IMPACT OF PART-MUSLE IN SUNITE SHEEP WITH REARING SYSTEMS ON VOLATYILE COMPOUNDS PROFILE

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Abstract – The volatile flavor components of longissimus dorsi ,biceps femoris and triceps brachii muscles of 12 months house-feeding methods of Sunite sheep were extracted by using solid-phase micro extraction (SPME) and then analyzed by gas chromatography-mass spectrometry (GC-MS) to investigate the effect of part-muscle on the flavor of muscle. The results showed that A total of 35 volatile compounds were identified,including2 hydrocarbons, 17 aldehydes, 2 ketones, 2 acids, 9 alcohols,and2 Miscellaneous compounds.Aldehydes and alcohols compounds may be mainly responsible for the formation of meat flavor.Aldehydes compounds in biceps femoris were lower than longissimus dorsi and triceps brachii.But alcohols compounds in biceps femoris were higher than longissimus dorsi and triceps brachii.

Key words – volatile compounds;solid-phase micro extraction;gas chromatography-mass spectrometry (GC-MS)

I. INTRODUCTION

Sunite Sheep, belonging to the family of Mongolia sheep in Inner Mongolia grassland,is increasing in popularity in China due to its distinctive aroma,desirable taste and high nutritional value[1]. It is clear that opportunities exist for the expansion of the sheep meat market; sheep meat is more tender than meat from other domestic red meat species,as well as being comparable in terms of its nutritional constituents.There are lots of papers dealing with volatile compounds of these meat products stduied straight chain aldehydes derived from lipid oxidation[2].Those compounds arising from lipid degradation seems to provide the characteristic flavor of the different species[3].More than 1000 volatile compounds described[4].However, only some of them play a significant role in the overall flavor characteristics of meat[5].Very few studies discussed the effect of parts-musle on sheep meat flavour formation.Meanwhile, very little is known about the volatiles compounds of sheep meat.Therefore, it is important to identify the volatile compounds and furthermore to find out the compounds responsible for the special flavor in the sunite sheep meat. In the present study, the volatile compounds in sheep meat were extracted and concentrated by headspace solid phase micro-extraction(HS-SPME), then the volatiles were identified by gas chromatography-mass spectrometry(GC-MS). The aim of this work was to investigate the influence of part-muscle on the volatile compound generation of sunite lamb. Furthermore,the main flavor on volatile compounds of sunite lamb will be evaluated.

II. MATERIALS AND METHODS

Material and Instruments. Longissimus dorsi,biceps femoris and triceps brachii muscles of 12 months house-feeding methods of Sunite sheep packed in small bags, storage in 80℃.HS-SPME, Manual injection handle, fiber coating 65μm PDMS/DVB,Supelco. GC-MS: GC TRACE 1300, MS ISQ, ThermoFisher

Sample preparation for method of HS-SPME. Accurate weight 5 g meat sample, adding 3 mL of saturated NaCl solution, homogenate and put in the 15mL bottle with headspace, then inject to the bottle by SPME needle fixed extraction in the top of head empty volume. Stirring speed for the magnetic mixer was 800~1000r/min, in 65˚C for 45min. After extraction end, quickly insert theneedle of SPME into the gas chromatograph injector, desorption for 4min.

Headspace SPME conditions. The optimize conditions of HS-SPME extraction process are: fiber coating 65μm PDMS/DVB, sample extracted for 45 min at 65˚C, saturated NaCl solution and magnetic mixer was 800~1000r/min.

GC conditions. Chromatographic column: DB-5 capillary column (30m×0.25mm×0.25μm),initial temperature 40℃ hold for 3 min, then an increase of 4℃/min to 150℃, hold at that temperature for 1 min; then an increase of 5℃/min to 200℃, then followed by an increase of 10℃/min to 230℃ and hold at that temperature for 5 min. Helium was used as carrier gas with flow of 1.0mL/min.

MS conditions. Transmission temperature 250℃, Ion source temperature 250℃, 70eV electronic energy, Quality scanning range m/z: 30~400.

Data analysis of GC-MS. Experimental data were processing by Xcalibur software system. The volatile components were confirmed through NIST and Wiley qualitative spectral library only when both positive and negative matching degree for more than 800 (maximum 1000) identification results will be reported.Quantities of the volatile compounds were approximated by comparison of their peak areas with that of the 2-Methyl-3-heptanone internal standard, obtained from the total ion chromatograms, using a response factor of 1.

Statistical analysis. One-way analysis of variance (ANOVA) was carried out on the quantitative data for each compound identified in the analyses of volatiles. and the means were compared by a least significant difference method. Significance was declared at $p<0.05$. Statistical analyses were performed with the SPSS 19.0.

III. RESULTS AND DISCUSSION

Identification of volatile compounds in meat of Sunite Sheep

To obtain a wider volatile profile, the extraction methods HS-SPME were used.The volatile compounds identified in meat of Sunite Sheep are presented in Table 1.A total of 35 volatile compounds were identified , including 2 hydrocarbons, 17 aldehydes, 2 ketones, 2 acids, 9 alcohols, and 3 Miscellaneous compounds.Aldehyde and alcohol compounds are the predominant components identified.Hexanal,Heptanal,Octanal,Nonanal,1-Pentanol,1-Octanol and 2,3-Octanedione had the higher values in meat.Short chain fatty acids are associated with goaty odor.

Comparison of volatile compounds in the three parts

Aldehyde compounds.A comparison of three parts for Sunite Sheep meat was performed.Overall, the abundance of most aldehydes derived from lipid oxidation.Table 1 displayed aldehydes in longissimus dorsi ,biceps femoris and triceps brachii are 17,16,17 compounds. Aldehydes in longissimus dorsi and biceps femoris have higher values than triceps brachii.Some of these linear aldehydes arising from fatty acid oxidation show low odor threshold values and might play an important role in the flavor of meat products [6]. These aldehydes include hexanal,heptanal,octanal, nonanal.Hexanal,Heptanal and Nonanal in longissimus dorsi were significantly higher than biceps femoris and triceps brachii（$P<0.05$）.They may impart a pleasant fruity flavour at lowconcentration.while 2-Nonenal, (E)- presented above 18 μg in the headspace of 1kg of meat in triceps brachii was significantly higher than longissimus dorsi （$p<0.05$）.Hexanal in longissimus dorsi and biceps femoris were significantly higher than triceps brachii （$p<0.05$）. Overall,Hexanal and Nonanal can effect the aroma in sheep meat.

Alcohol compounds. Rraight-chain aliphatic alcohols and ketones are most likely oxidative decomposition products of lipids[7].Some of them show interesting aromatic notes.Table 1 displayed alcohols in meat are 9 compounds.Alcohols presented above 380 μg in the headspace of 1kg of meat in triceps brachii was the highest values,while presented above 142 μg in biceps femoris was the lowest values.Alcohols like 1-Pentanol,1-Octen-3-ol,1-Octanol can significantly influenced the flovor of sheepmeat.1-octen-3-ol is a product of the enzyme degradation of linoleic acid by lipoxygenase and hydroperoxide lyase and its smell as a marked mushroom flavour, that may contribute to overall flavour due to its low threshold[2].Unsaturated alcohol like 1-octen-3-ol presented above 200 μg in the headspace of 1kg of meat in triceps brachii was significantly higher than longissimus dorsi and biceps femoris （$p < 0.05$）.Saturated alcohol like 1-Pentanol and 1-Octanol in triceps brachii was significantly higher than longissimus dorsi and biceps femoris（$p < 0.05$）.Remaining alcohols have been detected, but it has low values, which is not so intense to generate them.Overall,the flovor in triceps brachii is better than longissimus dorsi and biceps femoris.

Ketone and acid compounds.2,3-Octanedione is generated in reasonably large amounts in lamb meat.This compound is the most widely recognised pasture diet tracer in the literature,which originates from the oxidation of linoleic acid by the action of the enzyme lipoxygenase[8-9].In this study, longissimus dorsi showed higher levels of 2,3-Octanedione compared to biceps femoris and triceps brachii.Short chain fatty acids are associated with goaty odor,Table 1 displayed acids in meat are just 2 compounds.acids include Butanoic acid and Hexanoic acid presented above 10 μg in the headspace of 1kg of meat.Butanoic acid in biceps femoris is significantly higher than triceps brachii($p < 0.05$),but Hexanoic acid in longissimus dorsi and triceps brachii are significantly higher than biceps femoris($p < 0.05$).

Hydrocarbons and other compounds. Aliphatic hydrocarbons with more than 10 carbon atoms are found accumulated in the fat depots of animal , resulting probably from feeding [10].Tridecane and ethylbenzene in triceps brachii is significantly higher than other two parts.ethylbenzene and Tridecane have poorly contribute to lamb flavour due to their high threshold value and low concentration.

IV. CONCLUSION

A total of 34 volatile compounds were identified, including 2 hydrocarbons, 17 aldehydes, 2 ketones, 2 acids, 9 alcohols, and 3 Miscellaneous compounds.Aldehydes and alcohols compounds may be mainly responsible for the formation of meat flavor.those representative compounds include Hexanal,Heptanal,Octanal,Nonanal,1-Pentanol,1-Octen-3-ol,1-Octanol and 2,3-Octanedione have relative high concentration and may be responsible for the special flavor of lamb meat.Aldehydes compounds in biceps femoris were lower than longissimus dorsi and triceps brachii,but alcohols compounds in biceps femoris were higher than longissimus dorsi and triceps brachii.

Table 1 Volatile compounds in the headspace of the three parts Sunite sheep meat

Compound (μg/1kg) [a]	Longissimus dorsi	biceps femoris	triceps brachii
Aldehydes			
Pentanal	20.52±5.26^b	11.06±2.38^a	12.98±4.63^a
Hexanal	851.90±149.03^b	995.41±220.82^b	583.47±135.12^a
Heptanal	47.34±9.95^a	82.99±27.66^b	65.98±17.34^b
Octanal	91.10±22.55^b	46.67±13.03^a	45.58±16.36^a
2-Heptenal,(E)-	2.31±1.10^a	4.65±1.65^b	3.27±0.84^a
Nonanal	360.22±82.57^b	202.72±54.11^a	148.35±65.41^a
2-Octenal, (E)-	11.39±2.86^a	14.81±5.74^{ab}	17.99±4.96^b
2,4-Heptadienal, (E,E)-	N.D	1.27±0.42	N.D
Decanal	2.53±0.50^a	3.41±1.04^a	4.82±1.24^b
Benzaldehyde	14.77±6.83^a	18.59±6.03^a	14.91±2.75^a
2-Nonenal, (E)-	10.25±2.37^a	16.18±5.53^b	18.58±6.19^b
2-Decenal, (E)-	8.97±2.31^b	4.70±0.89^a	12.20±2.48^c
2-Undecenal, E-	2.71±0.72^a	3.58±0.33^b	5.88±1.54^c
2,4-Dodecadienal, (E,E)-	4.26±1.57^a	6.38±2.07^b	7.83±1.64^b
2,4-Dodecadienal	5.35±1.76^a	7.81±1.51^b	14.52±3.75^c
Tetradecanal	3.18±0.72^a	4.21±0.90^b	5.15±1.63^c
Hexadecanal	2.22±0.59^a	9.38±2.76^c	4.17±1.25^b
Alcohols			
1-Pentanol	21.70±6.17^a	22.61±8.55^a	75.35±9.61^b
1-Hexanol	8.76±2.46^b	5.03±1.84^a	12.88±5.05^c
1-Octen-3-ol	96.18±23.52^a	75.60±25.43^a	195.93±52.00^b
1-Heptanol	8.24±1.89^b	5.13±1.56^a	12.29±3.69^c
1-Hexanol, 2-ethyl-	N.D	3.12±2.17^a	4.31±1.05^a

1-Octanol	24.33±4.31^{b}	12.66±3.35^{a}	42.24±9.42^{c}
2-Octen-1-ol, (E)-	14.10±3.75^{a}	10.30±3.00^{a}	30.55±7.92^{b}
1-Dodecen-3-ol	2.00±0.52^{b}	1.32±0.17^{a}	3.96±1.27^{c}
Benzyl alcohol	2.31±0.53^{a}	5.96±2.65^{b}	3.26±1.00^{a}
	ketones		
2,3-Octanedione	514.91±106.05^{b}	178.55±30.84^{a}	166.94±41.10^{a}
4-Dodecanone	9.91±2.82^{b}	3.79±1.29^{a}	13.55±2.90^{a}
	acids		
Butanoic acid	N.D	4.09±1.28^{b}	3.36±0.13^{a}
Hexanoic acid	5.61±1.35^{b}	2.22±0.34^{a}	5.03±1.12^{b}
	hydrocarbons		
Ethylbenzene	N.D	4.96±0.81a	10.76±1.02b
Tridecane	2.38±0.33^{a}	N.D	10.41±1.61^{b}
	Other compounds		
Allyl 2-ethyl butyrate	5.82±1.69^{b}	1.51±0.33^{a}	6.09±1.15^{b}
Oxime-, methoxy-phenyl-_	2.29±0.52^{a}	5.46±2.84^{b}	7.35±1.64^{c}
Anethole	1.65±0.27^{a}	2.47±0.24^{b}	3.78±1.12^{c}

[a]Means for the same volatile compound with different letters (a, b, c) are significantly different ($P < 0.05$); N.D means not detected

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