CARCASS AND MEAT CHARACTERIZATION OF HOLSTEIN-FRIESIAN CULL COWS

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Abstract – Finishing effect on main quality attributes were evaluated in fourteen longissimus dorsi (vacuum packaged) from Holstein-Friesian breed cows. EUROP carcass conformation was "fair" with an average fatness level. Finishing treatment had a great influence on the final meat value. Intramuscular fat content (6.14%), shear force (5.07 Kg/cm^2) and meat tenderness (5.93 kg) were affected. The most abundant fatty acids were the monounsaturated C18:1n9c (41.34%) and the saturated C16:0 (28.13%). Finishing period improved conformation and fatness scores, meat and eating quality. This is advantageous when the carcass is destined to a market with the basic end of commercializing as "entrecote for gourmet".

Keywords – conformation, meat quality, eating quality

I. INTRODUCTION

In Galician (NW Spain), there are around 344.000 dairy cows [1] that mainly belong to the Holstein-Friesian (HF) breed. The continuous renewal of dams, due to reduction of production and reproduction problems, join to more than 50% of the animals are slaughtered without finishing period, none of which prevent them from being used for butchering [2]. It is estimated that annually around 50.000 dairy cows could be destined to produce meat. Finishing dairy cows allows improving carcass conformation and fatness scores [3], meat and eating quality [4] and increases the price [5]. As a result, an improvement and revalorization of the pieces is produced, for different destinations within meat industry.

Therefore, the aim of this study was to evaluate the finishing effect of dairy cows on the main attributes of quality, such as physicochemical composition, textural properties, fatty acids and sensorial attributes.

II. MATERIALS AND METHODS

II.1. Animal management

Fourteen cows of the HF breed, obtained from Galician farms and finished in the agricultural cooperative SAT Frontón (Escairón, Lugo, Spain), were used for this study. These animals were previously destined to the milk production during a mean of five years. Completed their productive life, were finished seven months until their slaughter in extensive systems with feeding on pasture and supplemented with silage. Animals were slaughtered at a commercial abattoir. Carcasses were classified using a conformation score, according to the EUROP scale (Conformation: Poor=1, Fair=2, Good=3, Very good=4, Excellent=5), and a fatness score with ranges from 1 (low fat) to 5 (high fat) [6]. Immediately after slaughter, carcasses were weighted and chilled at 4ºC in a cold chamber for 24 hours.

II.2. Carcass measurements

At this point, the left half of each carcass was transferred in cooling conditions to the research centre pilot plant and the following carcass measurements were made to assess carcass morphology: carcass length (LC), chest external depth (EDC), chest internal depth (IDC), leg length (LL) and leg width (WL) as described in De Boer et al. [7], whereas leg maximum perimeter (MPL) was performance as per Carballo et al. [8]. Carcass compactness index (CCI) that relates carcass weight and length, and hindlimb compactness index (LTI) that relates

leg length and width, were also calculated [9]. Carcass was cut according to Carballo et al. [8], and the muscle *Longissimus dorsi* (LD) was extracted between the fifth and the tenth rib. Samples were packaged and stored 7 days under vacuum conditions to the subsequent analysis.

II.3. Analytical methods

In LD muscle took place the following physicochemical measures to assess the meat quality: pH, colour, chemical composition, water holding capacity and texture analysis. pH and colour were measured according to the conditions described by Franco et al. [2]. A NIRS (Foss Tecator NIRS Neotec 6500, Denmark) was used to determine chemical composition (water, protein, intramuscular fat and ash). The water holding capacity (WHC) was measured in three ways: cooking loss (CL), drip loss (DL) and pressing loss (PL), which were evaluated according to Hönikel [10]. To measure properties of texture, the meat was cooked in a water bath at 80 ºC by immersion until the temperature reached 70 ºC *in quore*. The temperature control was carried out using type K thermocouples connected to a data logger (N3000 Comark, United Kingdom). Warner-Braztler (WB) test and texture profile analysis (TPA) were carried out according to the conditions described by Franco et al. [2]. A texture analyzer (TA.XT.plus Stable Micro Systems, Surrey, United Kingdom) was used for both test, and all samples were cut or compressed perpendicular to the muscle fibre direction at a crosshead speed of 3.33 mm/s. The average value for each LD sample was recorded from four replicates.

II.4. Analysis of fatty acids

The fat extraction for the determination of fatty acid composition was performance following the method proposed by Folch et al. [11]. The fatty acid methyl esters formation was carried out using the acid transesterification method described by Carreau and Dubacq [12]. The identification and quantification took place using gas chromatography techniques according to the chromatographic conditions described by Lorenzo et al. [13].

III. RESULTS AND DISCUSSION

III.1. Carcass quality characteristics

Carcass characteristics and measurements are shown in Table 1. The weights of the analyzed carcasses ranged between 373.0 and 256.0 kg, with a mean value of 313.9±33.4 kg. The animals showed a fair conformation, with an average carcass fatness level and a CCI of 1.98 kg/cm.

Table 1 Carcass characteristics, morphology, and proportion of cuts and tisular composition

	MEAN	**MAX**	**MIN**	**SD**
Carcass weight (kg)	313.90	373.00	256.00	33.37
Conformation (EUROP)	1.86	2.00	1.00	0.38
Fatness level (1-5)	2.71	3.00	2.00	0.49
Carcass morphology (cm)				
LC	158.21	163.00	147.50	4.00
LL	89.54	96.00	86.00	3.05
WL	25.29	29.50	22.00	2.08
MPL	122.00	127.00	115.00	3.14
EDC	82.36	86.00	74.00	2.98
IDC	52.79	57.00	50.00	2.04
CCI	1.98	2.30	1.63	0.18
LTI	3.56	4.18	2.98	0.31
Carcass Percentage				
Front quarter	34.00	34.83	32.67	0.96
Hind quarter	65.76	67.33	65.10	1.06
Tisular Composition (%)				
Meat	60.35	65.17	55.81	4.39
Bone	26.31	29.61	23.43	2.64
Fat	13.34	17.22	5.22	5.65

LC=Carcass length; LL=Leg length; WL=Leg width; MPL=Leg maximum perimeter; EDC=Chest external depth; IDC=Chest internal depth; CCI= Carcass compactness index; LTI=Hindlimb compactness index.

The left half carcass percentages and tisular composition are shown in Table 1. The obtained percentages reflected a greater proportion of hind quarter, with mean values of 65.76±1.06% *vs.* 34.00±0.96% obtained for fore quarter. Hind quarter is the part of the carcass where several of the most cuts are located, like loin, tenderloin or eye round. These cuts accounted percentages of 6.89±0.71, 1.61±0.18 and 1.51±0.19%, respectively. Regarding the tisular composition, the percentages obtained for meat, bone and fat were 60.35±4.39, 26.31±2.64 and 13.34±5.65%, respectively. These carcass characteristics were

lower than the scores found by other authors in other HF cull cows [2,4,14,15], what could be due to the different feed, the time that they have been engaged in producing milk and the finishing period.

III.2. Meat quality

Chemical composition, color parameters, WHC and textural parameters of meat from the cull cows are shown in Table 2.

Table 2 Characteristics of the cull cows meat quality

	MEAN	MAX	MIN	SD
Chemical composition				
pH	5.71	6.00	5.57	0.13
Water (%)	71.13	76.04	61.76	3.09
Protein (%)	20.88	23.17	17.79	1.50
Ashes (%)	2.07	2.09	2.04	0.02
Intramuscular fat (%)	6.14	18.84	3.35	3.99
Color parameters				
Luminosity (L*)	35.62	39.84	32.65	1.95
Index of red (a*)	20.56	23.25	16.43	2.00
Index of yellow (b*)	11.81	13.84	8.98	1.70
WHC (%)				
Pressing losses (%)	19.93	28.60	15.20	3.52
Drip losses (%)	1.66	2.71	1.09	0.54
Cooking losses (%)	22.51	27.66	17.86	3.51
Textural parameters				
Firmness (Kg/s)	1.27	1.96	0.56	0.41
Total work (Kg·mm)	25.15	39.85	12.27	8.53
Shear force (Kg/cm^2)	5.07	7.91	2.17	1.81
Hardness (Kg)	5.93	9.06	4.16	1.30
Springiness (mm)	0.46	0.51	0.43	0.03
Cohesiveness	0.56	0.61	0.52	0.03
Gumminess (Kg)	3.33	5.48	2.31	0.83
Chewiness (kg·mm)	1.56	2.65	1.03	0.42

In all cases, the pH values were within an acceptable range (below 6). Similar values were found by other authors in dairy cull cows [2, 4, 15]. The mean percentages of water (71.1±3.1), protein (20.9±1.5), IMF (6.1±4.0) and ashes (2.1±0.0), that conform the chemical composition, were similar to those obtained in other animals of the breed HF [2, 14]. The color measurement was performed at seven days of slaughter on the muscle under study. The luminosity (L*) values (35.62±1.95) were similar to those obtained in other breeds of dairy cull cows [2, 4, 16], while redness (a*) and yellowness (b*) values were slightly higher. The WHC has a great importance in the final value of the meat, because it affects the consumer acceptance. As well, appearance, suitable for preservation, weight, color and some extent tenderness and juiciness, are affected by WHC, due to the water losses that occur during cooking. The mean values obtained for CL in the analyzed samples were 22.51±3.51%. This value was lower than that found by Franco et al. [2] in HF cull cows finished two months until their slaughter and stored seven days under vacuum conditions at 4ºC. The results for PL and DL were lower than CL, with mean values of 19.93±3.52% and 1.66±0.54%, respectively. The textural parameters obtained in WB and TPA test were lower than those obtained by Franco et al. [2] under similar *post-mortem* conditions. Thereby, the main textural parameters, shear force (5.07 *vs.* 5.60 Kg/cm^2) and hardness (5.93 *vs.* 16.24 kg) showed a meat more tender than that found by the aforementioned author.

III.3. Fatty acid composition

The fatty acid composition of LD muscle is shown in Table 3.

Table 3 Fatty acid composition (%) of *Longissimus dorsi* muscle from cull cows

	MEAN	MAX	MIN	SD
C14:0	2.78	3.66	1.91	0.46
C16:0	28.13	30.06	26.10	1.23
C18:0	16.29	21.14	12.19	1.98
C21:0	0.51	0.73	0.23	0.13
∑SFA	48.79	52.92	43.88	2.26
C16:1	4.49	6.08	2.73	0.79
C18:1n7t	1.53	2.09	1.20	0.31
C18:1n9c	41.34	44.89	38.17	2.51
∑MUFA	48.02	54.28	43.45	3.13
C18:2n6t	0.21	0.30	0.16	0.06
C18:2n6c	2.12	4.40	1.29	0.98
C18:3n3	0.51	2.24	0.27	0.51
C20:4n6	0.41	1.81	0.09	0.45
∑PUFA	3.19	7.71	1.75	1.75
∑n3	0.51	2.24	0.27	0.51
∑n6	2.68	5.82	1.40	1.40
n6/n3	6.35	15.08	2.45	3.01
PUFA/SFA	0.07	0.16	0.04	0.04

SFA=Saturated fatty acids
MUFA=Monounsaturated fatty acids
PUFA=Polyunsaturated fatty acids

C16:0 and C18:0 were the saturated fatty acids (SFA) more abundant with percentages of 28.13 and 16.29%, respectively. C18:1n9c was the

predominant monounsaturated fatty acid (MUFA), with a mean value 41.34%. In the case of polyunsaturated fatty acids (PUFA), C18:2n6c had the highest proportion, with a rate of 2.12%. Like other authors [16], the percentages found for SFA and MUFA were similar, with mean values around 48%.

IV. CONCLUSION

The results obtained in terms of carcass conformation and fatness scores, meat and eating quality confirm that the finishing of dairy cows in this study improve quality and commercial parameters of the meat from Holstein-Friesian cull cows.

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