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Effect of goat milk and milk substitutes and sex on productive parameters and carcass composition of Creole kids

P. Perez[a,*], M. Maino[a], M.S. Morales[a], A. Soto[b]

[a]*Departamento de Fomento de la Producción Animal, Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile, Santiago, Chile*
[b]*Departamento de Medicina Preventiva Animal, Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile, Santiago, Chile*

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Abstract

Sixty Creole kids were assigned to three groups, fed either goat milk only (T1) or a commercial calf milk substitute/replacer (T2) or a goat kid milk substitute/replacer (T3). Kids in all groups were maintained with their mothers until 5-day-old, then placed into individual pens. Milk and milk substitute intakes for T1, T2 and T3 until reaching 10 kg slaughter weights were 55, 79 and 68 kg, respectively. Dressing percentages (DP) for T1, T2 and T3 were 53, 50 and 51%, while the REAs were 4.25, 3.90 and 4.3 cm^2, respectively. The heaviest carcass component was the digestive tract, followed by head and skin, extremities, blood, liver, lungs and heart. HCWs represented 43–47% of slaughter weight and 50–53% of empty live weight (LW) in the three groups. T1 had better average daily gains (ADG) and feed conversion efficiency than T2 or T3, reaching slaughter weight earlier (63 days) ($P < 0.05$) than the other groups (88 and 78 days for T2 and T3, respectively). They also seemed to have better carcass characteristics ($P > 0.05$). Differences for male kids in growth rates, feed efficiency (FE) ratio, and carcass characteristics were statistically not significant. Profitability of either kid feeding system depends on local price conditions and needs further studies.

Keywords: Goat kids; Creole; Carcass composition; Milk substitutes

1. Introduction

Chilean goat production is based mainly on extensive systems, characterized by low productivity. The greatest percentage of the goat population is maintained by small farmers living in extreme poverty (Pérez, 1993). In these conditions, animal nutrition depends on pasturing of natural prairies and cutting leaf branches from bush species (Menéses, 1992). The main product from goat rearing is domestic cheese production. The second most important income is generated from the sale of kids. These are marketed seasonally during springtime, because a higher demand exists during national holidays (Pérez et al., 1997).

Kids are usually reared naturally under these conditions. This permits the production of kids for human consumption at a live weight (LW) of 10 kg. This system uses 45–70 l milk, which is not profitable because of the low prices paid for goat meat in the country (Pérez, 1993; Haenlein, 1997). Considering the economic and social importance of goat meat production, this paper evaluates various kid-rearing alternatives that allow the reduction of the amount of milk used to produce good quality kid carcasses.

* Corresponding author. Tel.: +56-2-6785537; fax: +56-2-6785611.
E-mail address: pperez@uchile.cl (P. Perez).

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Table 1
Chemical composition of the different treatments diets[a]

DM basis (%)	T1	T2[b]	T3[c]	Starter diet[d]
Total solids/DM	15.6	97.0	91.1	88.3
CP	30.3	21	20.5	21.8
Crude fiber	–	0.3	0.6	2.7
Ether extract or fat	32.5	15.0	21.0	4.6
NFE	30.8	54.7	49.6	66.5
Ash	6.4	9.0	8.3	4.4

[a] DM basis (%).
[b] Commercial substitute (Sprayfo blue™).
[c] T3 composition (%DM): powder milk (30), dry whey (25), powder milk fat (10), whey protein concentrate (34), vitamin and mineral premix (0.1), artificial flavor (0.1) and preservatives (0.8).
[d] Starter diet (%DM): ground corn (65.03), fish meal (8.08), soybean meal (25.0), tallow (0.90), sodium chloride (0.50), vitamin and mineral premix (0.50).

2. Material and methods

The growth rate of 60 Creole kids of both sexes belonging to a private flock were studied. Kids were left with their mothers during the first 5 days of life and divided into three groups of 20 animals. Groups were allocated to three different feeding treatments: T1 was fed only goat milk (1 l per day); T2 was fed a commercial calf milk substitute (1 l per day); T3 a goat kid milk substitute (1 l per day) (Table 1). Milk substitutes were prepared in a concentration of 17% w/v. All 10 days old kids received a concentrate starter ration of 100 g per animal per day, which was increased according to intake. During the experiment, the daily intake of milk, milk substitute and concentrate was determined by measuring the difference between what was offered and what was consumed. The chemical composition of the diets on a DM basis is shown in Table 1.

On day 6, kids were marked and placed in individual pens where they were fed the respective milk or milk substitute by bottle-feeding. Kids were weighed at the start of the experiment and again every 14 days thereafter. Once the group reached a mean body weight of 10 kg, animals were weighed and slaughtered after a 12 h fasting.

After slaughter, the skin, head, feet, liver, lungs and trachea, heart, kidneys, and full and empty digestive system were weighed (Gallo and Tramon, 1990). Some parameters measured were LW, empty body weight (EBW), dressing percentage (DP), weights of digestive tract content (DCW), hot carcass (HCW), skin, liver, kidney, pelvic and kidney fat (PF + KF), feet, lung and trachea, head, REA and depth of dorsal fat (Ruiz de Huidobro and Cañeque, 1994a,b).

Carcasses were divided by a sagittal cut through the spinal cord, leaving the tail on the left half of the carcass. Left half carcasses were wrapped in plastic bags, marked and frozen until dissection. Half carcasses were thawed at room temperature for 24 h, weighed and cut according to the Official Chilean Standard Cutting Procedure for Lambs (NCh 1595–80) (Gallo et al., 1996). Anatomic dissection of the forelimb and limb quarters was performed using a scalpel and forceps, following the technique proposed by Cuthbertson et al. (1972), resulting in five groups of tissue: muscle, fat, bone, waste tissues and dehydration losses.

The experimental design was a 3×2 factorial model, with three feeding treatments and two sexes (Ruiz-Maya, 1983).

3. Results and discussion

3.1. LW and feed intake

The LW of kids began to differ ($P < 0.05$) from day 33, when T2 and T3 showed less LW than T1. Group T1 reached slaughter weight (group mean at 10 kg) earlier than T3, with T2 reaching the final weight

Table 2
Effect of sex on LW (kg) of goat kids at different ages

Age (days)	Treatments (Mean ± S.D.)			Sex (Mean ± S.D.)	
	T1	T2	T3	Male	Female
6	3.3 ± 0.4	3.4 ± 0.5	3.3 ± 0.4	3.4 ± 0.5	3.3 ± 0.4
19	5.4 ± 0.5	4.8 ± 0.7	4.9 ± 0.6	5.2 ± 0.6	4.9 ± 0.6
33	7.3 ± 0.6a	5.5 ± 0.8b	5.7 ± 0.5b	6.4 ± 1.0a	6.0 ± 1.0b
47	8.5 ± 0.7a	6.2 ± 1.0b	6.7 ± 0.6b	7.5 ± 1.3a	6.8 ± 1.3b
61	9.8 ± 0.8a	7.4 ± 1.2b	8.2 ± 1.3b	8.9 ± 0.4	8.1 ± 1.3b
65	10.0 ± 0.9	–	–	–	10.0 ± 0.9
75	–	8.6 ± 1.4	9.4 ± 0.7	9.6 ± 1.3a	8.3 ± 1.0
81	–	10.0 ± 1.9	10.1 ± 0.6	10.0 ± 1.9	–
89	–	9.5 ± 1.1	–	–	9.5 ± 1.1
95	–	10.0 ± 0.9	–	–	10.0 ± 0.9

last. Groups T2 and T3 did not differ ($P > 0.05$) (Table 2).

Other authors have shown a great variation in LW of kids due to differences in breed, sex, food quality, etc. (Caro, 1986; Falagan, 1985; Galleguillos, 1993; Gayan, 1994). Falagan (1985), studying Murciano-Granadina kids reared with 15% concentration of milk substitute, reported LWs of 3.1, 4.7 and 9.1 kg at 10, 30 and 60 days, respectively. At the same ages, Peña et al. (1994) reported better growth rates, with both milk and milk substitute fed animals.

ADG for the whole period were 130, 92 and 108 g per day for T1, T2 and T3, respectively (Table 3). The better performance of T1 could be explained by the higher digestibility of the milk nutrients (Fehr, 1981; Potchoiba et al., 1990) when compared with the other tested replacers. In a similar experiment, Peña et al. (1994) obtained ADG of 200 g for the total experimental period.

3.2. Feed efficiency (FE)

The FE (Table 3) for the different groups showed that kids fed goat milk (T1) utilized the diet more efficiently than kids that were fed milk substitutes. This was found in the first three periods as well as in FE for the entire experimental period.

Hetherington (1980) reported that during the first weeks of life the FE varies between 1.2 and 1.4, depending on the nutritional quality of the milk provided. On the other hand, Church (1988) established that milk substitutes may result in similar, and sometimes better growth rates than goat milk, although the FE may be a little lower. This agrees with our results.

The amount of milk and days required to reach a mean 10 kg body weight, differed significantly between treatments. T1 registered the lowest total consumption of milk and reached the required weight in a shorter period, followed by T3 and T2 (Table 4).

Table 3
Daily gain (g) and FE (intake/gain) of kids fed with different milk diets in different periods[a]

Period (day)	Daily gain (Mean ± S.D.)			FE (Mean ± S.D.)		
	T1	T2	T3	T1	T2	T3
0–6	154 a ± 31	114 b ± 25	121 b ± 29	0.9 b ± 0.3	1.2 a ± 0.4	1.1 ab ± 0.3
20–33	1470 ± 27	53 b ± 24	60 b ± 24	1.1 b ± 0.6	3.8 a ± 2.4	3.6 a ± 3.5
34–47	95 a ± 31	51 b ± 25	71ab ± 26	1.9 b ± 0.6	4.7 a ± 2.4	2.9 b ± 3.5
48–61	97 ± 25	91 ± 23	111 ± 45	1.8 ± 0.5	2.0 ± 0.5	1.7 ± 0.9
62–75	–	92 ± 29	91 ± 27	–	2.1 ± 0.7	2.1 ± 0.6
76–81	–	147 ± 31	180 ± 26	–	1.4 a ± 0.4	0.7 b ± 0.2
Total	130 a ± 43	92 b ± 49	108 b ± 75	1.4 b ± 0.6	2.5 a ± 2.0	2.1 a ± 2.1

[a] All different letters are significant at $P < 0.05$.

Table 4
Total milk consumption (kg), time (day) to slaughter weight and main carcass characteristics of kids fed with different milk diets and analyzed by sex[a]

	Treatments(Mean ± S.D.)			Sex (Mean ± S.D.)	
	T1	T2	T3	Male	Female
Milk consumption	55 b ± 3	79 a ± 8	68 ab ± 3	–	–
Time	63 b ± 3	88 a ± 10	78 ab ± 4	–	–
LW (kg)	9.9 ± 0.8	10.0 ± 1.4	10.0 ± 0.6	9.97 ± 1.1	9.96 ± 0.7
EBW (kg)	8.8 ± 0.7	8.6 ± 1.5	8.7 ± 0.6	8.50 ± 1.0	8.40 ± 0.8
HCW (kg)	4.7 ± 0.5	4.3 ± 0.9	4.4 ± 0.5	4.60 ± 0.6	4.30 ± 0.6
Commercial dressing (%)	47.0 ± 2.6	43.9 ± 4.3	44.5 ± 6.3	46.0 ± 2.1	44.0 ± 2.8
Real dressing (%)	53.0 ± 4.8	50.4 ± 4.6	51.2 ± 6.3	54.0 ± 2.2	50.0 ± 3.1
REA (cm^2)	4.3 ± 0.3	4.3 ± 1.1	4.3 ± 0.3	4.3 a ± 0.2	4.0b ± 0.2
Perirenal and pelvic fat (g)	53 b ± 22.0	50 b ± 24.0	75 a ± 21.0	60.0 ± 22.0	58.0 ± 23.0

[a] All different letters are significant at $P < 0.05$.

Total consumption reflected the amount of milk in each treatment required to obtain a specific weight, assuming that a fixed quantity was provided and an equal amount was ingested by each kid daily (1 l per day). This suggests that the differences among treatments can be explained by the quality of the diets used. These results agree with those of Fehr and Sauvant (1984), who showed that although goat kids use milk substitutes efficiently, it is important to consider the source of the milk substitute components. Especially the energy concentration and protein quality should be considered because of their influence on growth indices (Galina et al., 1995).

As Table 4 shows, to reach the same LW, the consumption of milk substitute in T2 and T3 was 44 and 24% more than by the control (T1), respectively. This agrees with data of Fehr et al. (1982) who obtained the same LWs using goat milk or milk substitute, but 50% more of the substitute was needed. These results can be explained by the lower fat content of the substitute and possibly by its poorer and slower digestive utilization.

The intake of starter concentrate was low, not rising above 7.9 g for T1, 27.2 g for T2 and 18.0 g of DM per day for T3. This low consumption could be explained by the low palatability of some constituents of the starter, especially the fish meal. The total feed intake was T1: 55 l goat milk, 0.4 kg of starter; T2: 70.58 l calf milk replacer and 1.6 kg starter, T3: 64.71 l kid milk replacer and 1.0 kg starter.

The cost of the different feed ingredients was for goat milk (US$ 0.34/l), calf milk replacer (US$ 0.22/l), kid milk replacer (US$ 0.16/l), and for starter concentrate (US$ 0.20/kg). The calculated variable cost of feeding each treatment was T1: US$ 18.41; T2: US$ 15.34; and T3: US$ 10.65, making T3 the most economical treatment under the local conditions. However, the sale price of kid carcasses was lower than the price of the feeding systems, thus to raise kids under the current conditions is not economical. In the case of female kids, that are needed as replacements, it is cheaper to use goat milk substitutes, because of the lower price in Chile, which is different from conditions in Mexico (Galina et al., 1995), where raising with milk substitutes was more expensive than with goat milk.

3.3. Characteristics of carcasses depending on treatments

The effects of different treatments on carcass characteristics are presented in Table 4. T1 attained the highest values, followed by T3 and T2, although differences were statistically not significant ($P > 0.05$). Reasons could be the relative similarity of the given foods and the same slaughter weight for all kids. Furthermore, Pérez (1982) stated that the effect of feeding on the quality of the carcass can only be detected when there are marked differences between the rations used.

The values found in this study are comparable to those of other reports. Gallo and Tramon (1990) working with Creole and Saanen × Creole kids reared in an artificial system, obtained carcasses of 4.9 and

6.0 kg at 80 days and a slaughter weight of 10 and 14 kg, respectively. DP were similar to those in other reports, which varied between 35.2 and 55.8% (Lapido, 1973; Devendra and Owen, 1983). Sanz et al. (1987) obtained commercial and real DP values of 46 and 53% in kids slaughtered at similar weights to this experiment.

3.4. REA and weight of kidneys and pelvic fat

Table 4 shows the results of REA and some fat deposits. There were no significant differences with respect to REA among groups and the obtained values agree with the 4.0 cm^2 of REA found by Gall (1982) in Sudanese goat kids slaughtered at 12.5 kg of body weight. Mancilla (1993), working also with Creole goat kids, obtained a REA of 3.5 cm^2. However, Le Bretón (1994) reached a REA of 7.9 cm^2 in Creole goat kids slaughtered at 15 and 25 kg of body weight.

T3 showed a greater proportion of kidney and pelvic fat with respect to T1 and T2, although no significant differences were detected. This was also reported by Sanz et al. (1990), who established that milk quality affects the proportion of kidney and pelvic fat, and by Gall (1982), who determined that fat deposition depends on the nutritional quality of the diet.

The dorsal fat thickness was not measured because of the limited development of fat cover shown in the carcasses. This is explained by the low slaughter body weight of the study animals. Devendra and Owen (1983) found very little fat development in castrated animals slaughtered at 24 kg. Falagan (1985) in Granadine kids found 1 mm of dorsal fat and Le Bretón (1994) in kids slaughtered at 15–25 kg, measured 0.7 mm dorsal fat thickness. Gall (1982) and Colomer-Rocher et al. (1988) have pointed out that PF + KF can be of great value as an indicator of fat content in animals and as a useful predictor of total fat content when it is difficult to measure dorsal fat thickness.

3.5. Carcass characteristics depending on sex

The effects of sex on the main carcass characteristics were not significant (Table 4), although, in males a better yield was observed. This situation could be explained by the similarity in nutritional treatments and slaughter body weights. Similar results were reported by Gayan (1994) in Creole goat kids when slaughtered at 14 kg of body weight. Differences in carcass weight according to sex were found by López et al. (1990) in heavier animals. Saxena et al. (1974) determined that the maximum yield of carcass is reached at slaughter body weights of 25–30 kg in males and 10–15 kg in females.

3.6. Body components

Body component weights are shown in Table 5. Head, lung plus trachea, empty digestive tract, feet and skin were different ($P < 0.05$) between treatments. Nevertheless, no trend was seen from these differences, while liver, kidney, heart and blood were similar between groups ($P > 0.05$). These results are in agreement with Tramon (1989), who sacrificed Saanen × Creole male kids at 12 kg LW.

Table 5
Body component weights (g) at 10 kg body weight of kids fed with different milk diets[a]

Components	Treatments (Mean ± S.D.)		
	T1	T2	T3
Liver	186 ± 19	186 ± 41	197 ± 20
Kidney	48 ± 8	53 ± 11	62 ± 11
Heart	62 ± 11	65 ± 17	63 ± 14
Blood	439 ± 65	414 ± 67	450 ± 40
Head	824 a ± 56	750 b ± 83	812 a ± 78
Lung + trachea	151 a ± 30	167 a ± 42	125 b ± 20
Empty digestive tract	1006 b ± 150	1068 b ± 198	1200 a ± 130
Feet	470 a ± 53	424 b ± 75	391 b ± 47
Skin	844 a ± 85	738 b ± 164	802 ab ± 74

[a] All different letters are significant at $P < 0.05$.

Table 6
Proportions of cuts (%) in the carcass of goat kids fed with different milk diets by sex

	Feeding treatments (Mean ± S.D.)					
	T1		T2		T3	
	Male	Female	Male	Female	Male	Female
Half carcass weight (kg)	2.27 ± 0.15	2.22 ± 0.28	2.27 ± 0.23	2.19 ± 0.26	2.29 ± 0.55	1.97 ± 0.47
Leg (%)	28.53 ± 1.72	27.50 ± 2.27	26.98 ± 0.84	26.30 ± 1.11	25.82 ± 1.12	27.99 ± 3.32
Chops (%)	23.76 ± 2.05	26.51 ± 4.37	24.41 ± 1.10	25.80 ± 1.51	25.10 ± 2.21	26.61 ± 3.75
Shoulder (%)	20.35 ± 0.95	19.36 ± 1.00	19.56 ± 1.12	18.46 ± 0.55	18.15 ± 0.48	18.93 ± 2.34
Thorax (%)	15.60 ± 1.12	17.29 ± 1.38	16.61 ± 1.58	15.71 ± 0.66	16.23 ± 1.18	17.16 ± 2.54
Neck (%)	11.12 ± 0.98	9.84 ± 2.02	11.41 ± 1.62	13.55 ± 1.63	13.79 ± 1.14	13.20 ± 2.63
Tail (%	0.92 ± 0.31	0.85 ± 0.21	0.74 ± 0.30	0.60 ± 0.09	0.64 ± 0.06	0.65 ± 0.12

3.7. Yield of commercial cuts

Different yields of commercial cuts according to treatments and sex are shown in Table 6. Differences were non-significant ($P > 0.05$). Cuts of half carcasses arranged from greatest to smallest were: legs, chops, shoulder, thorax, neck and tail. According to Colomer-Rocher et al. (1988), goat carcasses yield a high proportion of valuable cuts. From this point of view, the carcasses obtained in this experiment represented very good cut composition.

When the results in Table 6 are compared with those obtained by Tramon (1989), who worked with carcasses of goat kids slaughtered at 12 kg of body weight, there were similarities on half carcass weights. However, carcass weights of females fed with calf milk substitutes, were less than those found in this work. According to the composition of cuts, the trend of best yield observed in the cuts of legs, chops and shoulder, agreed with results reported by Tramon (1989) and Herrera (1995).

4. Conclusion

The number of days needed to reach slaughter weight (10 kg) was least in goat kids fed goat milk, followed by the groups fed milk substitutes. However, there were no significant differences in average daily gains and there were no significant differences between treatments with respect to carcass characteristics. Under the current local pricing conditions for kid meat, it was not profitable to raise kids with either feeding system.

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