SENSORY PROFILING AND PHYSICAL/CHEMICAL ANALYSES OF WARMED-OVER FLAVOUR IN PORK MEAT FROM CARRIERS AND NON-CARRIERS OF THE RN^- ALLELE OVEN COOKED AT DIFFERENT TEMPERATURES

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Background

Warmed-over flavour or 'WOF' was first recognised as a sensory flavour defect and therefore, a scientific challenge in cooked meats by Tims and Watts (1958). The term WOF was used to describe the rapid onset of 'rancid' or 'stale' off-notes that developed in cooked meat as a result of refrigerated storage. Several studies have been carried out to determine the effects of cooking on WOF development (Satyanarayan & Honikel, 1992; Spanier et al., 1988). High cooking temperatures, above 100°C, have been reported to reduce the development of WOF in cooked and chill-stored meats (e.g. Satyanarayan & Honikel, 1992; Bailey & Um, 1992). This effect has been attributed to the preventive effect of products of the Maillard reaction (MRPs), a reaction of sugars and amines that is induced at elevated cooking temperatures (e.g. Bailey, 1998). Carriers of the dominant RN^- allele, discovered in Hampshire and Hampshire cross pigs in the mid-1980's have higher muscle glycogen and water content but no difference in lipid content relative to Hampshire non-carriers and other breeds (Naveau, 1986). The higher glycogen, found mainly in the glycolytic muscles results in lower post-mortem ultimate pH (pH_u) in RN^- carriers vis-à-vis non-carriers (Enfält et al., 1997). A lower pH_u results in reduced water holding capacity and higher cooking losses in RN^- carrier meat (Lundström et al., 1998). Overall, the biochemical differences in meat from RN^- pigs may be expected to have an influence on the sensory properties of meats once cooked in comparison to non-carriers. It has been reported that meat from RN^- allele pigs has elevated taste and flavour intensities (LeRoy et al., 1996). More recently, meat form carriers of the RN^- allele has been described as having a more 'acidulous' taste and an enhanced 'meaty' flavour (Johansson et al., 1999).

Objectives

The objectives of the present study were to investigate the sensory variation that resulted from WOF and cooking temperature in meat samples derived from carriers and non-carriers of the RN^- allele. Moreover, the association of physical/chemical measurements with the experimental sensory variation and the descriptive terms that described this sample variation was investigated. To achieve these aims descriptive sensory profiling was carried out to evaluate warmed-over flavour (WOF) development in cooked, chill-stored and reheated pork patties derived from the meat (*Musculus longissimus dorsi*) of carriers (RN^-/rn^+) and non-carriers (rn^+/rn^+) of the RN^- gene.

Methods

Patties were oven-cooked at 150 and 170°C and chill-stored for 0, 1, 3 and 5 days to facilitate warmed-over flavour development. In addition, thawing losses, cooking losses, pH and TBARS concentrations were measured in the oven-cooked pattie samples on all storage days. In analysis of data, a strategy that involved Analysis of Variance (ANOVA), to investigate changes in the physical/chemical measurements due to the experimental design variables (storage days, cooking temperature and genotype) and multivariate ANOVA-Partial Least Squares Regression (APLSR), to determine relationships between the design variables and the sensory-physical/chemical data was utilised.

Results and Discussion

WOF was determined to involve the development of lipid oxidation derived nuance off-flavour and odour notes, e.g. rancid-like flavour and linseed oil-like odour, in association with a concurrent decrease in 'meatiness' as described by, e.g. cooked pork meat-like flavour (Fig. 1a). Cooking temperature was described by roasted-like and caramel-like odours and samples from carriers of the RN^- gene were described as more 'sour' and 'metallic' in nature (Fig. 1b). Thawing and cooking losses were found to be significantly ($P < 0.05$) higher in meat from carriers of the RN^- gene. Measured pH in RN^- carriers could not be significantly ($P < 0.05$) ascribed as lower than non-carriers in the freshly cooked meat samples. TBARS were found to be significant ($P < 0.05$) predictors of the sensory terms related to the lipid oxidation aspect of WOF. Moreover, TBARS were significantly ($P < 0.05$) higher in meat from RN^- gene carriers but, significantly ($P < 0.05$) lower in meat cooked at 170°C. The former effect was postulated as related to pH and the latter as related to the antioxidant effects of Maillard reaction products developed at higher cooking temperatures. Overall, WOF, cooking temperature and genotype were differentiated as individual dimensions through sensory profiling of the meat samples and each design variable was characterised by specific sensory descriptors. In addition, the predictive nature of thawing losses, cooking losses and TBARS was established for the effects of RN^- gene, cooking temperature and WOF in meat samples.

Pertinent literature

Bailey, M. E., & Um, K. W. (1992). Maillard reaction products and lipid oxidation. In A. J. St. Angelo, Lipid Oxidation in Food (pp. 123-139). New York: American Chemical Society.

Bailey, M. E. (1998). Maillard reactions and meat flavour development. In F. Shahidi, *Flavor of Meat, Meat Products and Seafoods* (pp. 267-289). London: Chapman and Hall.

Enfält, A.-C., Lundström, K., Hansson, I., Johansen, S., & Nyström, P.-E. (1997). Composition of non-carriers and heterozygous carriers of the RN^- allele for carcass composition, muscle distribution and technological meat quality. *Meat Science, 45*, 1-15.

Le Roy, P., Juin, H., Caritez, J. C., Billon, Y., Lagant, H., Elsen, J. M., & Sellier, P. (1996). Effet du génotype RN sur les qualités sensorilles de la viande de porc. *Journées de la Recherche. Porcine en France, 28,* 53-56.

Lundström, K., Enfält, A.-C., Tornberg, E., & Agerhem, A. (1998). Sensory and technological meat quality in carriers and non-carriers of the RN^- allele in Hampshire crosses and in purebred Yorkshire pigs. *Meat Science, 48,* 115-124.

Naveau, J. (1986). Contribution à l'étude du déterminisme génétique de la qualité de viande porcine Héritabilité du Redement Technologique Napole. *Journées de la Recherche. Porcine en France, 18,* 265-276.

Johansson, L., Lundström, K., Jonsäll, A., & Lundh, T. (1999). Effects of red clover silage and ageing time on sensory characteristics and cooking lossess of loin (M. longissimus dorsi) from Hampshire crosses with and without the RN^- allele. *Food Quality and Preference, 10*, 299-303.

Satyanarayan, V. T., && Honikel, K. O. (1992). Effect of different cooking methods on warmed-over flavour development in pork. *Zeitschrift Lebensmittel-Utersuchung und Forschung, 194*, 422-425.

Spanier, A. M., Vincent Edwards, J., & Dupuy, H. P. (1988). The warmed-over flavor process in beef: a study of meat proteins and peptides. *Food Technology, 46*, 110-118.

Tims, M. J., & Watts, B. M. (1958). Protection of cooked meats with phosphates. *Food Technology, 12*, 240-243.

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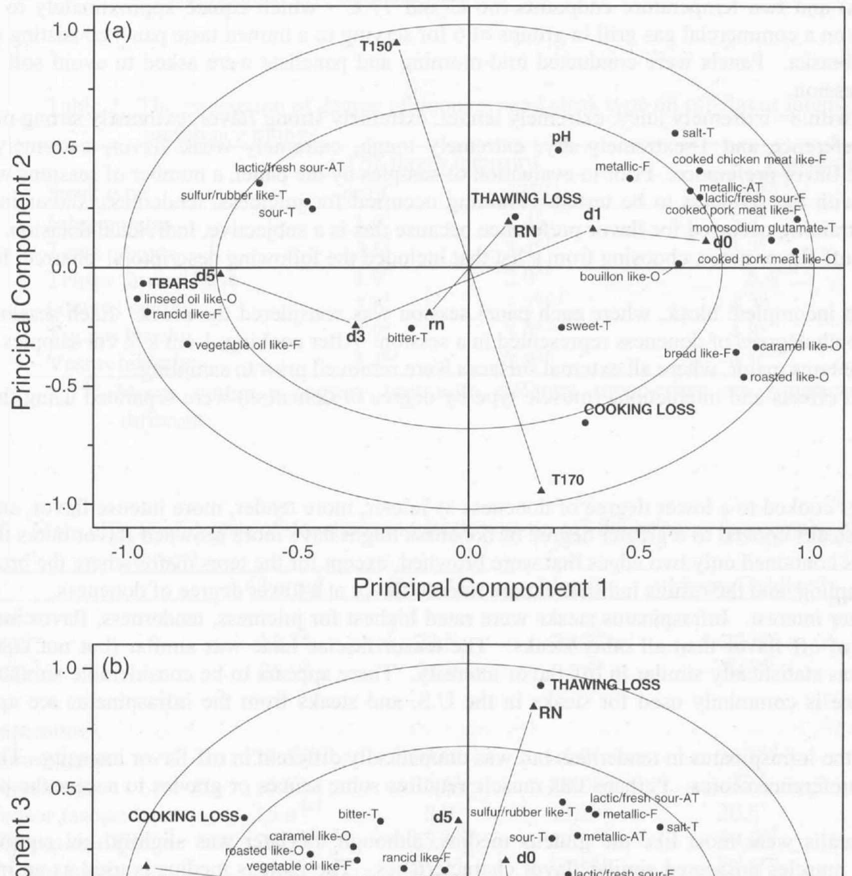

Fig. 3 (a) PC 1 versus 2. (b) PC 2 versus 3. ANOVA-Partial Least Squares Regression (APLSR) correlation loadings plot of main design variables, WOF days = d0, d1, d3, d5, rn = rn^+/rn^+ and RN = RN^-/rn^+ non-carriers and carriers of the RN^- allele, respectively and cooking temperatures 150 and 170°C in the X-matrix (●) and sensory terms and physical/chemical variables in the Y-matrix (▲). Ellipses represent r^2 = 50 and 100 %. The levels of each main design variable are connected by line segments.