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EFFECT OF AGEING METHOD AND TIME ON THE SENSORY CHARACTERISTICS OF BEEF: A FOCUS ON TEXTURE, ODOUR AND FLAVOUR

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I. INTRODUCTION

The sensory quality of beef, including its texture, odour, and flavour, is significantly influenced by the ageing process [1]. Different ageing methods, such as Dry, Wet, and In-bag Dry, have been studied for their effects on these attributes, but the specific impact of each method over different ageing durations remains a subject of ongoing research. Ageing not only enhances the tenderness and chewiness of meat but also contributes to the development of distinct flavour profiles and aromatic characteristics [2]. This study aims to investigate how different ageing methods and durations (4 and 10 weeks) affect the sensory attributes of meat, focusing on texture, odour, and flavour.

II. MATERIALS AND METHODS

Loins from 13 *Bruna dels Pirineus* breed calves (11.3 ± 0.31 months old) were used to obtain 6 portions, to which an aging method (Dry, Wet, In-bag Dry) and an ageing time (4 or 10 weeks) were assigned following a design to randomize treatments across anatomical positions. In addition, a smaller portion of the fresh (non-aged) loin was kept as a reference.
The samples were aged at 2ºC ± 0.5ºC and 75% ± 5.0% relative humidity. After the assigned ageing period, a 2.5 cm thick slice was cut, individually vacum-packaged, and frozen at -18 ºC until the day of the sensory analysis.
Sensory characterization was carried out by a panel of 9 trained panellists. Samples were assessed over 13 sessions, with 7 samples per session, coming from the same animal (fresh and 3 methods × 2 times).
Meat samples were thawed for 24 hours at 4 ºC, tempered for 2 hours, and then cooked on a preheated sandwich-type grill at 200 ºC until reaching an internal temperature of 63 ºC in the centre of the steak (measured with a TP type K probe; Testo Instruments SA, Cabrils, ES). The cooked loins were cut into 9 portions and distributed to each panellist taking into account the position within the loin. The foil-wrapped and labelled portions were placed in a low-temperature warmer to keep them warm until they were evaluated by each panellist, less than 15 minutes after cooking. The evaluation order of each sample was designed to avoid the first sample and carry-over effects [3].
The final attributes were decided after a discussion during 4 training sessions. Ultimately, the intensity of aged odour and flavour, toughness, initial and final juiciness and chewiness were evaluated on a 10-point scale from 0 (not perceptible) to 10 (extremely intense perception).
The data were standardized and then analysed using the GLM procedure of SAS® software (version 9.4, SAS Institute Inc., Cary, NC, USA). The aging method (dry, wet or in-bag dry), the aging time, and their interaction were considered fixed effects and panellist and session as blocking effects. Least square means were compared using the PDIFF option, and significance was considered at the 5% level.

III. RESULTS AND DISCUSSION

Table 1 summarizes the sensory attributes of fresh and aged meat following 4 and 10 weeks of ageing, using Dry, Wet, or In-bag Dry methods under controlled conditions. A significant effect ($P<0.0001$) of the interaction aging method and time was observed for all de sensory attributes presented in Table 1.
During the first 4 weeks, meat toughness decreased significantly across all ageing methods, which is consistent with previous studies [1]. However, in the present study, toughness continued to decline up to 10 weeks. By the end of the ageing period, significant differences among the methods were evident, with the In-bag Dry method showing the lowest toughness values.
Additional texture attributes were also assessed. After 4 weeks, juiciness decreased significantly only in the Dry-aged samples, whereas at 10 weeks, all three methods showed a significantly decrease, with the wet-aged samples being the least juicy. Chewiness also improved progressively over the ageing period: after 4 weeks, all three methods showed significant improvement without any differences among them. However, after 10 weeks, differences became evident, with the In-bag Dry method showing the best chewiness values.

Regarding odour attributes, the intensity of aged odour increased progressively over time, reaching statistical significance at 4 weeks for both the Dry and In-bag Dry methods. These differences became more pronounced after 10 weeks of aging. For aged flavour, an increase in intensity was observed at 4 weeks only for the In-bag Dry samples, and at 10 weeks in both the Dry and In-bag Dry methods.
Overall, results of this study suggest that extended ageing, particularly using the In-bag Dry method, can enhance the sensory qualities of meat while maintaining favourable texture characteristics.

Table 1 – Sensory attributes of fresh meat and meat aged for 4 or 10 weeks using Dry, Wet, or In-bag Dry ageing methods, under controlled conditions (2 °C, 75% relative humidity).

	Fresh	Dry		Wet		In-bag dry			Method x time
	0	4w	10w	4w	10w	4w	10w	RMSE	Pr > F
Texture attributes									
Toughness	5.94^{a}	4.18^{bc}	3.27^{d}	4.22^{b}	3.81^{c}	4.01^{bc}	2.96^{e}	0.658	<.0001
Initial juiciness	3.54^{a}	3.28^{cd}	3.39^{bc}	3.60^{a}	3.14^{d}	3.51^{ab}	3.34^{bc}	0.363	<.0001
Final juiciness	4.61^{ab}	4.45^{bcd}	4.29^{de}	4.67^{a}	4.12^{e}	4.50^{ab}	4.40^{cd}	0.425	<.0001
Chewiness	6.49^{a}	4.91^{b}	3.98^{d}	4.84^{b}	4.48^{c}	4.78^{bc}	3.66^{e}	0.672	<.0001
Odour attributes									
Aged meat	1.19^{e}	1.54^{d}	4.06^{b}	1.29^{de}	2.17^{c}	2.02^{c}	4.78^{a}	0.786	<.0001
Flavour attributes									
Aged meat	1.11^{e}	1.38^{de}	3.59^{b}	1.18^{e}	2.40^{c}	1.68^{d}	4.70^{a}	0.744	<.0001

IV. CONCLUSION

In conclusion, this study shows that both the ageing method and its duration, up to 10 weeks, significantly influence the sensory attributes of meat, including its texture, odour, and flavour profile. The results show that over a 10-week period, all ageing methods resulted in a noticeable improvement in texture, with the In-bag Dry method producing the most tender and flavourful meat. Juiciness and chewiness also exhibited clear variations, with the In-bag Dry method showing the best sensory results, particularly after 10 weeks of ageing. Furthermore, the intensity of aged odour and flavour increased over time, with the Dry and In-bag Dry methods showing stronger profiles after 10 weeks.
The sensory profile footprint is established between 4 and 10 weeks of ageing; therefore, it would be necessary to evaluate whether the development of characteristic aromas and flavours could be achieved closer to the 35 days stipulated by Commission Delegated Regulation 2024/1141 [4]
These findings highlight the importance of both the ageing method and duration in shaping a distinct and desirable sensory profile, which could be tailored to specific consumer preferences and market demands.
Furthermore, it would be of interest to identify the compounds responsible for the aged odour and flavour and explore the mechanisms that allow the In-bag Dry method to develop a sensory profile distinct from the Dry method in some of the attributes studied. Additionally, assessing consumer acceptability of the meat produced by these methods would provide crucial insights into the practical applicability of these ageing techniques in the market.

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