that the MEm requirements are 429 kJ/kg $BW^{0.75}$ (Sanz Sampelayo *et al.*, 1990) or 449 kJ/kg $BW^{0.75}$ (Luo *et al.*, 2004), it was calculated that ME intake was 2.39 ± 0.17 or 2.28 ± 0.16 times the MEm requirements. Both the MEm and ME intake were correlated ($r = 0.91$, $P < 0.05$), supporting Sanz Sampelayo *et al.* (1990).

Body weight development of the kids followed a linear trend during the pre-weaning period (Peña *et al.*, 1985; Prieto *et al.*, 1991; Yeom *et al.*, 2002). However, an average daily weight gain (ADG) of 120 g/d which is lower than 180 g/d, was reported for Malagueña (Subires *et al.*, 1991), 169 g/d for Alpine (Goetsch *et al.*, 2001) and 162 g/d for Florida (Peña *et al.*, 2009). This is due to the fact that the Murciano-Granadina breed has a smaller adult BW than the other breeds mentioned (Daza Andrada *et al.*, 2004). The observed ADG was lower than that reported by Sanz Sampelayo *et al.* (1997, 2003) on Murciano-Granadina male kids fed a milk replacer for up to 30 to 40 days of age (162 and 135 g/d ADG). This difference was probably due to a lower daily ME intake in the present study (1025 *vs*. 1244 and 1068 kJ/kg $BW^{0.75}$/d). Correcting for an MEm of 429 kJ/kg $BW^{0.75}$ (Sanz Sampelayo *et al.*, 1990), the ME per gram of ADG was similar in the three experiments (4.97 *vs*. 5.03 and 4.73 kJ/kg $BW^{0.75}$/d).

All the data on BW, weight gain and ME intake (n = 60) was used to assess the accuracy of NRC (2007) to predict the ME requirements. It was observed that the NRC (2007) underpredicted the ME requirements (Figure 1). The regression equation obtained was: ME intake observed (kJ/d) = 904 + 0.76 x ME intake predicted (kJ/d); $r^2 = 0.62$ and $P < 0.05$. The standard errors (SE) of the y-intercept and the slope were 236 and 0.08, respectively. The root mean square prediction error (the average vertical distance of each point to line y = 0 in Figure 1) was 268 kJ/d and the mean bias (the average inaccuracy of the predictions across all data) was 171 kJ/d or 5.4%.

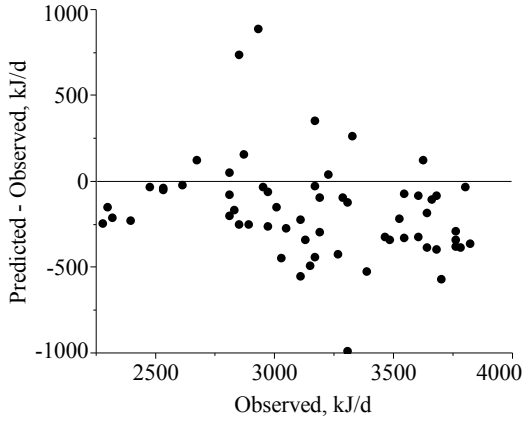

Figure 1 NRC-predicted minus observed metabolizable energy intake *versus* observed metabolizable energy intake. Solid line represents no bias or error.

The observed bias could be due to overestimation of the ME intake, underestimation of the ME requirements in NRC (2007), or both. The overestimation of ME intake due to the calculated ME content of the milk replacer was not likely. The ME content of the milk replacer used, calculated according to Yeom *et al.* (2002), was lower than calculated according to NRC (2001) and Moran (2002), i.e. 19.8 *vs*. 20.4 and 20.3 MJ/kg DM, respectively. Moreover, our estimate is conservative, since milk replacers that are rich in skimmed milk and milk products are highly digestible (Chiou & Jordan, 1973; Mantecón & Lavín, 1999); thus the ME : gross energy ratio is comparable to that of whole milk (NRC, 2001). On the other hand, ME

requirements have two components, MEm and ME for weight gain (MEg). In respect to MEm, the value used by NRC (2007) is in agreement with Bezabih & Pfeffer (2003), which was not included in the dataset of Luo *et al.* (2004): 449 *vs*. 458 kJ/kg $BW^{0.75}$. Therefore, the difference between predicted ME requirements and observed ME intake is probably due to MEg. Moreover, if the MEm requirements equaled 449 kJ/kg $BW^{0.75}$, it can be calculated that MEg was 15.2 kJ/g (SE = 0.4) in this study. This value is higher (P <0.05) than 13.4 kJ/g used by NRC (2007) but is not different (P >0.05) to the 14.8 kJ/g observed in Murciano-Granadina male kids by Sanz Sampelayo *et al.* (1988). Energy content of the weight gain is not a constant. Sanz Sampelayo *et al.* (1995) and Bezabih & Pfeffer (2003) observed that the energy retained as fat in suckling male kids increased with an increasing ME intake, and so did the energy content of weight gain. Therefore, the use of a unique figure for MEg when calculating the ME requirements can cause some error.

In conclusion, the NRC (2007) underprediction was low enough to support the use of this system to calculate the ME requirements of strictly preruminant female kids of the Murciano-Granadina breed. More research is needed to split ingested ME exceeding MEm between energy retained as fat, protein, and the corresponding heat increment.

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