Muscle meat quality differences on kids

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Palabras clave: Cabrito, Calidad de carne, Diferentes músculos.
Keys words: Goat kids, Meat quality, Muscle differences.

RESUMEN: 55 cabritos machos de la Agrupación Caprina Canaria fueron empleados para comparar la calidad de la carne de diferentes músculos. Sobre el Longisimus, Semimembranosus y Triceps braquii se estudió el pH, color (L*C*H*), resistencia al corte, capacidad de retención de agua, composición química y población de fibras musculares y sus áreas. El Triceps braquii presentó el mayor valor de pH inicial y final, los valores más elevados de L* y Croma inicial, así como la mayor resistencia al corte y capacidad de retención de agua. No se encontraron diferencias estadísticamente significativas en la composición química ni en la composición fibrilar de estos tres músculos. Los resultados sugieren que en los estudios de calidad de carne de cabrito no es suficiente la inclusión de un solo músculo, ya que existen diferencias importantes entre diferentes músculos.

SUMMARY: Fifty-five twin male kids from Canary Caprine Group breed were compared for muscle meat quality differences. pH, colour (L*C*H*), shear force, water holding capacity, chemical composition, muscle fibre populations and its areas were recorded on Longisimus, Semimembranosus and Triceps brachii muscles. Triceps brachii presented the highest initial and final pH value, the highest initial L* and Croma values, the highest shear force and water holding capacity. No differences were founded between muscles in chemical composition and muscle fibre population and areas. Results suggest that in goat kids meat quality studies is not enough with to include just one muscle, because muscles present important differences.

Introduction

[29] described the goat population as comprised of four types i.e. fiber goats (e.g. Angora, Cashmere), dairy goats (e.g. Saanen, Toggenburg, Nubian), meat goats (e.g. Boer) and feral goats. The world's goat population was around 720 million in 2000, with annual meat production of around 3.7 million metric tonnes [13]. The goat is an important meat animal in Africa, Asia, and the Far East, the goat is now emerging as an alternative and attractive source of meat in other parts of the world [12]. In India, the local community specifically seeks meat from mature goats, whereas in France and Latin America meat from young milk fed kids is considered a delicacy [29]. Acceptability of meat is so much influenced by local custom and preference that it is impossible to apply a universal standard for quality of goat meat [29]. The Canary Caprine Group is a dairy goat population present in Canary Island (Spain) with a mean production of over 500 kg of milk in 210 days of lactation [15].

There is little published information relating to muscle meat quality differences in dairy goat kids. [24] observed that colour stability is not just myoglobin dependent, but muscle sampled have a important effect too. [21] had related muscle shear force differences between Semimembranosus, Semitendinosus, Adductor and Biceps femoris in native Florida goats. Meat ageing depend of proteases and inhibitors concentration, muscle protein sensibility to proteases, and osmotic pressure [31, 27]. High type II fibre muscle proportions seem a higher hypertrophy growth capacity, because they are not oxygen dependent [30]. Muscle differences in proximal chemist composition had been described. Moisture and fat content present high variability between muscles, but protein and ash percentages are more stable [19]. The objective of the present study was to investigate the muscles meat quality differences in goat kids from 5 to 30 kg of live weight at slaughter (LWS).

Material and methods

The study was conducted at the University of Las Palmas de Gran Canaria, Canary Island, Spain, approximately 400 km from Morocco West Coast. 55 Canary Caprine Group genotype male kids were used in the study. Kids were slaughtered between 5 to 30 kg of live weight. Kids were colostrum feed during the first two days of live, according [4]. After that, were milk replacer (Table 1) fed until fifteen days of life, and then were raised with milk replacer fed plus ad *libitum* access to starting concentrate pellets (Table 1) and hay. Animals were weaning when they reach 10 kg of live weight. From weaning to slaughter, kids were raised indoors with control access to growth concentrate pellets. Kids were weighed every fortnight.

After slaughter, measures were performed on the right carcass side. Muscle pH was determined using a Crisson 507 pH meter with a combined electrode, by insertion into

Table 1. Chemical analysis of feedstuffs offered to the kids during the experimental period.

	Composition, DM basis (%)		
	Milk replacer	**Starting concentrate**	**Growth concentrate**
Dry matter	95,5	87,5	88,4
Ash	8,0	7,6	6,2
Crude protein	23,6	16,4	19,6
Crude fiber	0,1	4,5	4,3
Ether extract	22,7	2,5	2,1

the Longisimus (at the 12/13th rib site), Semimembranosus (central portion) and Triceps brachii (central portion) muscle, immediately after slaughter, at 45 minutes after slaughter and after chilled (approx. 24 hours after slaughter). Muscle Colour was measured at the same sites and times, using a Minolta CR200 Chroma-meter (where L* depicts relative lightness, a* indicates relative redness and b* represents relative yellowness). Hue and Croma were calculated using a* and b* values according to [41]. After chilling, mentioned muscles were excised. Water holding capacity was performance according [16] modified by [36]. Cooked muscle cores with cross section of 1 x 1 cm and at least 3 cm length were cut parallel to the muscle fibers and shear force values were taken using Warner-Bratzler shear force apparatus on a INSTRON Machine. Proximate analysis was performance. Moisture was determined by air drying [2 procedure 24.003] and fat by soxhlet extraction using petroleum ether [2 procedure 13.032]. The kjeldahl procedure [2 procedure 2.057] was used for percentage of nitrogen determination; the conversion factor of 6.25 was used to convert nitrogen to percentage protein. Determination of ash was done according to [2 procedure 14.066], and Collagen content and solubility was determined according [8] and [18]. Muscle fibre populations were determinate according [9] histochemistry techniques. The effects of muscle tested were analysed using ANOVA procedure (SPSS V. 8.0 programme) including birth weight as covariables.

Results and discussion

The initial pH of three tested muscles ranged from 6.3 to 6.5 with statistic differences between them (Table 2). Triceps brachii initial pH was significantly higher than Longisimus muscle, while these differences did not found in Semimembranosus. 45 minutes after slaughter pH did not show significative differences between muscles, but Triceps brachii showed the highest value. Triceps brachii final pH value was significantly higher than Longisimus and Semimembranosus muscles. The ultimate pH range is acceptable according [17], but lower than showed by [14] in Alpine kids slaughter at 24 kg of LWS. The relationship between pH value and fibre muscle population is good known, but in the present study this relation have not been showed (Table 4).

Triceps brachii initial muscle lightness was significantly higher than Longisimus and Semimembranosus lightness values, while this differences disappeared during meat ageing. Triceps brachii initial Croma value was significantly higher than Longisimus, but at 45 minutes Triceps brachii Croma value was significantly higher than Longisimus and Semimembranosus muscle, while these differences disappeared at 24 hours post slaughter. No statistic differences were founded for Hue values between muscles tested at any study time. The colour results are according with previous studies in the same breed [3] or different breeds [10]. The colour of raw meat is largely dictated by the concentration and chemical nature of the haemoproteins present and the temperature/pH history of the muscle post slaughter [25]. In opposite to that [24] observed that half of variability in meat colour was raised in muscle type.

Triceps brachii shear force value was significantly higher than Longisimus and Semimembranosus muscle (Table 2). Shear force values were in the range of 53.9 to 89.9. These shear force values were high compared to 58.8 N observed in the adult Florida native goat and its crosses with Nubian and Spanish breeds [22] and similar to 83.4 as reported by [32] in Angora and Spanish breeds of goats. This varia-

Table 2. pH and colour evolution, water holding capacity and shear force results in Longisimus, Semimembranosus and Triceps brachii muscle.

	Muscle tested		
	Longisimus	**Semimembranosus**	**Triceps brachii**
pH slaughter	6.27 ± 0.32^{a}	6.40 ± 0.27^{ab}	6.52 ± 0.21^{b}
pH 45 minutes	6.28 ± 0.33	6.27 ± 0.27	6.46 ± 0.24
pH 24 hours	5.64 ± 0.15^{a}	5.62 ± 0.08^{a}	5.76 ± 0.11^{b}
L slaughter	47.67 ± 4.43^{a}	52.46 ± 4.70^{a}	52.56 ± 9.42^{b}
L 45 minutes	46.47 ± 5.08	47.91 ± 6.15	48.11 ± 6.17
L 24 hours	53.22 ± 5.81	54.18 ± 4.46	53.54 ± 6.06
Croma slaughter	10.24 ± 2.09^{a}	11.27 ± 2.32^{ab}	12.07 ± 2.59^{b}
Croma 45 minutes	11.16 ± 2.31^{a}	11.35 ± 2.22^{a}	13.31 ± 5.75^{b}
Croma 24 hours	16.32 ± 5.65	15.75 ± 4.23	16.42 ± 2.71
Hue slaughter	27.23 ± 10.71	30.14 ± 9.28	27.22 ± 9.60
Hue 45 minutes	27.50 ± 9.79	30.71 ± 9.17	27.48 ± 8.70
Hue 24 hours	38.74 ± 8.78	39.41 ± 9.08	36.9 ±10.45
Shear force (N)	57.47 ± 13.25^{a}	53.92 ± 13.74^{a}	89.93 ± 7.76^{b}
WHC (g)	0.49 ± 0.14^{a}	0.59 ± 0.15^{c}	0.35 ± 0.09^{b}

Results expressed in mean±standard deviation, n=55; data show in the row with different letter is significant difference (P<0.001). WHC: Water holding capacity.

tion might be due to differences in post-mortem carcass treatment, age, liveweight and the types of muscles used by these workers. [21] had reported similar shear force differences between muscles in Native Florida goats. The reason for these muscle shear force differences are raised in several factors as proteases and inhibitors concentration, muscle protein sensibility to proteases, and osmotic pressure [31, 27]. [35] had reported a high correlation between collagen content and muscle shear force, but in the present study this relationship is between collagen solubility and muscle shear force, having Triceps brachii muscle the low collagen solubility and the high shear force value. The WHC values ranged from 0.3 to 0.6 expelled grams (Table 2), being the three tested muscles significantly different. These results are lightly lower than observed by [34] in adult Spanish goat, but close to related by [3] in Canary Caprine Group kids. Triceps brachii muscle presented the highest final pH value, for that, muscle proteins were far from it isoelectric point and WHC was the highest.

Muscle tested did not affect the moisture, protein, intramuscular fat, ash, collagen content or collagen solubility of uncooked composite goat samples (Table 3). The moisture values ranged from 77.8 to 78.4%, the protein values ranged from 18.6 to 19.4%, the intramuscular fat values ranged from 1.1 to 1.4%, the ash values ranged from 1.12 to 1.14%, the collagen content values ranged from 0.41 to 0.44 and the collagen solubility ranged from 72.0 to 80.4%. Moisture percentages reported by [7], [22] and [19] for goats slaughter at higher weights were little lower than observed in the present study, due to during the animal growth the protein and fat percent increased, reducing moisture muscle content. In opposite to present study, [19] founded in Saanen x Angora goats differences in moisture and fat content in different muscles. Protein and ash percentages in the present study were similar at reported by [33] or [23] in goat kids meat. The intramuscular fat content founded in the present study were similar at cited by [23] in Black Bengal kids slaughter at 18 kg. These results were lightly lower than reported by [22] in Florida goat breed slaughter at 20 kg LWS, but it were lower than reported by [7, 19, 33] in different breeds slaughter at higher LWS. Collagen muscle kids content in the present study was similar at founded by [39] in Boer goats or [1] in lambs. Values of collagen solubility were higher than related by [39] in Boer goat or [28] in lambs. Different ages should be the reason for these collagen solubility results, as reported [11].

Muscle tested did not affect the muscle fibre proportions and it areas (Table 4). The muscle fibre interconversion had been described by [6] and [38], but in the first stages of the mammals life, it is affected by several factors, such as nerve net [40], muscle over exercise [26] or T3-T4 level [37]. The results founded in the present study are in agreement with [20] and [5].

Table 3. Chemical composition in Longisimus, Semimembranosus and Triceps brachii muscle.

	Muscle tested		
	Longisimus	**Semimembranosus**	**Triceps brachii**
Moisture (%)	77.76 ± 0.98	78.20 ± 1.20	78.38 ± 0.56
Protein (%)	19.37 ± 1.26	18.56 ± 1.81	18.90 ± 0.85
Intramuscular fat (%)	1.39 ± 0.92	1.16 ± 0.52	1.08 ± 0.44
Ash (%)	1.13 ± 0.08	1.14 ± 0.09	1.12 ± 0.07
Collagen (%)	0.42 ± 0.12	0.41 ± 0.08	0.44 ± 0.10
Collagen solubility (%)	80.41 ± 14.99	79.45 ± 15.00	72.01 ± 11.66

Results expressed in mean±standard deviation, n=55; data show in the row with different letter is significant difference (P<0.001).

Table 4. Muscle fibre composition in Longisimus, Semimembranosus and Triceps brachii muscle.

	Muscle tested		
	Longisimus	**Semimembranosus**	**Triceps brachii**
Fiber type I (%)	30.67 ± 15.60	25.73 ± 16.0	23.29 ± 90.38
Fiber type IIA (%)	31.84 ± 6.75	27.59 ± 24.93	23.45 ± 12.13
Fiber type IIB (%)	37.47 ± 14.23	57.47 ± 27.86	53.19 ± 7.77
Fiber type I (m2)	611.72 ± 289.27	586.19 ± 99.27	892.44 ± 364.02
Fiber type IIA (m2)	618.77 ± 357.89	663.66 ± 139.61	865.38 ± 246.07
Fiber type IIB (m2)	589.55 ± 240.95	638.72 ± 126.54	929.34 ± 300.91

Results expressed in mean±standard deviation, n=55; data show in the row with different letter is significant difference (P<0.001).

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