ACCEPTABILITY OF BEEF ENRICHED WITH n-3 AND CLA FATTY ACIDS

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Abstract – *Longissiums* steaks aged for 7 and 21 days from forty-eight Freisian males finished on 4 diets (T: control; L: 10% whole linseed; C: 2% protected CLA; LC: 10% whole linseed plus 2% protected CLA) were used to evaluate consumer sensory acceptability in three Spanish cities: Barcelona, Zaragoza and Pamplona. Seven-hundred and twenty consumers, between 18 and 75 years old participated in the study (240 in each city). Addition of 10% linseed in the diet increased consumers' sensory acceptability of beef at 7 days of aging, but did not differ from the 2% CLA diet at 21 days of aging. Furthermore, the geographical location affected consumer sensory acceptability of beef.

Key Words – consumers, fatty acids, meat.

I. INTRODUCTION

Consumers are becoming more health conscious and this is leading to a growing preference for healthier, more nutritious and more functional food products [1]. Modifying the fatty acids profile in meat during its productive stage would offer the consumer a product that is more adequate to nutritional recommendations and this in fact is possible through diet supplementation or modification [1-3]. Feeding grass or concentrates containing linseed (rich in alpha-linolenic acid, 18:3 *n*-3) in the diet, increase the content of 18:3 *n*-3 and its longer chain derivative eicosapentaenoic acid (EPA, 20:5 *n*-3) in beef muscle resulting in a lower *n*-6: *n*-3 ratio [1]. Previous studies in cattle that were focused on the effect of different fats and oils (animal fat, fish, oilseeds) on beef quality [4-7], indicated that flavour [4, 8] and juiciness or tenderness [5, 9] were the most affected attributes due to the increase of polyunsaturated fatty acids. Previous sensory studies using trained panellists evaluated the sensory quality of beef fed linseed and CLA [8] and lamb fed linseed [10]. However, there is no available information on the consumer sensory perception regarding beef enriched with n-3, CLA or both fatty acids. The aim of this work was to study the effect of diets enriched with *n*-3, CLA and their combination on consumers' acceptability of beef aged for 7 and 21 days in three Spanish cities (Barcelona, Zaragoza and Pamplona).

II. MATERIALS AND METHODS

Sampling procedure

Forty-eight entire male Friesian were randomly assigned to one of four dietary treatments. All the diets contained, in average, 10% barley straw and 90% concentrate formulated with 35 to 40 % maize, 19 to 22% barley, 5 to 12% gluten meal, 4 to 12% beet pulp, 0 to 5% palm oil and 2% minerals. The diets were isoenergetic and isoproteic, supplemented with vitamin E (110 mg/ kg concentrate) and differed in their amount of whole linseed and CLA. Control (T): 0% linseed and 0% concentrate (L): 10% whole linseed, CLA (C): 2% protected CLA, and whole linseed plus CLA (LC): 10% whole linseed and 2% protected CLA. After a finishing period of 123.53±11.15 days, the bulls (mean live weight 458.46±16.62 kg) were slaughtered using standard procedures in an EU-licensed abattoir (Mercazaragoza, Zaragoza, Spain). Carcasses were chilled at 4±2ºC for 24 h under commercial conditions. The left *Longissimus* muscle was removed from each carcass at 24 h *post-mortem* and cut into 2-cm thick steaks from the 10th thoracic rib in the

caudal direction. Samples were vacuum packaged, aged at 2±2ºC during 7d or 21d, frozen (-18±2ºC) and transported to Barcelona, Zaragoza and Pamplona for consumer sensory evaluation. Fatty acids were analyzed in LD and the content in total n-3 resulted 0.63%, 2.56%, 0.71% and 2,87% and the content for CLA were 0.13%, 0.17%, 0.22% and 0.30% for T, L, C and LC diets, respectively [11]. Before the sensory analysis, samples were thawed at 2±2ºC for 24 h and cooked in a double hot-plate grill pre-heated to 200ºC until final internal temperature reached 71ºC that was determined using individual thermocouples inserted into the geometric centre of the muscle. Steaks were trimmed of external fat and connective tissue, cut into 2x2x2 cm samples, wrapped individually in coded aluminum foil and kept warm in a heater until tasting. Beef from one animal was evaluated by 10 consumers from each of the 3 Spanish cities, and consumers evaluated beef from 12 animals per dietary treatment in each city.

Consumer sensory evaluation

The study was carried out during spring 2011 at three Spanish cities of different regions: Barcelona (Catalonia), Zaragoza (Aragón) and Pamplona (Navarra). Seven-hundred and twenty consumers, between 18 and 75 years old participated in the study (240 in each city). Consumers were selected by means of a probabilistic sampling per quotas within each city according to the national distribution by gender and age. Table 1 shows the distribution of the selected consumers in each country.

Table 1. Consumer demographic data (%)

City	Gender		Age			
	Male	*Female*	*18-25*	*26-40*	*41-60*	*61-75*
BAR	50.0	50.0	12.5	33.3	36.7	17.5
ZAR	46.3	53.8	13.8	33.8	34.2	18.3
PAM	49.0	51.0	17.6	30.6	35.5	16.3

n= 240; BAR=Barcelona, ZAR=Zaragoza, PAM= Pamplona.

Consumers evaluated in a blind condition the acceptability of four different grilled *Longissimus* samples of beef (4 diets: T, C, L and LC) under white lights in the order that was established to avoid the effect of sample order presentation, first-order or carry-over effects [12]. Consumers ate unsalted toasted bread and drank mineral water to rinse their palate between samples. Each consumer rated taste, juiciness, tenderness and overall acceptability using 9-point category scales (from 1'dislike extremely' to 9'like extremely').

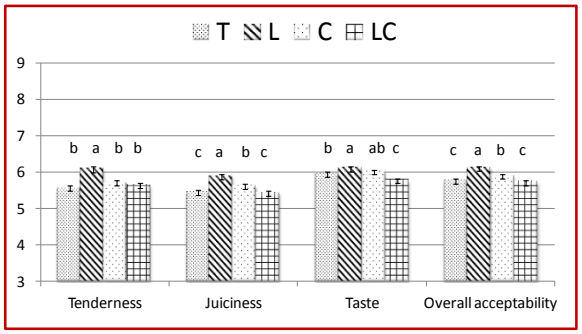
Statistical analysis

Tenderness, Juiciness, Taste and Overall acceptability data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC), and mean separation was carried out using the Tukey test. The statistical model included dietary treatment, city and their interaction as fixed effects, consumer within city as random, and session within city as a block effect. There were no interactions ($P > 0.05$) between dietary treatments and cities and data are presented as main effects.

III. RESULTS AND DISCUSSION

Effect of diet

The effect of diet on tenderness, juiciness, taste and overall acceptability of beef aged for 7 and 21 days is shown in Fig. 1 and Fig. 2, respectively.



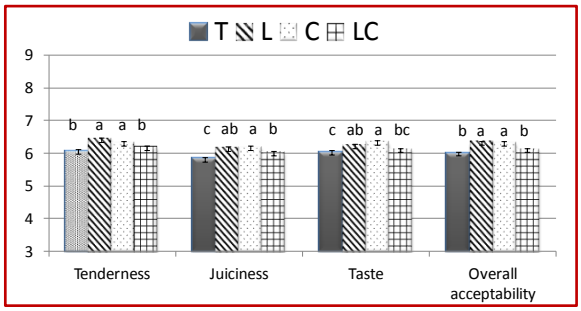
(T=control; L=linseed; C=CLA; LC=linseed+CLA)

Figure 1. Effect of diet on tenderness, juiciness, taste and overall acceptability scores for beef aged for 7 days.

Beef aged for 7 days (Fig. 1) from animals fed the linseed enriched diet showed the highest ($P<0.05$) tenderness, juiciness, taste and overall acceptability scores, but did not differ ($P>0.05$) in taste from beef enriched with CLA. Beef from

animals fed CLA showed higher juiciness and overall acceptability scores than T and LC treatments which did not differ with the exception of taste with was lower for LC than T.

Beef aged for 21 days (Fig. 2) from animals fed L and C diets did not differ (P>0.05) for any of the evaluated attributes and showed higher scores for tenderness and overall acceptability than T and LC. Beef from animals fed LC showed lower scores than C for all attributes, lower tenderness and overall acceptability scores than L and higher juiciness scores than T.
Zymon [9] studied the effect of linseed addition in animal diet on meat quality from calves. These authors concluded that linseed addition had no effect on the sensory quality of meat, while results from the present study showed highest scores for beef from animals fed the linseed-enriched diet. Gillis [13] studied the effect of a diet enriched with protected CLA on beef quality and found minimal changes in lipid oxidation and sensory attributes (by trained panel) despite significant changes in fatty acid profile of meat. There is limited information on the consumer sensory perception regarding beef enriched with both functional fatty acids (CLA and n-3). Barahona [8], using the same diets, showed higher scores for tenderness, juiciness and overall acceptability and lower scores for fibrousness for meat from animals fed linseed. In the present study, the L diet was also the best scored treatment which agrees with the results obtained by the trained panel [8].



(T=control; L=linseed; C=CLA; LC=linseed+CLA)

Figure 2. Effect of diet on tenderness, juiciness, taste and overall acceptability scores for beef aged for 21 days.

Effect of city
The effect of city (Barcelona, Pamplona or Zaragoza) on tenderness, juiciness, taste and overall acceptability of beef aged for 7 and 21 days is shown in Fig. 3 and Fig. 4, respectively.

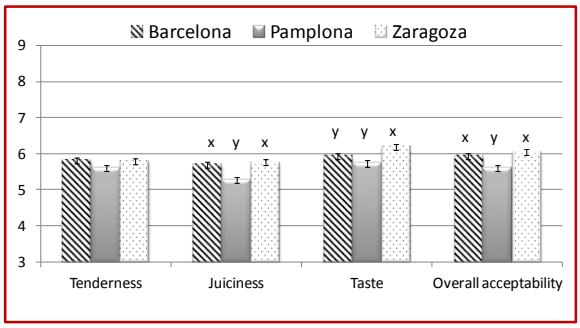


Figure 3. Effect of city on tenderness, juiciness, taste and overall acceptability of beef aged for 7 days.

Beef aged for 7 days (Fig. 3) and 21 days (Fig. 4) evaluated in Pamplona resulted in lower (P<0.05) tenderness (except for 7 days of aging), juiciness, taste and overall acceptability scores compared with Barcelona and Zaragoza which did not differ (P>0.05). In the region of Navarra, where Pamplona is located, extensive feeding systems are more common than feedlot feeding. Consequently, in this region, the animal diets and animal characteristics differ from those used in the present study. In addition, in the Navarra area consumers are used to eat beef with a lower degree of doneness than the other two evaluated regions, which could explain in part the sensory differences found among cities in this study.

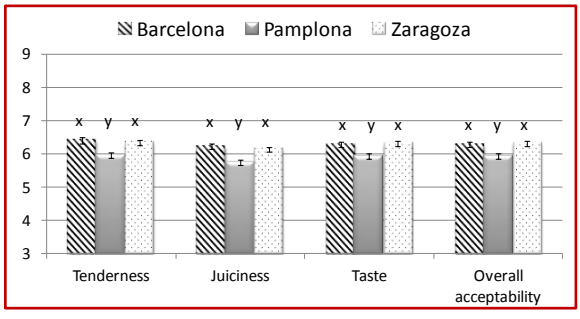


Figure 4. Effect of city on tenderness, juiciness, taste and overall acceptability of beef aged for 21 days.

IV. CONCLUSION

Addition of 10% linseed in the diet increased consumers' sensory acceptability of beef at 7 days of aging, but did not differ from the 2% CLA diet at 21 days of aging. The geographical location may affect consumer sensory acceptability of beef depending on the type of meat that is normally consumed in the region.

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