# Influence of Conditioning and Fat on the Odour of Pressure-cooked Beef

I. JAIME

Departmento de Producción Animal y Ciencia de los Alimentos. Facultad de Veterinaria. Universidad de Zaragoza. 50013 Zaragoza. Spain.

and E. DRANSFIELD

Department of Veterinary Medicine, University of Bristol, UK

SUMMARY : Sensory paired comparison and free and fixed category scale showed that both fat removal and time of conditioning affected significantly the odour of cooked beef. Conditioning normal meat for 21 days had much less effect than defatting with lower scored for defatted meat.

INTRODUCTION: The flavour of meat varies according to the level of aminoacids, sugars and fats and their complex interactions during cooking (Pearson et al., 1983, Fogerty et al., 1989). Species-specific flavours are due to both fatty and lean tissues (Hornstein and Crowe, 1960, Wasserman and Spinelli, 1972, Mottram et al., 1982), although fat seems to be mainly responsible for differences between species. Naturally occurring high ultimate pH appears to reduce flavour but it is not clear whether or not this was due to higher water binding or to the reduced level of sugars (Dransfield, 1981). The time of conditioning appears to improve flavour but the effect may be confounded with the associated changes in texture.

In this work the effect of pH, conditioning and fat removal were studied by sensory assessment of odour, which is the principal component of flavour and can be evaluated without interference with other sensory attributes of meat, like texture.

MATERIALS and METHODS : The Semimembranosus muscle from commercial beef animal was excised at 1 hour post-mortem and stored at 15°C for 24 hours, and later at 2°C for 21 days. Samples were prepared at five different times throughout conditioning: 1 and 5 hours and at 1, 4 and 21 days post-mortem. At each sampling time a muscle section was excised, trimmed of visible fat and connective tissue, minced in a bowl chopper and homogenised with 5 mM iodoacetate. Homogenates were vacuum packed in polyethylene bags and held at 2°C until 21 day post-portem.The fat was extracted from a portion of each sample by repeated washing with chloroform-methanol (2:1) solution. Fat content expressed as per cent dry matter was 9,18% ± 0.04 in normal meat and 1,61% ± 0.07 in defatted meat. Preparations were reconstituted by mixing 28 g of the dry meat or the dry defatted meat with distilled water to give 100 wet material which was allowed to stand for 16 h at 3°C to ensure complete penetration of water. Twenty five grams of reconstituted meat were placed in closed vessels and cooked at 120°C for 30 min in a pressure cooker and then kept at 60°C. Panellists were presented at each session with the coded (three random numbers) treatments in random order. Paired comparison and free choice profile - meat homogenised with iodoacetate (5 mM) at 1 h pm and meat aged for 21 days; both with and without fat, fixed category scaling - meat homogenised with iodoacetate (5 mM) at 1 day pm and meat aged for 21 days; both with and without fat.

**Paired comparison**. From the 4 treatments, all paired comparisons were made, including the 4 duplicate pairs.The intensity of the odour difference between the two samples which composed a pair was scored using an unstructured 100-mm line scale, labelled "nil" and "intense" at left and right ends, respectively. Five pairs were presented successively to panellists at each session. **Fixed category scaling**. Panellists were presented with the 4 treatments at each session. Four replicates of each treatment were evaluated using 100 mm line scales for "overall impression", "meaty", "beefy", "fatty" and "musty" descriptors. **Free-choice profiling**. The samples, prepared at five different times throughout conditioning, both with and without fat, were presented to each panellist to develop their own descriptors. Four treatments were assessed by panellists at each session using their own full range of descriptors. Four replicate sessions were held and the scores evaluated by Generalised Procrustes Analysis (GPA) used by Williams and Langron (1984).

RESULTS and DISCUSSION : Paired comparison is used to detect small differences between treatments. When replicates were used as a pair (AA, BB, CC or DD) differences (averaging 19 units on the 100-unit scale) were found (Table 1). Clearly these cannot be ascribed to treatments and reflect a reluctance of panellists to score zero difference and the non-directional form of this test. To reliably assess the

difference between treatments the difference score of pairs was calculated by taking the scores of each treatment and subtracting the aver score of the two pairs composed of duplicates. For example: the calculated difference between sample A and B = AB score - [(AA scor BB score) / 2]. Comparison of normal and defatted meat at 1 h pm (AB) gave a difference 16,6 which was higher than that (10,5 units) a days (CD). This may mean that it has a greater effect on odour soon after slaughter but would need to be verified by establishing clearly effect of the addition of iodoacetate since it increased the pH (to 6,7)and may also interfere directly with the odour precursors. The effec 21 days storage of normal meat (AC) was only slightly less than that of defatted meat (BD) and it is unlikely that the effect of defatting dependent on the time of defatting. The effect of both ageing and defatting (AD and BC) gave the largest effects on odour but were less the additive effects of the two treatments.

Table 1.- Intensity of the difference between odour of treatment pairs. Each value is the mean of the scores of seven panellists. Treatme **A** 1 hour pm, normal meat, **B** 1 h pm, defatted meat, **C** 21 days pm, normal meat, **D** 21 days pm, defatted meat.

| Pair | AA | AB | AC | AD | BB | BC | BD | CC | CD | DD |
|---|---|---|---|---|---|---|---|---|---|---|
| Average panel difference score | 23,0 | 34,9 | 33,7 | 44,0 | 13,6 | 39,6 | 34,0 | 17,4 | 29,7 | 21,0 |
| Computed difference | — | 16,6 | 13,5 | 22,0 | — | 24,1 | 16,8 | — | 10,5 | — |
| Standard deviation | — | 19,7 | 15,1 | 17,6 | — | 17,6 | 13,9 | — | 24,9 | — |
| T value (P< 0,001 except for * p< 0,05) | — | 3,2 | 3,4 | 4,2 | — | 4,3 | 4,5 | — | 2,1* | — |

Although the paired comparison test conducted here allows small differences to be detected, it does not allow for the direction of difference nor the description of the difference. Fixed category scaling was used to detect the direction of difference. "Beefy", "meat "fatty" and "musty" were the most common words used and they were combined in a simple profile together with the hedonic descrip "overall impression".

Table 2.- Analysis of variance for fixed category scales. Scores from 5 panellists and 4 different samples with four replicates of each samp were analysed and the F ratio and significance ( *P<0,05, **P<0,01, ***P<0,001) given..

| | Beefy | Meaty | Fatty | Musty | Ov. impression |
|---|---|---|---|---|---|
| Panelist | 16,0 *** | 14,1*** | 11,7*** | 7,6*** | 191,6*** |
| Sample | 2,8 * | 6,9*** | 6,7*** | 5,9** | 0,45 |
| Interaction | 1,2 | 1,0 | 1,8 | 2,0* | 2,2* |

When scores given by panellists for each descriptor were analyzed significant differences were found between panellists and often betwe the four treatments (Table 2). For "overall impression" and "musty" there was a significant interaction between panellists and treatm showing that the ranking of treatments for these attributes depends on the panellist (Table 2).

Table 3.- Average scores of 4 replicates for each of 5 panellists for four treatments evaluated by fixed category scaling.

| | Beefy | | | | Meaty | | | | Fatty | | | | Musty | | | | Overall impression | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panellist** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| 1 | 31 | 45 | 25 | 46 | 30 | 30 | 27 | 45 | 1 | 1 | 31 | 1 | 12 | 6 | 2 | 2 | 60 | 45 | 41 | 64 |
| 2 | 61 | 78 | 66 | 90 | 55 | 62 | 51 | 83 | *24 | 2 | 19 | 1 | *58 | 9 | 41 | 5 | *98 | 82 | 99 | 87 |
| 3 | 15 | 27 | 45 | 39 | 35 | 42 | 52 | 58 | 22 | 23 | 34 | 31 | 27 | 18 | 22 | 25 | 81 | 66 | 84 | 66 |
| 4 | *15 | 44 | 16 | 38 | *19 | 47 | 22 | 49 | *40 | 15 | 49 | 28 | 44 | 12 | 42 | 31 | *25 | 50 | 29 | 42 |
| 5 | 30 | 30 | 25 | 20 | 22 | 31 | 26 | 30 | 6 | 11 | 9 | 9 | 12 | 5 | 10 | 19 | 40 | 41 | 38 | 35 |

* Significant difference (P< 0,001). Treatments: **1** 1 day pm, normal meat, **2** 1 day pm, defatted meat, **3** 21 days pm, normal meat, **4** 21 days pm, defatted meat.

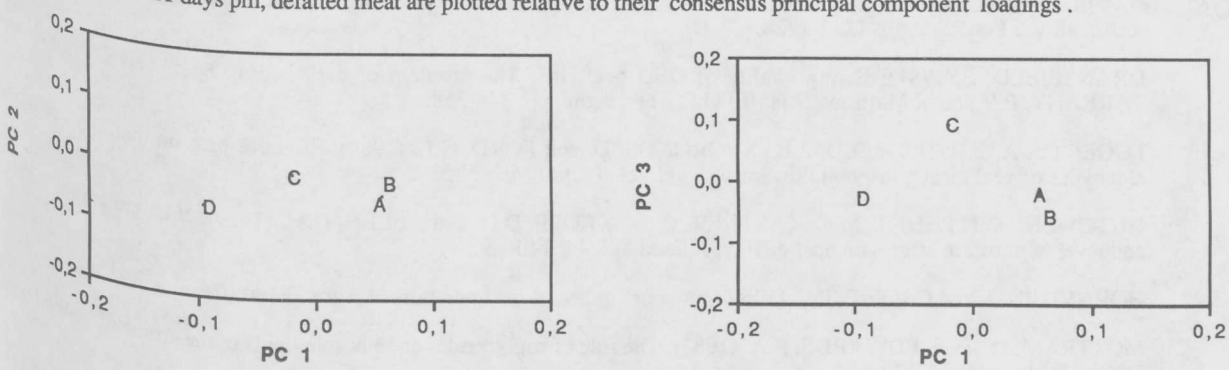
"Beefy" and "meaty" were generally scored higher in defatted meat (Table 3), and a close relation existed between both descriptors with correlation of about 0,6 for panellist 1 to 4. Scores for "beefy" remained unchanged by ageing but those for "meaty" increased (by an average of 7 units) over the 20 days storage period. Scores for "fatty" were lower in defatted meat than in normal meat, but tended to be higher in aged meat suggesting that the perception of fattiness was increased by conditioning due to the changes in lipid and proteolysis during storage. Scores for "musty" were also lower in defatted meat but did not change with conditioning (Table 3).

Scores of each panellist for "overall impression" were individually analyzed and a significant difference between treatment was found for two panellists. The treatment responsible appeared to be the removal of fat, and differences in odour due to conditioning were not discriminated by panellists. Individual preferences were clearly evident with panellists 2 and 3 preferring normal meat whilst panellist 4 preferred defatted meat (Table 3).

In view of the differences in meaning that descriptors had for each panellist free choice profile was used to evaluate odour properties. In this work one panellist used only five descriptors whilst another used thirteen. Figure 1 shows the three principal components of the GPA in which the first PC accounted for 46%, the second, 31% and the third, 8% of the total variation in sensory scores. This treatment plot of the consensus of panellists shows a similar loading for the unaged meats (treatments A and B) which are distinguished from aged meat (C) and, even more so, from aged and defatted meat (D). The differences were mainly found along PC 1, which consisted of terms like "musty", "mouldy" and other terms "roast", "biscuit", "cooked fat", "burnt" related to fat and cooking of meat.

Paired comparison is the most sensitive method to detect small variations in meat odour, however other techniques like fixed category scaling or free choice profile should be used to show the direction of the difference between treatments. Even though free choice profile does not require an agreement among panellists about the meaning of the descriptors used, this method did not seem to be the most suitable for detecting small differences in meat odour, and, as a consequence, less complicated methods should be chosen to carry out this study.

Figure 1.- Beef odour by free-choice profiling. Treatments: **A** 1 day pm, normal meat, **B** 1 h pm, defatted meat, **C** 21 days pm, normal meat and **D** 21 days pm, defatted meat are plotted relative to their consensus principal component loadings .




The changes of flavour after conditioning of meat for different periods of time under variable conditions were broadly studied some years ago. However, in those studies sensory assessment was, in general, extremely simple, being flavour of meat evaluated in terms of desirability or acceptability. Our comparisons clearly separated these hedonic assessments from those of odour intensity. We used paired comparisons and profiling to determine intensity of odour, free-choice profiling and Procrustes analysis to take account of differences in individual descriptions and hedonic scaling to establish individual preferences. An improvement (in hedonic terms) of flavour with aging was reported in several works (Smith at al., 1978, Gutowski et al., 1979). In both cases meat was stored for 21 days, the effect of ageing was evident only after several days, since changes in flavour (expressed as desirability) were not found before the 8th day of aging (Smith et al., 1978). However, there is some controversy about this subject since in other experiments no significant difference in hedonic flavour scores after 16 days of ageing was found in reformed beef loin steaks (Davis et al., 1975). An increase of flavour intensity during ageing

was reported by Seydi and Touraille (1986), which was considered in general to have a positive effect on meat desirability, although undesirable "fatty" flavour appeared on prolonged ageing.

With regard to the role of fat in meat odour, Mottram and Edwards (1983) demonstrated that removal of neutral lipids had little effect on the aroma of the cooked beef, but removal of phospholipids caused a change in aroma. Previous work was directed to the identification of the chemical components of meat flavour, given a great importance to the fat rather than the lean portion, and above all, its relation to species flavour characteristics (Hornstein and Crowe, 1960, Wasserman and Spinelli, 1972).

If fatty tissues provide the species characteristics while the lean is responsible for basic meaty flavour as Hornstein and Crowe (1960) concluded, similar scores for "meaty" in both meat with and without fat could be expected whilst "beefy" should have been higher scored in meat with fat. Similar scores for both "beefy" and "meaty" agree with Wasserman and Talley (1968) who found that, in contrast to the role of fat in others species, beef fat appeared to have little or not effect on the development of a characteristic beef aroma, although according to Mottram and Edwards (1983) these descriptors should have been scored higher in meat with fat, since the presence of some components fat appeared to be necessary for the development of the full aroma of beef meat. The sensory method used could influence these results, while in the latter experiment descriptors were scored, in the former only comparisons between treatment were carried out. On the other hand cooking method might be another factor responsable of differences between both experiments. However, probably the explanation was that panellists could not discriminate a species-specific odour, or at least they could not express it with a single descriptor.

CONCLUSIONS : Both time of conditioning and defatting caused modifications to the odour of meat, the effect of the two factor was additive but the effect of defatting appeared less in aged meat than in meat where glycolysis was prevented immediately after slaughtering. With the small differences in odour between the samples, sensitive sensory tests have to be chosen and the sensitivity of free-choice profiling needs to be improved.

ACKNOWLEDGEMENTS : Financial support from Diputación General de Aragón and Comisión Mixta CAI-CONAI.

REFERENCES : DAVIS, K.A., HUFFMAN, D.L. and CORDRAY, J.C. (1975): Effect of mechanical tenderization, aging and pressing on beef quality. J.Food Sci. 40: 1222-1228.

DRANSFIELD, E.(1981): Eating quality of DFD beef. In: "The problem of dark-cutting beef" (HOOD, D.E. and TARRANT, P.V., eds). Martinus Nijhoff Publ., The Hague, pp. 344-358.

FOGERTY, A.C., WHITFIELD, F.B., SVORONOS, D. and FORD, G.L. (1989): Effect of heat on the fatty acids and aldehydes of veal meat phospholipids. Int. J. Food Sci. Techn. 24: 529-534.

GUTOWSKI, G.H., HUNT, M.C. KASTNER, C. L., KROPF, D.H. and ALLEN, D.M. (1979): Vacuum aging, display and level of nutrition effects on beef quality. J. Food Sci. 44: 140-150.

HORNSTEIN, I. and CROWE, P.F. (1960): Flavour studies of beef and pork. J.Agric. Food Chem. 8: 494-498.

MOTTRAM, D.S. and EDWARDS, R.A. (1983): The role of triglycerides and phospholipids in the aroma of cooked beef. J. Sci. Food Agric. 34: 517-522.

MOTTRAM, D.S., EDWARDS, R.A. and MACFIE, J.H. (1982): A comparison of the flavour volatiles from cooked beef and pork meat systems. J. Sci. Food Agric. 33: 934-944.

PEARSON, A.M., WOLZAK, A.M. and GRAY, J.I. (1983): Possible role of muscle proteins in flavor and tenderness of meat. J. Food Biochem. 7: 189-210.

SEYDI, M. and TOURAILLE, C. (1986): Sensory evaluation of the flavour of beef after aging in air or under vacuum. Revue Technique Vétérinaire de l' Alimentation 218: 18-26.

SMITH, G.C., KULP, G.R. and CARPENTER, Z.L. (1978): Postmortem aging of beef carcasses. J. Food Sci. 43: 821-826.

WASSERMAN, A.E. and SPINELLI, A.M. (1972): Effect of some water-soluble flavour precursors of beef. J.Agric. Food Chem. 20: 171-174.

WASSERMAN,A.E. and TALLEY, F. (1968): Organoleptic identification of roasted beef, veal, lamb and pork as affected by fat. J. Food Sci. 33: 219-223.

WILLIAMS, A.A. and LANGRON, S.P. (1984): The use of Free-choice Profiling for the evaluation of commercial port. J. Sci. Food Agric. 35: 558-568.