DISCRIMINATION OF LAMB MEAT FROM RAMS FED DIFFERENT CONCENTRATE-BASED RATIONS

Vasiliki Gkarane[1], Nigel P. Brunton[1], Paul Allen[2], Sabine M. Harrison[1], Rufielyn S. Gravador[1], Noel A. Claffey[1,3], Alan G. Fahey[1], Michael G. Diskin[3], Aidan P. Moloney[4], Linda J. Farmer[5], Patrick Murphy[6] and Frank J. Monahan[1]

[1] School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland
[2] Teagasc Ashtown Food Research Centre, Ashtown, Dublin 15, Ireland
[3] Animal & Grassland Research and Innovation Centre, Teagasc, Athenry, Co. Galway, Ireland
[4] Animal & Grassland Research and Innovation Centre, Teagasc, Grange, Co. Meath, Ireland
[5] Agri-Food and Biosciences Institute, Newforge Lane, Belfast, BT9 5PX, UK
[6] School of Mathematics and Statistics, University College Dublin, Belfield, Dublin 4, Ireland
*Corresponding author email: frank.monahan@ucd.ie

I. INTRODUCTION

Consumers are increasingly concerned regarding the origin and quality of the meats they consume; thus, it is important to develop systems that will verify these parameters and will enable discrimination and authentication of meat that derives from different production systems [1,2]. Diet is a key factor in ruminant production systems, affecting the composition and quality of meat [3] by altering the fatty acid composition [4]. Volatile compounds, including those deriving from reactions involving fatty acids, have been examined for their influence on meat flavour and their usefulness as markers of dietary treatment, mainly among grass and concentrate diets [5]. The objective of this study was to evaluate the application of measurement of volatile compounds in cooked lamb to discriminate between lamb from animals fed different cereal-based diets.

II. MATERIALS AND METHODS

Forty-four non-castrated lambs (Texel x Scottish Blackface) were raised at pasture and finished on four cereal-based diets for 54 days before slaughter (11 animals, individually penned, per dietary treatment) as follows: a barley/maize/soya-based concentrate (C treatment), supplemented with a saturated fat source (Megalac®) (SAT treatment) or supplemented with protected linseed oil (PLO treatment) or a by-product (citrus pulp/distillers grain/soya-based diet (BPR treatment). Volatile analysis of cooked lamb samples (*M. longissimus thoracis et lumborum*, LTL) involved solid phase microextraction (SPME) followed by GC-MS (Varian Saturn 2000-3800) with separation of volatiles on a ZB5-MS column. The possibility of discriminating dietary treatments using the volatile profile of meat was assessed using a canonical discriminant analysis, carried out by a forward stepwise method of SAS software (version 9.4) with graphic illustration using XLSTAT®statistical software (V9.01.41647).

III. RESULTS AND DISCUSSION

Of the 64 volatile compounds detected in the meat, (*E*)-2-hexenal was significantly affected ($P = 0.03$) by dietary treatment while a number of compounds tended towards statistical significance ($P \leq 0.1$) (Table 1). The multivariate analysis indicated compounds which contributed to the separation of the treatments; thus, stepwise discriminant analysis showed that 24 compounds were retained, with 2-ethylhexanol showing the highest discriminatory power (R^2:0.37). Canonical discriminant analysis applied to the 24 variables gave three canonical variables, the first two accounting for 93.96% of the total variability and efficiently separating the four treatments (Figure 1). The Mahalanobis squared distances between the four treatments were all significant ($P < 0.005$; data not shown). The first variable (CAN1) separated the four treatments, with 1-pentadecanol, 2,5-dimethylpyrazine, pentanal and pentadecane accounting mainly for the discrimination (Table 1). The second variable (CAN2) separated the PLO treatment from the others, with *p*-cymene, tridecane and (*E,Z*)-2,6-nonadienal contributing to the discrimination. The contributions of these compounds to discrimination likely reflect the influence of the dietary treatments on flavour precursors and on thermal degradation reactions involving fatty acids, amino acids and sugars, leading to volatile

generation in lamb meat. The discriminant analysis classified with 100% accuracy each animal to the correct dietary treatment and after cross-validation correctly classified each animal to its original treatment with an accuracy of 93.2% (coefficients listed in Table 1). The results show that the volatile profile of the lamb meat was effective in assigning lamb meat to one of four dietary treatments with good accuracy.

Table 1. Least square mean values for logarithmically transformed peak areas of aroma compounds detected in the headspace of grilled LTL muscle as affected by diet.

	Dietary Treatment				SEM	Significance	Coefficients of total canonical structure		
Variables	C	SAT	PLO	BPR			CAN1	CAN2	CAN3
(*E*)-2-Hexenal	2.91^{b}	1.28^{a}	2.94^{b}	1.53^{a}	0.263	0.03	-	-	-
2,5-Dimethyl pyrazine	0.48^{a}	2.58^{b}	0.79^{a}	1.31^{ab}	0.322	0.10	**-0.36**	-0.08	0.12
Pentanal	4.60	3.74	4.62	4.41	0.152		**0.31**	0.11	-0.18
(*E*,*Z*)-2,6-nonadienal	3.99	4.02	4.09	3.93	0.027		0.00	**0.32**	0.14
Tridecane	4.58^{ab}	4.77^{b}	4.72^{ab}	4.46^{a}	0.048	0.09	-0.16	**0.25**	**0.30**
Pentadecane	4.66	4.84	4.73	4.71	0.032		-**0.28**	0.04	0.14
p-Cymene	3.35	3.08	2.18	3.02	0.180		0.05	**-0.38**	0.14
1-Pentadecanol	4.97^{a}	5.22^{b}	5.15^{ab}	5.15^{ab}	0.036	0.08	**-0.38**	0.11	-0.07
4-ethyloctanoic acid	1.16	2.09	1.58	1.84	0.026		-0.21	-0.01	-0.02
γ-nonalactone	3.11	3.42	3.40	3.38	0.085		-0.20	0.09	-0.08

IV. CONCLUSION

Discriminant analysis was efficient in identifying compounds which allow the discrimination between four cereal-based diets. The high percentage of lamb meat samples correctly allocated, show that the volatile profile could in part be used as indicator of the diets that lambs received, although additional production and chemical analysis data could contribute to clear identification. The potential application is of interest considering the increase in consumer concerns about meat origin, safety and quality.

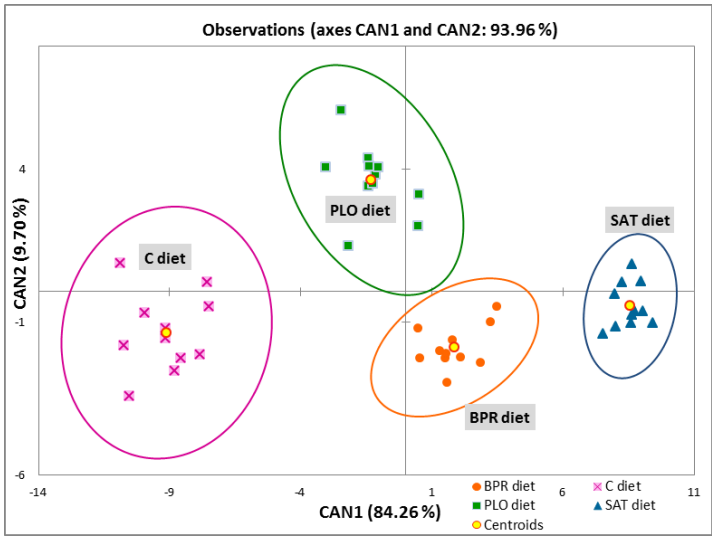

Figure 1. Discrimination of dietary treatments based on canonical discriminant analysis

ACKNOWLEDGEMENTS
The financial support of the Food Institutional Research Measure of the Irish Department of Agriculture, Food and the Marine (project 11/SF/310) and of the Teagasc Walsh Fellowship programme (award 2013058) is gratefully acknowledged.

REFERENCES
1. Prache, S., Kondjoyan, N., Delfosse, O., Chauveau-Duriot, B., Andueza, D., & Cornu, A. (2009). Discrimination of pasture-fed lambs from lambs fed dehydrated alfalfa indoors using different compounds measured in the fat, meat and plasma. Animal, 3(4), 598-605.
2. Priolo, A., Cornu, A., Prache, S., Krogmann, M., Kondjoyan, N., Micol, D., & Berdagué, J.L. (2004). Fat volatiles tracers of grass feeding in sheep. Meat Science, 66(2), 475-481.
3. Pethick, D.W., Davidson, R., Hopkins, D.L., Jacob, R.H., D'Souza, D.N., Thompson, J.M., & Walker, P.J. (2005). The effect of dietary treatment on meat quality and on consumer perception of sheep meat eating quality. Australian Journal of Experimental Agriculture, 45(5), 517-524.
4. Sinclair, L. (2007). Nutritional manipulation of the fatty acid composition of sheep meat: a review. Journal of Agricultural Science, 145(5), 419-434.
5. Vasta, V., Ventura, V., Luciano, G., Andronico, V., Pagano, R.I., Scerra, M., Biondi, L., Avondo, M., & Priolo, A. (2012). The volatile compounds in lamb fat are affected by the time of grazing. Meat Science, 90(2), 451-456.