The effect of further dry aging on the volatiles of wet aged rib eye steaks

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Abstract – This study compares volatile profiles between wet aged rib eye steaks and wet aged rib eye steaks that were dry aged in an opened condition with 60% relative humidity at 4°C for six days. Volatiles were extracted using simultaneous steam distillation-solvent extraction and analysed using Gas Chromatography-Mass Spectrometry. Twenty-seven compounds were identified in the study where the flavour compounds 2-hexanone, 2-heptanone, 3-methyl butanol, 1-octen-3-ol and E-2-decenal were found to be significantly higher in the dry aged treatments. The additional dry aging process of six days does have an effect on the flavour volatiles of the meat.

Key Words – Flavour analysis, Simultaneous steam distillation-solvent extraction, Gas chromatography

I. INTRODUCTION

Meat aging has been used in the meat industry to develop better meat flavour and increase tenderness [1]. Wet and dry aging are the common aging techniques. In the wet aging process, the meat is vacuum packaged inside a sealed barrier against oxygen and moisture migration that is held at a temperature above the freezing point of the meat during shipping and storage [2]. Dry aging is the process of aging meat in a cooler where the meat is fully exposed to the circulating air while humidity is controlled. Dry aging is a more expensive process than wet aging because of the high weight loss associated with this process, but it can be done to a whole carcass. Dry aging is reported to produce a higher palatability product compared with wet aging [3]. In this study, wet aged meat was aged further under dry aging conditions to investigate the changes in the volatile profiles. It is predicted that the volatile profile between the two treatments will enable the production of distinct flavour volatiles due to lipid oxidation and possible enzymatic activity.

II. MATERIALS AND METHODS

Sample Preparation

Twelve rib eye steaks (2.5 cm thick) were obtained from a local butcher. The samples were from grass-fed cattle which were wet aged for three weeks. Half of the samples was dry aged for six days at 4ºC and 60% humidity. The other half of the samples was kept vacuum packed frozen at -40ºC until analysis. Each steak was cooked using a double griller (George Foreman 10946, UK). The two-plate grill was set to high allowing it to reach 200°C. The steaks were grilled until the sample internal temperature reached 90°C as measured by a meat thermometer. The meat was left to cool to 30°C. After cooling, the meat samples were minced using an electric bowl chopper and introduced to the SDE immediately.

Simultaneous Steam Distillation-Solvent Extraction (SDE)

A 150 g sample of minced meat in 350 mL of deionised water and 100 µL of decane (an internal standard; 1000 ppm in hexane) was extracted using the Likens-Nickerson apparatus for 1 hour into 100 mL pentane. The organic extract was concentrated down to 1 mL using rotary evaporator and stored at -80ºC until analysis.

Gas Chromatography- Mass Spectrometry (GCMS)

Analysis of each sample was carried out using a GC/MS (Agilent 6890N, USA) system. Sample injection was carried out using an auto-injector (PAL RSI 85 robotic CTC analytics, Switzerland). The injection volume was one µL. The oven temperature started at 50°C and was increased at a rate of 5°C/min until it reached 180°C. The temperature was then increased at a rate of 10°C/min until it reached its maximum temperature of 240°C, where it was held for 5 minutes. The total run time was 37 minutes. Helium was used as the gas carrier gas at a constant flow of 1.0 mL/min. The front inlet temperature was 230°C, and the column was a 60 m x 0.32 mm x 0.5 µm ZB-wax column (Zebron, Phenomenex, New Zealand). The mass spectrometer was an Agilent 5975B VLMSD with a triple axis detector

(Agilent, USA), and identification was performed using MassHunter data analysis (Agilent, USA). The mass spectrometer was operated in electron impact mode with a source temperature (250 °C), and a scan range from m/z 30 to m/z 300 at 6.1 scans/s. Tentative identification of the compounds was based on the comparison of their mass spectra with spectra from the NIST Mass Spectral Database (14.L). The approximate quantities of the volatiles were estimated by comparison of their peak areas with that of the 100 ppm decane internal standard, obtained from the total ion chromatograms, using a response factor of one.

III. RESULTS AND DISCUSSION

Application of SDE led to an identification of twenty-seven compounds. These were two ketones (2-hexanone and 2-heptanone), two aromatics (1, 3-dimethyl benzenes and benzaldacetaldehydes), seven alcohols (2 ethyl-1-hexanol, 2-methyl-1-butanol, 3-methyl butanol, 1-octen-3-ol, 2 ethyl-1-hexanol, 1-octanol and 2-octen-1-ol), five aldehydes (hexanal, nonanal, benzaldehyde, E-2-decenal and pentadecanal), one terpene (D-limonene), three alkanes (pentadecane, hexadecane and heptadecane) and seven heterocyclic compounds (dimethyl pyrazine, 2-ethyl-6-methyl pyrazine, trimethyl pyrazine, 2 (3) ethyl- 3, 5-dimethyl pyrazine, 2, 3, 5-trimethyl 6-ethyl pyrazine and 3-diethyl 2-methyl pyrazine.
Compounds of significance that increased after the dry aging were 2-hexanone ($P < 0.01$), 2-heptanone ($P < 0.001$), 3-methyl butanol ($P < 0.01$), octen-3-ol ($P < 0.05$) and E-2-decenal ($P < 0.05$) were both significantly higher after the extra dry aging whereas pentadecanal ($P < 0.001$) was slightly less. There were also several compounds (possibly long chain aldehydes with RI over 2094) yet to be identified that were found with the late eluting compounds, where some of them did have a significant difference due to treatments.

Aldehydes, alcohols and ketones are the product of lipid oxidation which increased during the dry aging due to the exposure of air during aging. The extra period of dry aging did not cause any significant change to the heterocyclic compounds (formed from the strecker degradation [4]), alkanes (formed from auto-oxidation of lipids [5]) and aromatic compounds. D-limonene is the main discriminating compound of grass fed animals. Other literature reported that, there was no significant difference in ketone, alcohol and most of the aldehyde derivative compounds in wet aged beef (aged for 30 days) [6].
Further work could be done on the identification of those unknown compounds as some of them do have a significant effect on the volatile profile.

IV. CONCLUSION

An additional dry aging process on beef meat does create a significant difference to the volatile profiles of the meat. Compounds such as 2-hexanone, 2-heptanone, 3 methyl butanol, octen-3-ol, E-2-decenal and were found to have a significant increase after dry aging.

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