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Effects of the rearing system on meat quality in young kids

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SUMMARY – The objective of our study was to examine the effects of the rearing system on meat quality in young Canary Caprine Group kids. Thirty twin, male kids were allotted to one of two rearing systems based on feeding regimes: kids nursed by their dams (ND, n=15), or kids fed a commercial milk replacer and controlled intake (CR, n=15). All kids were slaughtered at a live weight of ten kg. After slaughter, pH was measured on the *Longissimus dorsii* (LD), *Semimembranosus* (SM) and *Triceps brachii* (TB). The carcasses were chilled at 4°C for 24 h, and pH, Warner-Brazler shear force (WBSF), colour (lightness) and water holding capacity (WHC) were determined in the LD, SM and TB muscles. Compared with the ND-raised kids, the TB muscle from CR-raised kids had higher L (56.28 vs 50.77) and lower WHC (6.5 vs 9.27 percent) and pH (5.73 vs 5.84) 24-h postmortem ($P<0.05$). TB muscle had a higher final pH (5.79 ± 0.11), greater firmness (84.2 ± 15.0 N), and a lower WHC (7.96 ± 2.72) than the LD and SM muscles ($P<0.05$). In this experiment, raising goat kids on a commercial milk replacer, rather than suckling from their dams, had minimal effects on their meat quality.

Key words: Goat kids, meat quality, milk replacer.

RESUME – "Effets du système d'élevage sur la qualité de la viande chez les jeunes chevreaux". L'objectif de ce travail est de comparer le système d'élevage pour la qualité de la chair de chevreau du Groupement Caprin Canarien. Les chevreaux utilisés ($n=30$) naissent de mise bas double et ils furent élevés en suivant deux régimes d'alimentation : avec leurs mères (AM, $n=15$) ou allaitement artificiel (AA, $n=15$). Après l'abattage à dix kg de poids vif, le pH fut mesuré sur trois muscles : *Longissimus dorsii* (LD), *Semimembranosus* (SM) et *Triceps brachii* (TB). On a également déterminé le pH, la force de coupe avec la méthode Warner-Bratzler, la couleur (luminosité) et le pouvoir de rétention d'eau (PRE) après la réfrigération de la carcasse à 4°C pendant 24 h. Dans le muscle TB, la luminosité présentait une plus grande valeur pour AA (56,28) que pour AM (50,77), tandis que le PRE et le pH 24-h postmortem furent plus petits pour AA (6,50 et 5,73%) que pour AM (9,27 et 5,84%) ($P<0,05$). Le muscle TB présentait une plus grande valeur pour le pH ($5,79\pm 0,11$) et pour la force de coupe ($84,2\pm 15,0$ N) mais un PRE plus petit ($7,96\pm 2,72$) que les muscles LD et SM ($P<0,05$). Donc, l'élevage avec allaitement artificiel n'eut pas de grands effets comparé à l'allaitement maternel.

Mots-clés : Chevreau, chair, allaitement artificiel.

Introduction

With milk goat breeds, kids are usually reared on a milk replacer, so that all the milk the goats produce can be sold or made into cheese. An artificial rearing system was recently developed by the Canary Caprine Group (high producer goat), in the Canary Islands. Growth, carcass quality and live weight at slaughter (LWS) had been studied in kids fed on milk replacer (López, 1990; Argüello *et al.*, 1997; Argüello *et al.*, 1998), but no work had been done (in Canary Caprine Group) to compare the meat quality between two rearing methods. Very few papers had studied meat quality in young kids, papers usually describe mature animals (8 month to 5-6 years). In fact, Zygoyiannis *et al.* (1992) and Rojas *et al.* (1994) had worked with young kids, but they only studied the fatty acid composition of carcass fat.

Some papers had considered variation factors in the quality of goat meat. Borghese *et al.* (1990) reported that housing (in crates or on straw) had no influence on meat quality (Shear force). Thus, Esguerra *et al.* (1995), Singh *et al.* (1995) and Snell (1996) found small differences in pH and Water Holding Capacity (WHC), between genotypes. Although the colour of the meat is an important factor in the consumer's preference, it has hardly been studied in kids slaughtered at around 10 kg LWT. Nevertheless, Nunez *et al.* (1983) concluded that slaughtering at higher

LWT (12 to 24 kg) does not affect the meat quality of castrated male Criollo goats, Chiofalo *et al.* (1983) observed that meat colour was affected by age at slaughter (in mature goats of 4-8 years of age). Meat colour characteristics were significantly affected by goat genotype (Chiofalo *et al.*, 1983; Borghese *et al.*, 1990; Snell, 1996) and muscle sampled (Chiofalo *et al.*, 1983), but not by an additional protein supplement in artificially reared kids (Pisula *et al.*, 1994) and post-mortem electro-stimulation treatment (Chiofalo *et al.*, 1983). The aim of the present study was to determine the effect of rearing method on kid's meat quality.

Materials and methods

Two groups of 15 twin male Canary Caprine Group kids were used to study the effects of rearing systems on meat quality. The rearing system was based on feeding regimens: kids nursed by their dams (ND, n=15), and kids fed a commercial milk replacer (23.7 percent protein and 22.8 percent fat) and controlled intake (CR, n=15). At birth, all kids were removed from their dams and weighed, the umbilical cord was disinfected and the animals were numbered with a necklace. At this moment, the ND kids were put back with their dams (24 hours daily) and CR kids were fed with colostrum for two days. On the third day, their diet was changed and they were fed with milk replacer and a controlled intake with a 16% w/w concentration. The milk replacer concentration was the same throughout the study. On the fifteenth day of life, the CR kids were given solid food (starter) and clean water. The kids were weighed once a week. When they reached 10 kg of LWS they were slaughtered. Immediately after slaughter, pH was measured in the *Longissimus dorsii* (LD), *Semimembranosus* (SM) and *Triceps brachii* (TB). The carcasses were chilled at 4°C for 24 h, and pH, Warner-Brazler shear force (WBSF), colour (Lightness, L, Chroma, C, Hue, H), and water holding capacity (WHC) were determined (as % weight loss) in the LD, SM and TB muscles. The CIE (L C H) colour system, is useful for measuring colour in meat. The statistical analysis (GLM procedure) was carried out with a SPSS program.

Results and discussion

The daily gain in growth (DGG) of ND and CR kids was 212 and 150 g/d respectively. These values are higher (16.5%) than those reported by López (1990) in naturally suckled kids of the same breed. Other milk breeds, like Saanen or Alpine presents similar DGG (Owen and Mtenga, 1980; Fehr and Sauvant, 1976) when they are raised together with their dams. In the same breed, the results shown by CR kids are higher (22.2%) than those reported by López *et al.* (1991). In spite of the fact that growth values are high, the CR kids only achieve 70% of potential growth, which is a long way from the results presented by Sanz *et al.* (1985).

Rearing methods have no effect on shear force in any sample muscle. The results (Table 1) are similar to those found by Argüello *et al.* (1998) in the same breed and at a similar live weight at slaughter (LWS). Other authors (Mueller *et al.*, 1985) did not find any differences between animals raised in similar conditions to ours, but at a higher weight (17 kg). Even though different rearing methods have no effect on shear force, there is a tendency towards higher shear force in CR kids. This could be because CR kids are older. This tendency is in line with the results presented by Argüello *et al.* (1998). The values obtained in the present study are higher than those found by Pisula *et al.* (1994) at high LWS (15 kg), but lower than the values reported by Kesava *et al.* (1984) in Black Bengal Kids (18 kg LWS) and very much lower than those obtained by Johnson *et al.* (1995) in cross Nubian Kids slaughtered at 20 kg (in *Longissimus dorsii* muscle). The *Triceps brachii* muscle is firmer than the other two muscles sampled, being similar to the results reported by Argüello *et al.* (1998) in similar muscles. Indeed, Johnson *et al.* (1995) and Johnson and McGowan (1998) found differences in shear force between different muscle samples.

The effect of rearing method on the colour characteristics is present only in *Longissimus dorsii* (redder in CR kids) and *Triceps brachii* (darker in CR kids). In contrast other researchers (Matassino *et al.*, 1981; Chiofalo *et al.*, 1983) observed that colour differed significantly between the different muscles sampled. In previous studies (Argüello *et al.*, 1998), the *Longissimus dorsii* muscle was darker ($P < 0.05$) than the *Semimembranosus* or *Triceps brachii*. The differences found between muscles sampled might be explained by differences in the concentration of sarcoplasmic proteins, or muscle myoglobin, or intramuscular fat content (Babiker *et al.*, 1990), and also differences in muscle fibre populations. The differences between muscles were greater with an

increase in LWS, possibly due to a higher degree of muscle maturity or solid higher feed consumption.

Table 1. Meat quality parameters in kids[†]

Rearing	<i>Longissimus dorsi</i>		<i>Semimembranosus</i>		<i>Triceps brachii</i>		M
	ND	CR	ND	CR	ND	CR	
SF(N)	50.2±1.7	56.6±2.6	50.0±13.6	50.9±10.6	71.7±18.7	90.3±8.4	*
Colour L	52.7±6.9	53.6±4.3	50.7±4.7	55.0±4.5	<i>50.8±5.14</i>	56.3±2.6	*
Hue	43.0±10.9	36.9±11.1	36.4±7.2	38.0±7.6	30.8±12.4	41.4±9.2	ns
Croma	<i>9.0±7.5</i>	<i>16.8±7.2</i>	13.3±4.6	15.3±6.0	13.3±5.6	16.0±1.8	*
WHC (%)	11.8±2.8	9.7±3.2	13.5±2.6	13.1±2.6	<i>9.3±3.1</i>	<i>6.5±1.0</i>	ns
pH-fall	0.61±0.23	0.60±0.35	0.67±0.15	0.82±0.34	0.61±0.27	0.76±0.19	ns
pH-24	5.68±0.11	5.62±0.14	5.73±0.19	5.60±0.06	<i>5.84±0.10</i>	<i>5.73±0.07</i>	ns

[†]ND: nursed dams; CR: commercial replacer; SF(N): shear force (Newton); WHC: water holding capacity; *Italic numbers*: differences ($P<0.05$) between rearing method; M: significant effects of muscle sampled.

WHC (% weight loss) is only affected by rearing method in *Triceps brachii*; it is lower in CR kids. Mueller *et al.* (1985) did not find any major differences between kids raised in similar conditions. There are significant differences in water holding capacity between the three muscles. Similar differences have been shown by Matassino *et al.* (1981).

Whereas the pH fall is not affected by rearing method or sample muscle, the pH of CR kids is lower than ND kids in *Triceps brachii* muscle, this muscle has got the highest pH-24. These results are in agreement with Argüello *et al.* (1998). Thus, a possible explanation for this is the difference in muscle fiber populations. In this sense, Manabe *et al.* (1996) found higher type I fiber percentages (Brook and Kaiser, 1970) in *Triceps brachii* than in *Semimembranosus*. Thus, this could be the reason for lower values in these muscles (Weiler *et al.*, 1995).

The kids with low WHC have got firm muscles (SH), as is shown in Table 2. Thus, GDG was interrelated with large part of the meat quality parameters, specially with shear force (-0.31) and colour L (-0.41). The kids with low growth (CR) have got meat more firm and luminosity than ND kids. In conclusion raising goat kids on a commercial milk replacer had minimal effects on their meat quality.

Table 2. Correlation matrix

	SF(N)	Colour L	Hue	Croma	WHC (%)	pH-fall	pH-24
Colour L	0.27 (ns)						
Hue	0.15 (ns)	0.70 (0.001)					
Croma	0.27 (ns)	-0.09 (ns)	0.02 (ns)				
WHC (%)	-0.53 (0.001)	-0.25 (ns)	-0.16 (ns)	-0.01 (ns)			
pH fall	0.18 (ns)	0.15 (ns)	0.1 (ns)	0.20 (ns)	-0.14 (ns)		
pH-24	0.33 (0.04)	0.28 (ns)	-0.26 (ns)	-0.14 (ns)	0.02 (ns)	-0.22 (ns)	
GDG [†]	-0.31 (0.05)	-0.41 (0.005)	-0.16 (ns)	-0.16 (ns)	0.24 (ns)	-0.13 (ns)	0.32 (0.01)

[†]GDG: Growth daily gain.

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