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The Influence of Artificial Rearing and Live Weight at Slaughter on Kid Carcass Characteristics

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Abstract: The objective of this research was to study the effects of natural suckling vs a milk replacer diet and two slaughter weights (6 vs 10 kg) on carcass characteristics of kids. Forty male twins, Canary Caprine kids were randomly allocated to one of four treatments. Two groups were reared With their Dams (WD) while the other two were reared using a Milk Replacer (MR). Two end point live weights (LWS; 6 and 10 kg) were used for each feeding system. WD Kids grew faster (32%) than MR. The empty body weight, hot carcass weight and Cold Carcass Weight (CCW) were higher in the 10-kg compared to the 6-kg kids. In relation to carcass conformation measures and indices, there were differences ($p<0.01$) between the two diets for carcass length and leg length measurements. No effects of diet or LWS were observed for the percentage of primal cuts. WD kids were fatter than MR kids. The kids slaughtered at 10 kg LWS were fatter and less bony than 6 kg kids. The results showed that suckling method had few effects on carcass quality, but increasing slaughter weight substantially improved carcass quality.

Key words: goat, kid, carcass, quality, artificial rearing

INTRODUCTION

Goats are ruminant animals that produce fiber, leather, meat and milk. In some regions of the world goats have been selected primarily for milk production (Harvey and Rigg, 1964). Few goats are raised with meat production as the major selection criterion in the regions where milk production is the primary focus. Kid carcasses from milk production goats have little fat (Kirton, 1988; López, 1990). Traditionally, in the Canary Islands, goats kids are reared with their dams. This practice results in a decreased milk yield and thus less milk for cheese manufacturing (López, 1990). Therefore, goat keepers remove the kids from their dams very early postnatally (15 days of age; 5-6 kg live weight) and these kids are then slaughtered for meat. Unfortunately, the carcasses from these kids are very light in weight (3 kg) and have very little meat. Furthermore, Mediterranean countries and other regions (e.g., Canary Islands) prefer the meat from kids that have only been fed milk. All these factors contribute to a very light live weight at slaughter and carcasses with insufficient meat quality and yield (López, 1990), resulting in goat keepers not earning significant economic benefits.

Milk replacers are available that are cheaper than natural goat milk and are specially formulated for kids and permit raising kids with respectable average daily gains. We hypothesize that, if kids are artificially reared with milk replacers and raised to heavier live weights, then there would be a significant increase in edible meat yield from these carcasses with improved economic returns for goat keepers with no detrimental effects on the dams' milk production. The objective was to evaluate the effect of artificial rearing on carcass characteristics of newborn kids raised on a milk replacer when slaughtered at 6 or 10 kg live weight.

MATERIALS AND METHODS

This experiment was conducted at the Veterinary Faculty Farm of Las Palmas de Gran Canaria University (Canary Islands, Spain). Forty twins (males), Canary Caprine kids were randomly allotted to one of four treatments. Two groups were reared With their Dams (WD) while the other two were reared using a Milk Replacer (MR). Two end point Live Weights (LWS; 6 and 10 kg) were used for each feeding system. The WD animals were kept 24 h per day with their dams and

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allowed to naturally suckle when desired. Dams were fed corn, soy 66, dehydrated lucerne, dehydrated beetroot, wheat straw, plane tree *ad libitum*, vit-mineral corrector, 1.3-1.6 UFL, 155 PDIN, according to INRA (1987). The kids had free access to this diet. The MR animals were removed at birth from their dams and hand fed fresh colostrum for two days, after this until the 15th day of experiment, they received a milk replacer with a concentration of 16% w/w (23.6% total protein and 22.7% total fat on a DM basis) twice a day. From the 15th day until the end of experiment, water and a starter mixed feed (16.4% total protein and 2.5% total fat) were added in the milk replacer diet until the kids reached their designated Live Weight at Slaughter (LWS) of either 6 or 10 kg.

Hot Carcass Weight (HCW), Chilled Carcass Weight (CCW) and offal weights were recorded. Net Weight at Slaughter (NWS) was calculated as (LWS-gut content). Commercial Carcass Yield (CCY) was calculated as (CCW/LWS)×100 and Net Carcass Yield (NCY) as (HCW/NWS)×100. Measurements of width between hips (G), depth at 6th rib (Th), carcass Length (L) (Palsson, 1939), leg length (F) (McMeekan, 1939), chest width (Wr) (Barton *et al.*, 1949) and hips perimeter (B) (Robinson *et al.*, 1956) were measured. Carcass compactness index was calculated as (CCW/L) and long leg compact index as (G/F) or (B/F) following (Thwaites *et al.*, 1964). After chilling, the carcasses were split down the dorsal midline. The left side of each carcass was divided into five primal cuts (neck, flank, ribs, shoulder and long leg) as described by Colomer-Rocher *et al.* (1987). After recording weights for each cut, each cut was further separated into muscle, bone and fat, with the Subcutaneous (SC) and Intermuscular (IT) fat depots being recorded separately.

Data were analyzed using General Linear Model Procedure (SPSS v. 8.0. program) in a 2x2 factorial design. The model consisted of feeding system (WD vs MR), LWS (6 vs 10 kg) and their interaction. All data are reported as means±standard error.

RESULTS AND DISCUSSION

The birth weights of kids ranged from 2.92 to 3.29 kg (Table 1) and were in agreement with the Canary Caprine Group breed (López, 1990). No interactions between rearing method and live weight at slaughter were found. Main effect results are shown in Table 1.

Kids reared With their Dams (WD) grew faster (32%) than Milk Replacer-reared kids (MR). The higher Average Daily Gain (ADG) in WD kids was most likely caused by the higher digestibility component in goat milk than in milk replacer because the goat milk curd stays longer in the abomasum than milk replacer curd, which is in agreement with the results of Sanz *et al.* (1990).

Table 1: Carcass yield (means ± standard error) from kids of different feeding systems and live weight at slaughter

	Feeding systems		LWS				
	WD	MR	6 kg	10 kg		Effects	
	LSM				SE	FS	LWS
Birth weight (kg)	3.2	3.1	3.0	3.3	0.1		
Age (days)	30	39	31	39	2	***	***
Live weight at slaughter (kg)	8.3	8.1	6.2	10.2	0.3	NS	***
Daily gain	167.6	127.1	102.8	177.0	1.2	***	
Empty body weight (kg)	5.9	9.8	5.9	9.5	0.3	NS	***
Hot carcass weight (kg)	3.0	5.3	3.0	5.1	0.2	NS	***
Cold carcass weight (kg)	2.9	5.2	2.9	4.9	0.2	NS	***
Chilling losses (%)	3.5	3.3	3.5	3.4	0.2	NS	NS
Commercial carcass yield (%)	45.8	49.7	45.9	48.4	0.5	NS	***
Net carcass yield(%)	50.4	54.2	50.4	53.5	0.4	NS	***

WD, kids reared with their dams. MR, kids reared with milk replacer. FS, feeding systems. LWS, live weight slaughter. *Significance ($p<0.05$). **Significance ($p<0.01$.) ***Significance ($p<0.001$). NS, no significance

(Baumrucker and Blum, 1994) found that dams' milk has a growth promoter that is not present in milk replacers, which could explain the higher ADG in WD kids. The time frame for natural suckling was not consistent in previous studies, thus kids' access time to dams was different, varying from 10 min (Maiorana *et al.*, 1984) to 24 h a day (López, 1990). The ADG between 6 and 10 kg LWS was in agreement with (López , 1990) in Canary Caprine Group (CCG) kids. Chilling losses were not affected by LWS.

The Empty Body Weight (EBW), Hot Carcass Weight (HCW) and Cold Carcass Weight (CCW) were higher in 10-kg (Table 1) than6-kg kids. The results for Commercial Carcass Yield (CCY) 45.8 to 49.7% and Net Carcass Yield (NCY) 50.4 to 54.2% for the two feeding systems, were close to what (López, 1990) reported for the same breed. Higher LWS resulted in differences in carcass yield. The CCY and NCY values for 10-kg kids were higher than 6-kg kids. (López, 1990; Gutiérrez *et al.*, 1995) found higher carcass yield when the LWS was increased from 6 to 15 kg LWS. The principal reason may be a result of the head and liver Table 2 being a lower proportion of the body weight when slaughter weight was increased to 10 kg. No rearing method differences were observed for carcass yield, which is in agreement with (Sanz *et al.*, 1985) but not in agreement with (Gutiérrez *et al.*, 1995). The quality of milk replacer may be the reason for similar CCY and NCY in WD and MR kids.

The offal components are shown in Table 2 and no interactions were found between diets and LWS. There were no significant differences between diets (WD vs MR) for the percentage of blood, skin, feet,

Table 2: Offal components (means ± standard error) from kids of different feeding systems and live weight at slaughter

	Feeding Systems		LWS			Effects	
(%LWS)	WD	MR	6 kg	10 kg	SE	FS	LWS
Blood	3.89	3.27	3.28	3.84	0.14	NS	NS
Skin	10.18	9.93	10.12	9.98	0.01	NS	NS
Feet	3.85	4.09	4.30	3.65	0.10	NS	NS
GI tract (full)	14.57	15.33	14.49	15.44	0.49	NS	NS
GI tract (empty)	8.95	8.99	8.95	8.99	0.15	NS	NS
GI content	5.62	6.34	5.55	6.44	0.41	NS	NS
Liver	2.95	2.73	3.02	2.64	0.01	NS	**
Urinary bladder	0.48	0.24	0.39	0.33	0.01	NS	NS
Testicle and penny	0.24	0.26	0.24	0.27	0.01	NS	NS
Spleen	0.22	0.21	0.21	0.21	0.01	NS	NS
Right kidney	0.33	0.44	0.40	0.37	0.01	*	NS
Head	8.09	8.87	9.27	7.74	0.16	NS	***
Lungs + trachea	1.72	1.69	1.77	1.64	0.01	NS	NS
Heart	0.75	0.68	0.74	0.69	0.01	NS	NS
Thymus	0.54	0.37	0.47	0.43	0.01	NS	NS

WD, kids reared with their dams. MR, kids reared with milk replacer. FS, feeding systems. LWS, live weight slaughter. GI, Gastric intestinal *Significance ($p<0.05$). **Significance ($p<0.01$). ***Significance ($p<0.001$). NS, no significance

gastrointestinal tract full and empty, gastrointestinal content, liver, urinary bladder, testicle+penny, spleen, head, lungs+trachea, heart and thymus (Table 2). There were differences ($p<0.05$) in right kidney being higher in MR kids, although differences were very low (less than 1%) but significant. In reference to LWS effects, there were no significant differences between LWS for the percentage of blood, skin, gastrointestinal tract full and empty, gastro-intestinal content, urinary bladder, testicle+penny, spleen, right kidney, lungs+trachea, heart and thymus. There were differences ($p<0.01$) between LWS for the percentage of liver and head, with 10-kg LWS kids having less than 6-kg kids. (López, 1990) found a lower percentage of liver with increased LWS in Canary Caprine kids, which is in agreement with results in Table 2. A decrease in the proportional weight of the head with age reported in the present study had previously been observed (Dhanda *et al*., 1999).

The carcass conformation measures and indices are shown in Table 3. In reference to diet effects, there were differences ($p<0.01$) between diets for L and F measures. These differences were higher in 6- kg LWS kids than in 10-kg LWS kids. Perhaps, rearing the kids in small pens (MR kids) might have contributed to these little differences found between diets. Borghese *et al.* (1990) found differences in conformation between rearing in cage and pen. In spite of this, the differences between WD and MR kids were very low and had little effect on conformation indices (CCW/L, G/F, B/F). There were no significant differences between diets in G, WR, B, TH measures and CCW/L, G/F and B/F index. There were differences between LWS in all measures and indices except in F, being higher in 10- kg LWS kids. In kids from other breeds (Murciano-Granadina Falagan, 1986; Florida Sevillana, Gutiérrez *et al*., 1995) slaughtered at 10 kg of live weight, the animals reared with their dams always had higher CCW/L values, which is in agreement with the results shown in Table 3. There were significant interactions between diet and LWS for L and F measures and CCW/L, G/F and B/F indices. In 6-kg LWS kids, higher CCW/L values in MR kids were found.

The results for primal cut distribution are shown in Table 4 and no interactions were found between diets and LWS. The differences in diets did not have any effects on carcass primal cut percentages, in agreement with previous work using the same breeds (Argüello *et al*., 1997 b, c) and in the Alpine breed (Cosentino *et al*., 1997). (Sanz *et al*., 1985) found significant differences in lumbar-ribs percentages (around 2%) between kids fed with goat milk or milk replacer. These differences were likely a result of these workers using different carcass jointing procedures. (Wilson, 1960) reported that East African Dwarf kids fed two different levels of nutrition, a higher percentage of long leg in kids when fed a high

Table 3: Conformation measures (cm) and indices (means ± standard error) from kids of different feeding systems and live weight at slaughter

	WD		MR		Effects		
	6 kg	10 kg	6 kg	10 kg	FS	LWS	FsxLWS
F	24.92±2.11	23.92±0.86	22.0 6±0.79	24.21±0.66	**	NS	**
L	41.97±1.62	43.46±0.80	37.62±4.20	43.34±1.00	**	*	*
G	8.63±0.90	11.13±1.04	9.24±0.72	11.17±1.15	NS	***	NS
WR	11.10±0.57	12.45±1.19	8.97±0.72	12.26±2.72	NS	***	NS
B	29.68±2.44	36.49±1.37	29.34±1.53	34.54±3.21	NS	***	NS
TH	16.10±1.84	17.48±1.12	15.77±1.65	17.92±1.84	NS	*	NS
CCW/L	68.56±7.08	118.54±8.80	76.86±13.66	109.47±3.46	NS	***	*
G/F	0.35±0.05	0.47±0.05	0.42±0.03	0.46±0.05	NS	**	*
B/F	1.20±0.14	1.53±0.07	1.33±0.10	1.43±0.12	NS	***	*

WD, kids reared with their dams. MR, kids reared with milk replacer. FS, feeding systems. LWS, live weight slaughter. G, width between hips. Th, depth at 6th rib. L, carcass length. F, leg length. Wr, chest width. B, hips perimeter. CCW/L, carcass compactness index.. G/F and B/F, long leg compact index. CCW, Cold carcass weights. *Significance ($p<0.05$). **Significance ($p<0.01$). ***Significance ($p<0.001$). NS, no significance

Table 4: Percentage contribution of primal cuts (means ± standard error) of carcasses from kids of different feeding systems and live weight at slaughter

	Feeding Systems		LWS				
	WD	MR	6 kg	10 kg		Effects	
	LSM				SE	FS	LWS
Left kidney	1.32	1.44	1.48	1.29	0.01	NS	*
Kidney and pelvic fat	2.95	2.62	2.42	3.14	0.14	NS	*
Tail	0.50	0.39	0.47	0.41	0.01	NS	NS
Shoulder	20.85	20.76	21.15	20.43	0.24	NS	NS
Neck	10.09	10.80	10.61	10.32	0.26	NS	NS
Long leg	32.93	33.86	33.16	33.72	0.39	NS	NS
Flank	9.64	9.54	9.57	9.61	0.20	NS	NS
Ribs	21.64	21.33	21.92	21.00	0.36	NS	NS
By categories							
Extra	54.58	55.20	55.08	54.73	0.45	NS	NS
First	20.85	20.76	21.15	20.43	0.24	NS	NS
Second	19.73	20.34	20.18	19.93	0.30	NS	NS

WD, kids reared with their dams. MR, kids reared with milk replacer. FS, feeding systems. LWS, live weight slaughter. *Significance ($p<0.05$). **Significance ($p<0.01$). NS, no significance

plane of nutrition, although he only found these differences in 5.4 kg and not in 13.5 kg LWS kids. There were differences ($p<0.05$) in left kidney and kidney and pelvic fat percentage as a result of LWS. Left kidney presentage was lower in 10 kg LWS kids and kidney and pelvic fat percentage was lower in 6 kg LWS kids. (López, 1990) reported higher kidneys percentages in 4 kg LWS kids than 12-kg LWS kids. (Wilson, 1958; Colomer-Rocher *et al*., 1992) indicated that when the LWS increased in kids, the percentage of shoulder and long leg decreased, while the percentage of ribs, flank and neck increased. In the present work the difference between LWS was lower than reported previously by (Wilson, 1958; Colomer-Rocher *et al*., 1992) and this may have been due to the absence of differences.

Tissue composition for carcass, shoulder, neck, long leg flanks and ribs is shown in Table 5 (a and b). No interactions were found between diets and LWS. There were significant differences between diets in subcutaneous, intermuscular and total fat in carcass and ribs, the percentages being higher in WD animals. Shoulder, long leg and flanks had lower percentages of intermuscular and total fat in MR kids. There were no differences for fat depots in the neck. (Morand-Fehr *et al*., 1986) had found similar results and they expounded as the principal reason of this, a higher amount of fat fed in WD than in MR kids. The total carcass fat results were lower than that reported by Gutiérrez *et al*. (1995) but were closer for those reported by Colomer-Rocher *et al*. (1992). According to previous research using the same breed, (Argüello *et al*., 1997 a, b and c) found the amount of milk replacer was higher, the total fat percentage increased. The bone and muscle tissue percentage did not change between diets.

There were significant differences between LWS in subcutaneous fat content in the carcass, shoulder and flanks, with 10 kg kids having higher percentages. Intermuscular fat percentage was higher in the carcass, flanks and ribs of 10-kg LWS kids, while total fat was higher in the carcass, shoulder, long leg, flank and ribs of 10-kg LWS kids. These findings are in agreement with those reported by Falagan, (1986) and Morand-Fehr *et al*. (1986).

Table 5a: Proportions of subcutaneous, intermuscular and total fat, bone, muscle and losses of carcass [a] and primal cuts [b]

	Feeding Systems		LWS				
	WD	MR	6 kg	10 kg		Effects	
	LSM				SE	FS	LWS
Carcass							
Subcutaneous fat	4.69	3.79	3.83	4.60	0.20	*	*
Intermuscular fat	3.71	2.56	2.57	3.63	0.22	**	**
Total fat	11.35	8.97	6.30	8.23	0.46	**	**
Bone	29.43	30.32	31.24	28.50	0.45	NS	***
Muscle	55.03	55.70	55.44	55.35	0.46	NS	NS
Losses	1.08	2.31	1.61	1.89	0.26	NS	NS
Shoulder							
Subcutaneous fat	3.20	2.52	2.31	3.39	0.20	NS	*
Intermuscular fat	2.67	1.69	1.91	2.39	0.24	*	NS
Total fat	5.87	4.21	4.22	5.78	0.32	**	**
Bone	30.87	31.69	32.75	29.80	0.46	NS	***
Muscle	62.09	61.58	61.03	62.64	0.37	NS	NS
Losses	0.38	1.42	0.88	1.01	0.23	NS	NS
Neck							
Subcutaneous fat	6.89	6.43	6.61	6.67	0.51	NS	NS
Intermuscular fat	4.22	3.15	3.07	4.25	0.44	NS	NS
Total fat	11.11	9.58	9.68	10.92	0.55	NS	NS
Bone	28.53	29.30	29.63	28.22	0.66	NS	NS
Muscle	55.18	50.67	53.87	51.55	1.08	NS	NS
Losses	4.09	8.57	5.03	8.08	1.12	NS	NS

[a], proportions on carcass weight. [b], proportions on cuts weights. WD, kids reared with their dams. MR, kids reared with milk replacer. FS, feeding systems. LWS, live weight slaughter. *Significance ($p<0.05$).**Significance ($p<0.01$).***Significance ($p<0.001$). NS, no significance

Table 5b: Proportions of subcutaneous, intermuscular and total fat, bone, muscle and losses of carcass [a] and primal cuts [b]

	Feeding Systems		LWS				
	WD	MR	6 kg	10 kg		Effects	
	LSM				SE	FS	LWS
Long leg							
Subcutaneous fat	4.55	3.59	3.49	4.60	0.31	NS	NS
Intermuscular fat	3.64	2.46	2.60	3.43	0.23	**	NS
Total fat	8.19	6.05	6.09	8.03	0.41	**	**
Bone	30.16	29.94	31.37	28.63	0.46	NS	**
Muscle	60.26	61.93	60.59	61.77	0.40	NS	NS
Losses	0.49	1.03	0.83	0.73	0.13	NS	NS
Flanks							
Subcutaneous fat	6.49	5.55	5.00	7.02	0.43	NS	*
Intermuscular fat	6.95	4.70	4.48	7.06	0.57	*	**
Total fat	13.44	10.25	9.48	14.08	0.71	**	***
Bone	29.68	31.85	31.51	30.16	0.99	NS	NS
Muscle	54.19	54.34	55.42	53.06	1.01	NS	NS
Losses	0.47	0.43	0.45	0.44	0.12	NS	NS
Ribs							
Subcutaneous fat	5.44	3.88	4.53	4.66	0.31	**	NS
Intermuscular fat	3.96	2.66	2.44	4.12	0.32	*	**
Total fat	9.40	6.54	6.97	8.78	0.49	**	*
Bone	33.80	34.93	35.46	33.31	0.75	NS	NS
Muscle	53.18	52.97	52.19	53.99	0.63	NS	NS
Losses	1.61	3.06	2.44	2.35	0.30	NS	NS

[a], proportions on carcass weight. [b], proportions on cuts weights. WD, kids reared with their dams. MR, kids reared with milk replacer. FS, feeding systems. LWS, live weight slaughter. *Significance ($p<0.05$).**Significance ($p<0.01$). ***Significance ($p<0.001$). NS, no significance

The bone percentage was higher in 6 kg LWS kids carcass, shoulder and long leg than 10 kg kids. Falagan (1986) found a reduction from 25 to 22% in 6 and 12 kg LWS kids, respectively. This reduction would typically be higher if the LWS was higher as reported by Treacher *et al.* (1987). Bone tissue percentages in the present study were slightly higher than for the Saanen breed (25.6% at 5 kg LWS, Warmington and Kirton, 1990), but more similar to those found by (López, 1990) using the same breed and similar LWS. LWS had no effect on muscle tissue deposition percentage (55-62%). Falagan (1986) only showed minor differences in Murciano-Granadina kids muscle percentage when LWS increased from 6 to 12 kg (61.5 to 63%, respectively). Gutiérrez *et al.* (1995) working with Florida Sevillana kids slaughtered at 30 and 60 days did not find major differences (57.1 and 57.8%, respectively).

CONCLUSION

The results from this study showed that suckling method, either naturally with their dams or artificially using a milk replacer, had minimal effects on carcass characteristics and yield factors, but increasing slaughtering weight increased (improved) carcass and yield indices.

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