EFFECT OF WHOLE LINSEED AND PROTECTED-CLA ENRICHED DIET ON BEEF SENSORY QUALITY

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Abstract— **Forty eight Friesian calves were randomly allocated to four feeding batches: control, whole linseed (10% linseed), CLA (2% protected CLA), and whole linseed + CLA (10% linseed and 2% protected CLA). Thirteen attributes using a 10 cm unstructured line scale, were evaluated by an eight member trained panel. The diet had a significant effect on seven of the attributes studied. Meat from linseed fed animals showed higher scores for tenderness, juiciness, beef flavour, fat flavour, liver flavour and overall liking and lower scores for fibrousness. Ageing had significant differences on rancid odour and rancid flavour, and just a tendency on tenderness, increasing especially at 21 days. Animals fed enriched-linseed showed the most tender meat at 21 days of ageing.**

Keywords— ***PUFA, texture, flavour*.**

I. INTRODUCTION

There has been an increased interest in recent years in ways to manipulate the fatty acid composition of meat [1] being diet one of the most important strategies to do it. Beef fat is a significant source of saturated fatty acids in the human diet because red meat has a relatively high ratio of saturated to unsaturated fatty acids, which is a risk factor for the development of vascular and coronary diseases [2]. Besides a lower total fat intake, human nutritionists are recommending a higher intake of polyunsaturated fatty acids (PUFA), and especially of *n-3* fatty acids at the expense of *n-6* fatty acids [3]. It is well known that the low PUFA/SFA and high *n−6*/*n−3* ratios of some foods contribute to the imbalance in the fatty acid intake of today's consumers [1].

Conjugated linoleic acid (CLA) is a group of naturally occurring fatty acid isomers found in many foods. Beef and other ruminant products such as milk are dietary sources of CLA [4]. However, the CLA content of beef may also be increased by feeding ruminally protected CLA supplements, making CLA available for absorption in the intestine and deposition in tissues [5].

The fatty acid composition of the intramuscular fat of beef affects not only the nutritional value but also the sensory properties [6]. Although, there have been suggestions that dietary fatty acids influence tenderness and juiciness, these are more likely to be affected by the total amount of fatty acids rather than individual ones. The ability of unsaturated fatty acids to oxidize is important in flavour development during cooking [1].

The aim of this work was to study the sensory quality of meat from cattle fed with concentrates enriched with whole linseed and protected CLA.

II. MATERIALS AND METHODS

2.1 Animals and treatments

Forty-eight entire male Friesian were randomly assigned to one of four dietary treatments. All the diets were isoenergetic and isoproteic, supplemented with vitamin E (110 mg/ kg concentrate) and only differed in their amount of whole linseed and CLA. Control: 0% whole linseed and 0% of CLA, whole linseed: 10% linseed, CLA: 2% protected CLA, and whole linseed + CLA: 10% 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. Carcasses were chilled at 4±2º C for 24 h under commercial conditions. The M. *Longissimus dorsi* (after T10) was removed from the left-side carcass and sliced

into 2cm-thick steaks for sensory analysis with trained panel. Steaks were vacuum packaged and kept at 4º C for 7 and 21 days and frozen and stored at -18º C until further analysis.

2.2 Trained taste panel

In the sensory analysis, the 2cm-thick steaks were thawed 24 h before each session in refrigerator at 4º C. After the vacuum package was removed, the samples were wrapped in aluminium foil and cooked at 200º C in a double plate grill (SAMMIC P8D2) until the internal temperature, which was monitored using an internal thermocouple (JENWAY, 2000), reached 70º C.

Each cooked steak was trimmed of fat and any external connective tissues, cut into approximately 2 x 2 x 2 cm samples, wrapped in coded aluminium foil and stored at 55º C in a warming cabinet until tasting. To evaluate the effect of the four diets and the two ageing times (7 and 21 days), sensory tests were performed during 10 sessions in a standardised tasting room equipped with individual booths and, to mask any differences in meat colour, under red lighting. In comparative multi-sample test using a completely balanced design, the samples were served randomly to an eight-member trained sensory panel. To avoid the possible effects of the order of presentation, and first-order and carry-over effects, the samples were presented to panellists in different orders [7]. During one training session, the panellists agreed upon a set of sensory descriptors. Panellists used a 10 cm unstructured line scale to quantify beef, rancid and fat odour intensities, tenderness, juiciness, fibrousness, beef, acid, fat, liver, metallic and rancid flavour intensities and overall liking.

2.3. Statistical analysis

Data from the sensory panel were analysed by the GLM procedure of SPSS (15.0) considering panellist, session, diet, ageing time and their interaction as main effects. The Duncan test was used to compare mean values, with significance of $p \leq 0.05$.

III. RESULTS AND DISCUSSION

Significance of diet, ageing time effects and their interaction, on sensory attributes studied, is shown in Table 1. The diet effect had more significance differences than the ageing effect.

Table 1 *F* values and significance of diet and ageing effects and their interaction on sensory characteristics

	Diet	Ageing	Diet x Ageing
Beef odour	ns	6.15*	ns
Rancid odour	ns	11.46***	ns
Fat odour	2.25t	ns	ns
Tenderness	3.84*	2.99t	ns
Juiciness	4.13**	ns	ns
Fibrousness	3.62*	ns	ns
Beef flavour	5.20**	ns	3.50*
Acid flavour	ns	9.01*	ns
Fat flavour	3.70*	ns	ns
Liver flavour	4.13**	ns	ns
Metallic flavour	ns	3.09t	ns
Rancid flavour	ns	18.60***	2.93*
Overall liking	4.66**	4.75*	ns

ns = non significant effect; t = $p \leq 0,1$; * = $p \leq 0,05$; ** = $p \leq 0,01$; *** = $p \leq 0,001$

3.1 Diet effect

Diet was the main factor that affected the sensory characteristics, such as fat odour, tenderness, juiciness, fibrousness, beef flavour, fat flavour, liver flavour and overall liking. Table 2 displays, in an independent way, the effects of diet and ageing on sensory parameters.

It is known that tenderness is one of the predominant criteria in assessing the quality of beef [7]. The effect of fatty acids on firmness might be due to the different melting points of the fatty acids. Thus, the higher the unsaturation, the lower the melting point, which might increase tenderness [8]. It could be the explanation why meat enriched with linseed was more tender. Although the scores for this attribute were over the half of scale in all treatments, meat from linseed fed animals was the most tender.

Tabla 2 Mean (± SE) scores for parameters of sensory quality of meat from different diets and ageing times.

	Diet				Ageing	
	Control	Linseed	CLA	Linseed + CLA	7 days	21 days
Beef odour	4.92 ± 0.58	4.77 ± 0.51	4.91 ± 0.44	4.87 ± 0.44	4.77 ± 0.55b	4.96 ± 0.41a
Rancid odour	2.46 ± 0.65	2.38 ± 0.62	2.55 ± 0.69	2.32 ± 0.64	2.22 ± 0.58b	2.62 ± 0.65a
Fat odour	2.91 ± 0.49	2.65 ± 0.51	2.84 ± 0.44	2.69 ± 0.47	2.79 ± 0.49	2.76 ± 0.48
Tenderness	5.65 ± 0.98b	6.59 ± 1.00a	6.05 ± 0.95ab	5.88 ± 1.32b	5.86 ± 1.23	6.22 ± 0.97
Juiciness	5.13 ± 0.47b	5.49 ± 0.67a	5.10 ± 0.67b	5.04 ± 0.66b	5.14 ± 0.66	5.24 ± 0.62
Fibrousness	4.73 ± 0.92a	3.89 ± 0.87b	4.54 ± 1.10a	4.34 ± 1.12ab	4.52 ± 1.11	4.23 ± 0.96
Beef flavour	5.04 ± 0.40b	5.47 ± 0.45a	5.14 ± 0.52b	5.19 ± 0.48b	5.26 ± 0.44	5.15 ± 0.52
Acid flavour	3.84 ± 0.67	3.76 ± 0.55	3.97 ± 0.64	3.85 ± 0.64	3.66 ± 0.65b	4.05 ± 0.53a
Fat flavour	3.83 ± 0.53b	4.19 ± 0.48a	3.97 ± 0.49ab	3.76 ± 0.58b	3.96 ± 0.53	3.91 ± 0.55
Liver flavour	2.17 ± 0.53b	2.63 ± 0.59a	2.33 ± 0.55ab	2.34 ± 0.52ab	2.31 ± 0.54	2.43 ± 0.59
Metallic flavour	3.46 ± 0.58	3.55 ± 0.46	3.48 ± 0.50	3.65 ± 0.71	3.43 ± 0.60	3.64 ± 0.52
Rancid flavour	2.19 ± 0.80	1.94 ± 0.54	2.17 ± 0.68	2.02 ± 0.51	1.84 ± 0.54b	2.32 ± 0.65a
Overall liking	4.98 ± 0.74b	5.54 ± 0.42a	5.06 ± 0.76b	4.98 ± 0.81b	5.31 ± 0.68a	4.99 ± 0.73b

Different letters in the same row indicate significant differences at $p \leq 0{,}05$; 0= very low, 10= very high

Juiciness and fibrousness showed significant differences depending on the diet, since meat from linseed fed animals was considered the most juicy and the least fibrous.

The linseed diet produced meat that had a greater intensity of beef flavour. Other studies show that the content of *n-3* PUFA in the meat increases, sensory attributes such as 'grassy', 'greasy' and 'fishy' are perceived stronger [9]. That could also explain why fat flavour and liver flavour were higher in meat from linseed fed diet, which would imply that the amount of *n-3* fatty acids had been increased. The enriched diets showed more flavour intensity, except for acid, metallic and rancid flavour.

3.2 Ageing effect

Effect of ageing time was significant on beef and rancid odours, acid and rancid flavours and overall liking, and only had a trend on tenderness and metallic flavour.

Beef odour and rancid odour was rated higher at 21 days of ageing than 7 days, these results could be partly explained by the muscle cells, with a predominance of fast contracting white fibres, which have faster degradation at higher ageing times, which have faster degradation during ageing, with a possible development of beef odours at higher times [10]. Besides, rancidity is an exponential process that increases with time. Nevertheless, the fact that steaks were stored intact and under vacuum conditions has slowed down the process so that the maximum value at 21 days has been 2.32 on a 10-points scale.

Ageing time is one of the most influential factors affecting meat tenderness [11]. A number of authors observed that as ageing time increased, tenderness improved [12]. However, we found only a tendency in tenderness between 7 and 21 days of ageing time, probably because at 7 days, meat was already tender.

The ageing time is an important factor for the development of flavour precursors. In general, bovine meat with 1 day of ageing does not have a specific aroma. More ageing improves the flavour, reaching an optimum and then, at long ageing times, off-flavours develop [13]. The panellists found differences in some off-flavours such as acid and rancid flavour at different ageing times. The meat aged for 21 days showed rated higher for these

attributes. However, the scores were low in the ranting scale.

IV. CONCLUSIONS

The enriched diets with whole linseed, protected CLA and their combination had a stronger influence than ageing in the organoleptic properties of beef.

Meat from linseed fed animals may have a perceived off-flavour. However, other sensory quality characteristics, such as tenderness, juiciness and beef flavour had the highest notes.

Ageing for 21 days increased the meat off-flavour, but not its tenderness, suggesting that shorter ageing times (7 days) could be recommended for the consumption of enriched meat with linseed and protected CLA.

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VI. REFERENCES

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