PHASE II OF THE URUGUAYAN LAMB MEAT QUALITY AUDIT: HARVEST FLOOR AND CHILLING ROOM ASSESSMENTS

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Abstract – The 2013-Uruguayan Lamb Meat Quality Audit (LMQA) was conducted to evaluate characteristics on the slaughterhouses that affect the quality and value of lamb carcasses, and byproducts. Assessments were performed in four slaughterhouses that represented 70% of the Uruguayan lamb slaughter. Approximately 10,927 lambs were evaluated. Bruises were present in 24.8% of the carcasses and 4.1% corresponded to bruises type II that its removal implied loss of carcass value. Carcass weight was between 14.0 and 23.7 kg in 71% of the cases. About 60% of the carcasses were graded with scores representing deficient or excessive levels of fat cover. Incidence of bruises, liver condemnation, and carcass heterogeneity have been identified as the major factors associated to lamb meat quality losses.

Key Words – carcass, evaluation, losses.

I.   INTRODUCTION

Uruguayan LMQA began in 2002 with the objective to identify and quantify the main constraints faced by the lamb industry. The LMQA consist of three phases that contribute to the aforementioned goal. The first phase refers to interviews and surveys with the different lamb industry actors identifying meat quality perception. Meat quality aspects are perceived differently depending on each lamb market sector. Nevertheless, consumer´s preferences are key drivers when defining the relevance of different meat quality attributes [1]. However, consumer perceptions are dynamic, and there are often differences between what consumers perceive and their behavior [2]. The second phase is related to the assessments conducted in the slaughterhouses in which lamb carcasses, meat and by-products characteristics are evaluated. Once the main constraints are identified, a third phase of the LMQA is performed in order to prioritize future research programs and take actions to mitigate meat quality problems for the lamb industry. The findings from LMQA are used to develop good practices programs for producers, identify weakness in the harvest process, and define research lines. The ultimate goal is to enhance the competitiveness of the Uruguayan lamb chain taking into account export markets.

II.   MATERIALS AND METHODS

The third LMQA (2013) was performed in four slaughterhouses qualified for exporting that collectively represented 70% of the Uruguayan lamb slaughter. Data were collected in two complete slaughter days on each plant. Assessments in the slaughterhouses were conducted at five different stages on each plant: 1) before hide removal, 2) after hide removal, 3) condemnation, 4) hot carcass weight and grading and 5) carcass evaluation after 24 hours of chilling. A total of 10,927 lambs were evaluated, varying on the sample intensity on every stage between 18.3% (stage 3) to 100% (stage 4), being 21.4% the proportion of carcasses measured in the other 3 stages. Methodologies and procedures used during this Audit were mostly described by De Barbieri *et al*. [3]. A standardized scoring criteria were established among evaluators before data collection. A descriptive analysis was conducted using SAS software (SAS Inst., Inc., Cary, NC). *Stage 1* - It was located in the kill floor after exsanguination and before hide removal. The variables evaluated were: breed, sex, horn presence, potential contaminants on hide, and wool length. *Stage 2* - Presence of strange agents and bruises were assessed on carcass after hide removal and evisceration. Strange agents evaluated and present in the carcasses were: wool and/or hide (WH), gastrointestinal content (GC), feces (F) and others (O). The presence of bruises on carcass were evaluated on: shoulder, rack and loin, flank and leg regions. Severity of bruises was defined as type I: subcutaneous fat, its removal did not imply loss of carcass value,

and type II: muscular, its removal implied loss of carcass value. *Stage 3* - Condemnations were determined in the table of offal by veterinarians of the Official Veterinary Inspection of the Ministry of Agriculture, Livestock and Fishing (MGAP) of Uruguay. *Stage 4* - Data about hot carcass weight was provided by each slaughterhouse. *Stage 5* - After 24 hours chilling, carcass conformation, carcass fat cover, and presence of strange agents were determined in the chilling room. Conformation and fat cover was performed applying the Uruguayan Grading System of Sheep Carcasses based on conformation and fat cover scales [4]. Conformation: S (excellent), P (good), M (mean) and I (deficient) (Figure 3). Fat cover: 1 (insufficient), 2 (moderate), 3 (abundant), and 4 (excessive). Ultimate pH was measured 24 hours post chilling on the *longissimus dorsi* muscle between the 12th and 13th ribs.

III.   RESULTS AND DISCUSSION

Stage 1. Crossbreeds with meat breeds represented 43.9% of the total number of lambs evaluated, followed by Corriedale (33.4%) which is considered a dual-purpose breed. Compared to the 2008 LMQA, the proportion of crossbreeds in the national lamb slaughter increased more than twice (from 17.0% to 43.9%), probably indicating a more meat-oriented lamb production system instead of wool. Lambs slaughter were predominantly castrated (63.9%) followed by females (22.4%) and entire males (13.7%). Considering the three LMQA, castrated males represented more than 50% of the total slaughter (56% in 2002, 52% in 2007 and 64% in 2013). Lambs slaughtered did not present horns in 94% of the cases. Mud and manure are of great concern for meat processors because of the potential microbial contamination of the carcasses during hide removal process [5]. Incidence of mud and/or manure on hides is described in Table 1.

Table 1. Incidence of mud and/or manure on hides.

Presence	Percentage (%)
Visual absence	59.1
<25% of the region[1]	30.4
>25% of the region[1]	10.5

[1]: Different anatomical regions were: shoulder, rack & loin, leg, flank, and belly.

In regards to the presence of mud and/or manure at the different anatomical regions, the greatest proportion was detected in the rack and loin area (24.9%), followed by the belly (10.6%). This could be explained by the double floor truck used to transport lambs from the farm to the slaughterhouse. The lambs located in the bottom floor are more susceptible to be contaminated with feces and urine from lambs located in the top floor. Wool length is another important factor related to the presence of mud and/or manure in lambs and then associated to potential microbial contamination in carcasses. Ninety-four percent of the lambs had less than 3 cm of wool length at slaughter.

Stage 2. No presence of any strange agents were detected in 19.7% of the carcasses evaluated. This value is much lower than in the previous LMQA (44% in 2002 and 46% in 2007). The presence of different strange agents were identified in those carcasses contaminated (Fig. 1).
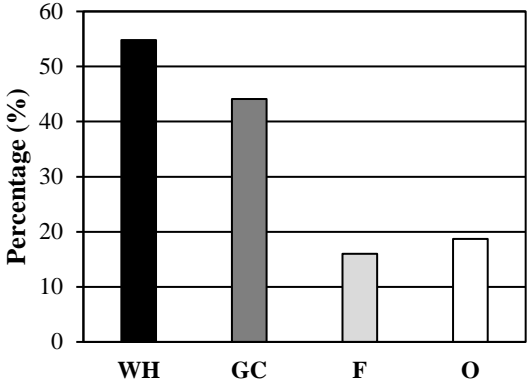

Fig. 1. Percentages (%) of different strange agents on contaminated carcasses.

The high presence of wool and/or hide on contaminated carcasses is consequence of a deficient hide removal process. In addition, the presence of gastrointestinal content would be associated to a deficient evisceration process.

Incidence of bruises on carcasses is presented in Table 2. It is important to note that the presence of bruising have diminished from the 1st LMQA (57% in 2002, 30% in 2007, and 25% in 2013). Severity of bruising was evaluated by carcass region within each severity type (Table 3). Noteworthy that one carcass could present bruises in more than one region and of different severity level.

Table 2. Proportion of carcasses (%) with bruises and severity type of the total number carcasses evaluated.

Bruises	Percentage (%)
Absence	75.2
Presence	24.8
Severity of bruises	
Type I	20.7
Type II	4.1

Table 3. Proportion of carcasses (%) with bruises type I and II identified by region for the total number of carcasses evaluated.

Bruises type I	Percentage (%)
Shoulder	4.0
Rack-loin	16.4
Flank	6.6
Leg	9.5
Bruises type II	
Shoulder	0.9
Rack-loin	1.9
Flank	1.4
Leg	2.0

Stage 3. Liver condemnation and its causes are presented in Table 4. Liver condemnation have decreased from the 1st LMQA (60% in 2002, 47% in 2007, and 32% in 2013).

Table 4. Incidence (%) of liver condemnation and its causes.

Liver	Percentage (%)
No condemned	68.1
Condemned	31.9
- Hydatic cysts	5.0
- Other cysts	3.3
- *Fasciola hepatica* alive	0.5
- *Fasciola hepatica* lesions	15.5
- *Taenia* spp.	3.7
- Others	4.0

Stage 4. The average hot carcass weight was 16.9 kg, and 71% of the carcasses weighed between 14 and 23.7 kg. In the 1st and 2nd LMQA the percentage of carcasses within this range was 87% and 86%, respectively.

Stage 5. In comparison with previous LMQA, the proportion of carcasses graded in Conformation as "P" decreased (91%, 72%, and 54% in 2002, 2007, and 2013, respectively) (Fig. 2). In contrast, the frequency of "M" carcasses increased from 7% in 2002 to 40% in 2013.
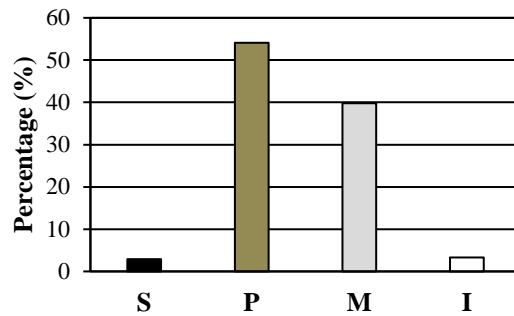
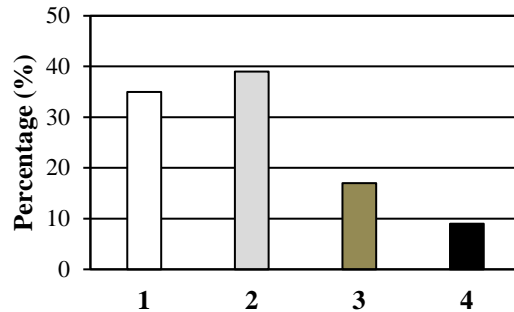Fig. 2. Frequency (%) of conformation scores of lamb carcasses.

Fig. 3. Frequency (%) of fat cover scores of lamb carcasses.

In regard to fat cover, approximately 40% of the carcasses evaluated had a moderate level of fat. In other words, around 60% of the carcasses were graded with scores representing deficient or excessive levels of fat cover (Fig. 3). Presence of strange agents on carcasses 24 hours post-chilling was determined applying the same criteria used on *Stage 2* (WH, GC, F, and O). About 60% of the total number of carcasses evaluated in this stage (n=2267) did not present any type of strange agent. This percentage was much lower than in 2007 LMQA where no presence of strange agents was detected in 92% of the carcasses.

IV.   CONCLUSION

Three factors have been identified as the main problems associated to the greatest lamb meat quality losses in the past three LMQA conducted in Uruguay. However, the relative importance of each factor has been different in each LMQA. These factors are: incidence of bruises, liver condemnation, and carcass heterogeneity. In this context, it is fundamental to focus on animal welfare issues (on farm, during transport, and on slaughterhouses), proper protocols for animal healthcare, and efficient lamb fattening production systems considering genetic, nutrition, and management.

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