PACKAGING EFFECTS ON FLAVOUR MARKER COMPOUNDS IN GRILLED BEEF

Linda J. Farmer[1*], Rod Polkinghorne[2], Terence D.J. Hagan[1], David W. Sanderson[1] and Alan W. Gordon[1]

[1]Agri-Food and Biosciences Institute, Food Research Branch and Statistics Branch, Belfast, UK;

[2]Birkenwood Pty Ltd, 431 Timor Rd, Murrurundi, NSW, Australia 2338

*Corresponding author email: linda.farmer@afbini.gov.uk

Abstract – The aim of the study was to determine the impact of packaging on flavour marker compounds in grilled beef that had been overwrapped, modified atmosphere packed or vacuum-packed. Differences were detected in volatile compounds selected as markers for desirable beef flavour. Some Maillard products were decreased in modified atmosphere-packed beef, possibly due to changes in protein breakdown. Other compounds were increased in overwrapped samples, probably due to increased oxidation. In combination with consumer sensory studies, these investigations will help to explain how packaging can impact on flavour.

Key Words – beef, flavour, volatiles.

I. INTRODUCTION

The impact of packaging on texture and tenderness has been well researched, and evidence obtained that modified atmosphere packaging enhances oxidation of proteins may inhibit proteolysis (1). The amino acids arising from proteolysis are precursors of the Maillard reaction, which contributes to cooked beef flavour. Therefore, packaging may also affect the formation of flavour volatiles during cooking. Many of the volatile compounds contributing to beef flavour are present at very low concentrations and are difficult to determine. Research at AFBI has identified marker compounds for beef eating quality which may not be the cause of desirable flavour but may be markers for it (2). The aim of the study was to determine the impact of packaging on flavour marker compounds in grilled beef that had been overwrapped, modified atmosphere packed or vacuum-packed.

II. MATERIALS AND METHODS

Beef: Beef samples from four muscles or portions of muscles (48 animals) from normal commercial production at Teys in Australia. Samples were each packaged using overwrap (OWP), modified atmosphere packaging (MAP) and vacuum-packaging (VSP). They were aged for three periods, 14, 21 and 49 days. The frozen samples were conveyed to Northern Ireland by commercial transport company and were stored at -80^{o}C until analysed.

Volatile analysis: Headspace volatiles were collected using Solid Phase Micro Extraction (SPME Carboxen/PDMS fibres). Samples were cooked according to a standard protocol (3) and were transferred to 15 ml sealed vias. After equilibration the volatiles collected for 10 minutes, as described previously (4). A HP 6890 Series gas chromatography System equipped with a 5973 Mass Selective Detector was used for separation and detection of volatile compounds. Extracted volatile compounds were analysed and selected volatiles quantified. Peak areas were converted to $\log_{10}$ values to create a normal distribution. Statistical analysis was by REML variance components analysis. Analyses were conducted using Genstat version 18.1.

III. RESULTS AND DISCUSSION

Packaging affected the concentrations of certain aldehydes, ketones, sulphides, an alcohol and a furan. Benzaldehyde was lowest in MAP-packed beef ($P<0.001$; Figure 1) and the same applies to dimethyltrisulphide ($P<0.01$; Figure 2). Other Strecker aldehydes formed from the Maillard reaction between amino acids and sugars follow a similar pattern, though not significantly (Figure 1). It is possible that MAP inhibits proteolysis and reduces the concentrations of free amino acids available for the Maillard reaction, causing reduced formation of these flavour compounds.

Amongst the n-aldehydes, pentanal shows a significant difference with at least 5 times ($P<0.001$) more in MAP-packed beef than the other two packaging treatments; there is a similar trend for the other n-aldehydes but it is much smaller and not significant (not shown). There are also some differences between overwrapped and vacuum-packed beef. Vacuum-packed beef has significantly lower concentrations than overwrapped beef of 3-heptanone, 5-methyl-3-

hexanone, 2-pentyl furan and 2-ethyl-1-hexanol. All these compounds are likely to be formed by oxidation pathways and it is possible that the reduced oxygen in vacuum-packed beef and higher oxygen permeability of overwrapped beef has caused this effect.

While the chemistry of these effects requires further elucidation, these data suggest that there are significant differences in volatile compounds caused by different packaging types. This is likely to link to flavour changes.

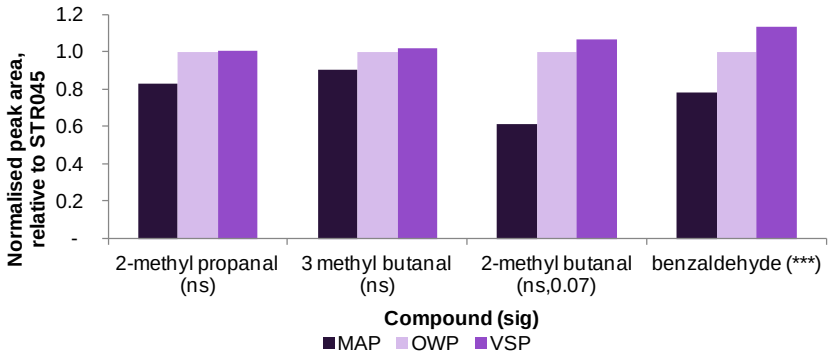

Figure 1. Effect of packaging on Strecker aldehydes (average of 4 muscles, 3 ageing periods, relative to OWP=1)

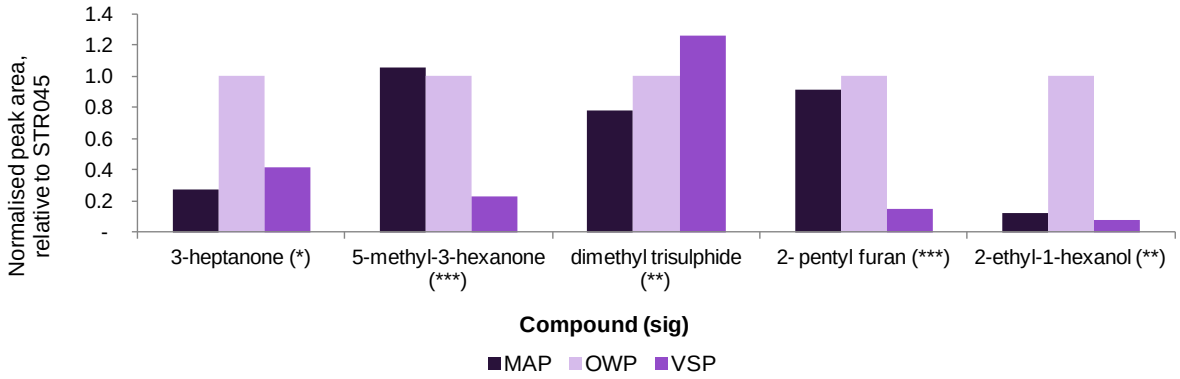

Figure 2. Effect of packaging on selected volatile compounds (average of 4 muscles and 3 ageing periods, relative to OWP=1)

IV. CONCLUSION

Some Maillard products were decreased due to MAP which may be explained by protein oxidation and reduced proteolysis. Other compounds from lipid oxidation were increased in overwrapped samples. In combination with consumer sensory studies, these investigations will help to explain how packaging can impact on flavour.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge funding from Teys Australia for this work.

REFERENCES

1. Lund, M.N., Lametsch, R., Hviid, M.S., Jensen, O.N., Skibsted, L.H. (2007). High-oxygen packaging atmosphere influences protein oxidation and tenderness of porcine longissimus dorsi during chill storage. Meat Science Volume: 77 Pages: 295-303
2. Farmer, L.J., Hagan, T.D.J., Devlin, Y., Gordon, A.W. and Oltra, O.R. (2012). Relationships between beef aroma compounds and other quality attributes. International Congress on Meat Science and Technology, Montreal, August 2012.
3. Polkinghorne, R., Watson, R., Thompson, J. M., Pethick, D. W. (2008). Consumer assessment of eating quality - development of protocols for Meat Standards Australia (MSA) testing. Australian Journal of Experimental Agriculture, 48, 1360-1464.
4. Legako, J.F., Brooks, J.C., O'Quinn, T.G., Hagan, T.D.J., Polkinghorne, R., Farmer, L.J., Miller, M.F. (2014). Consumer sensory evaluation and volatile beef flavor compounds of five USDA quality grades and four muscles. Meat Science, 100, 291-300.