

EFFECT OF FEEDING, MUSCLE AND PACKAGING ON VISUAL COLOUR ACCEPTABILITY OF MEAT FROM AVILEÑA-NEGRA IBÉRICA BREED

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Abstract – Twenty-four young bulls of the Spanish Avileña-Negra Ibérica breed were used to evaluate the effect of 2 feeding systems (concentrated, CON, vs. corn silage, SILO), 2 muscles (*Longissimus thoracis* (LT) vs. *Semitendinosus*, ST) and 2 packaging systems (film permeable to O₂, FILM vs. modified atmosphere packaging, MAP) on visual colour acceptability of beef throughout display. Feeding, muscle and packaging highly influenced acceptability throughout storage time. LT had better colour acceptability than ST. On the other hand, samples from MAP were well accepted by consumers at longer times of display (7 days), especially meat from SILO group. In ST, differences on visual colour acceptability between FILM and MAP were more pronounced.

Key Words –Corn silage, shelf-life, display.

I. INTRODUCTION

Many factors affecting ruminant carcass and meat quality are directly linked with the animal and its environment [1] and of these, breed and diet are probably the most important. Marketing differentiated products based on these factors have recently become a priority for beef producers. However, increased grain prices and declining animal prices have triggered the need for alternate feeding practices which can be utilized by farmers to reduce feeding costs [2]. Feeding diets based on silage are a feasible option, because they can easily be produced in irrigated areas located near, in many times, the feedlots or intensive units.

Including maize silage, in diets given as total mixed rations for fattening cattle, has aroused much interest in recent years [2, 3, 4, 5] Maize silage lowers the cost of rations by increasing forage consumption, without decreasing energy concentration [6].

Modified atmospheres are commonly used for preserving fresh meat. It has been reported that optimum colour stability in red meats is obtained by using gas mixtures containing elevated concentrations of oxygen joined with low proportions of carbon dioxide [7]. It is further known that colour stability varies between different muscles [8, 9], and that could affect the acceptability of the meat.

The aim of the current study was to evaluate visual colour acceptability of meat from Avileña-Negra Ibérica young bulls fed with corn silage throughout display, in different types of packaging.

II. MATERIALS AND METHODS

Twenty four Avileña-Negra Ibérica young bulls (initial live weight = 250.7 ± 64.7 kg and 200.5 ± 44.9 days old) divided in two groups of 12 animals were used. One group was feeding with concentrated (CON) and the other group was feeding with a mixture of 70 % of corn silage and 30% of concentrated (SILO) [10]. After a finishing period of 250 days, the animals (mean live weights 578.7 ± 36.4 kg and mean live age 455.2 ± 41.6 days) were slaughtered using standard procedures in an EU-licensed abattoir. Carcasses were chilled at 4° C for 72 h under commercial conditions. At 72 h post-mortem, the *M. Longissimus thoracis*, (LT) and the *M. Semitendinosus* (ST) were removed from the left side of the carcass, kept under vacuum conditions and sent to the University of Zaragoza. At 7 days post-mortem, two 2 cm-thick steaks from each muscle were cut and immediately vacuum packaged and kept at -18° C. Twenty four hours before the analysis the steaks were refrigerated at 4° C until thawing.

One steak from each muscle was placed in a polystyrene tray overwrapped with an oxygen permeable film (O_2 transmission rate of 650–750 $cm^3/m^2 \cdot day$ at 2° C and 0% relative humidity; Irma S.A., Zaragoza, Spain), and the other steak was packed in under modified atmosphere conditions (70% O_2 and 30% CO_2) performed with an Ulma Smart 500 machine. All the trays were placed in a Zafrio expositor (Zafrio S.L., Zaragoza, Spain) at 2-4° C with 16 hours of light exposure (1200lx). An installation with 4 fluorescent tubes and a fixed camera (Olympus P9000) was placed for taking photographs in similar constant conditions. A photo was taken of each tray daily up to losing the shelf life. Each tray was identified with a 2-digit code which was randomly changed every day to avoid sample recognition. Fifteen consumers evaluated the visual colour acceptability (from 1 dislike extremely to 9 like extremely) and the purchase choice (yes or no) of all samples with the photos in the computer.

All statistics were calculated using the SPSS 22.0 statistical package. Data from visual colour acceptability were analysed by analysis of variance with repeat measured. Feeding and packaging were used as fixed effect. Data from purchasing habits were analysed by frequencies.

III. RESULTS AND DISCUSSION

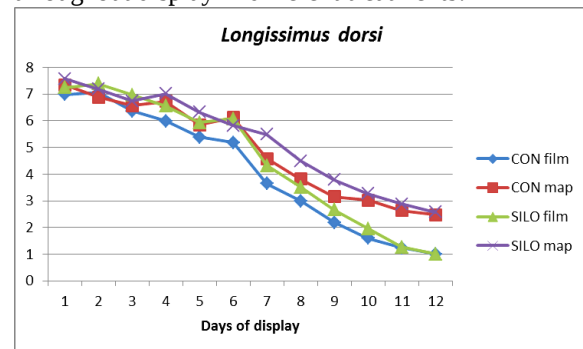
Feeding, packaging and display had significant differences on visual colour acceptability on both muscles (Table 1). Muscle LT showed more interactions than ST. Also the type of muscle affected the colour acceptability being samples from LT better accepted than ST. There were several differences between both muscles.

Table 1. *P*-values of feeding, packaging, display and their interactions on muscles LT and ST:

	LT	ST
Feeding (Feed)	<0.001	<0.001
Packaging (Pack)	<0.001	<0.001
Display (Dis)	<0.001	<0.001
FeedXPack	0.079	0.366
FeedXDis	<0.001	0.191
PackXDis	<0.001	<0.001
FeedXPackXDis	<0.001	0.624

At 6 days of display in the case of LT, scores were over 5, but in samples from ST at 5 days of display scores were below 5 (Fig.1). On the other hand, samples in MAP kept acceptability for longer time throughout display than samples in film. In LT, meat from SILO group had better acceptability throughout the display than meat from CON group. It can be seen that meat from SILO packaging in MAP had better visual colour acceptability throughout display than the others treatments.

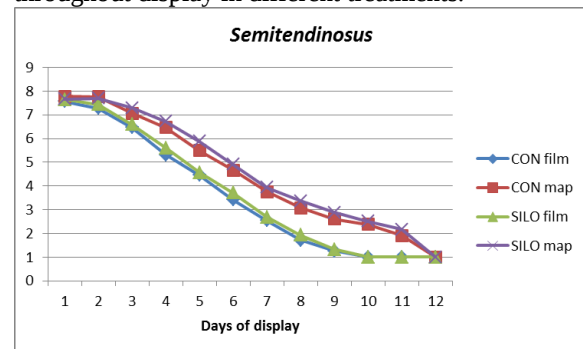
Figure 1. Visual colour acceptability of muscle LT throughout display in different treatments.



CON: concentrated; SILO: silage; film: samples packaging in film; MAP: modified atmosphere packaging.

Samples from muscle ST showed different visual colour acceptability between types of packaging, thus meat from MAP had better acceptability than meat from FILM independent of the feeding treatment (Fig.2). After 5 days of display samples from FILM had scores below 5 (CON: 4.46 and SILO: 4.57) while samples from MAP at 5 days of display had 5.49 (CON) and 5.88 (SILO).

Figure 2. Visual colour acceptability of muscle ST throughout display in different treatments.



CON: concentrated; SILO: silage; film: samples packaging in film; MAP: modified atmosphere packaging.

The consumer often tends to associate colour with flavour, tenderness, safety, storage time, nutritional value and satisfaction level [11]. Colour allows the detection of certain anomalies or defects that food items may present [12, 13, 14] and the consumer uses colour variations as an indicator of freshness and wholesomeness.

The percentage of positive assessments to buy the meat was higher in samples from MAP than from FILM. Meat from LT had better acceptability than ST, given that after 9 days of display there were 7.8% of positive assessments to buy the meat in the case of samples with film packaging. In the ST at 7 days of display only 0.6% and 1.1% of assessments from consumers would purchase meat from film packaging.

The purchase choice in LT was decreasing progressively with the display, however, the decreased was more pronounced in samples from film packaging, especially after 7 days of display, than in MAP samples, whose decrease was more pronounced after 9 days of display (Table 2).

Table 2. Percentage (%) of assessments for purchasing samples from *Longissimus thoracis* muscle throughout display.

Days	CON		SILO	
	film	map	film	map
1	91.7	88.9	91.1	92.8
2	90.6	88.3	93.3	93.9
3	75.6	88.9	87.2	86.1
4	68.3	90.6	81.7	93.9
5	60.6	86.7	79.4	91.1
6	50.0	84.4	77.2	76.7
7	21.1	54.4	30.0	70.0
8	7.8	45.6	11.7	55.0
9	7.8	18.9	7.8	29.4
10	0	19.4	0	23.9
11	0	15.0	0	16.1
12	0	0	0	0

CON: concentrated; SILO: silage

Table 3 shows the percentage of assessments to purchase meat from ST. After 4 days of display, almost 50% of assessments were positive in CON group on film packaging and more than a half (68.3%) in SILO group on film packaging.

In MAP samples from ST the purchase choice was decreased after 6 days of display, because the percentage of positive assessments to buy that meat after 7 days of display was less than 50%. Colour in meat is one of the most important organoleptic characteristics. It influences the acceptability of the product and plays a major role in the purchase decision [15, 16, 17]. The higher deterioration of ST vs LT implied the lower purchase acceptability of ST.

Table 3. Percentage (%) of assessments for purchasing samples from *Semitendinosus* muscle throughout display.

Days	CON		SILO	
	film	map	film	map
1	93.9	95.6	96.7	97.2
2	93.9	97.2	94.4	96.1
3	83.3	96.1	85.6	95.6
4	49.4	92.8	68.3	90.0
5	32.8	67.2	35.0	85.6
6	2.3	45.6	6.1	58.3
7	0.6	28.3	1.1	24.4
8	0	13.9	0	13.9
9	0	11.7	0	16.1
10	0	18.3	0	20.0
11	0	18.9	0	18.3
12	0	0	0	0

CON: concentrated; SILO: silage

IV. CONCLUSION

The type of muscle can affect the acceptability of visual colour of the meat, however, it is important the type of packaging. Modified atmosphere packaging preserved better meat colour than other type of packaging, such as oxygen permeable film. The use of corn silage could be a good alternative for feeding Avileña Negra Ibérica beef, without negatively influencing meat colour.

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