CHANGES OF VOLATILE COMPOUNDS DURING THE PROCESSING OF DRY-CURED TURKEY HAM

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Abstract: Sixty turkey hams were salted with 3% salt, then air dried-ripened by similar process to dry-cured ham. The changes of volatile compounds in dry-cured turkey ham were studied. 43 volatile compounds were identified through the processing, which included 12 aldehydes, 9 alcohols, 7 ketones, 7 alkanes, 3 alkenes and little 2-methyl-butanoic acide, acetic acid-ethyl ester and tetrahydro-furan. Hexanal was the dominant volatile flavour compound, and reached the peak at the end of salting. 2-methyl-propanal, 2-methyl-butanal and 3-methyl-butanal origined from amino acids were the most important and abundant branched aldehydes in dry-cured turkey ham, and reached the maximal level after drying-ripening 5 days. The first principal component was mainly dominated by 8 aldehydes, 4 carbohydrates, and explained 38.13% total variance of volatile compounds in all ripened turkey hams. The second principal was mainly dominated by 5 alcohols, 3 ketones and 3 branched aldehydes, and explained 24.80% of the total variance.

Keywords: Dry-cured turkey ham; Drying-ripening ; Volatile compounds ; Aldehydes

I. INTRODUCTION

Turkey is a very popular poultry in the Occident. Most of the recent researches on turkey were mainly focused on the quality characteristic of raw and cooked turkey meat, especially, the variation of the quality during storage（Btsoglou et al., 2003; Nam, & Ahn, 2003; Haugen, Lundby, Wold, & Veberg, 2006). Nam and Ahn (2003) reported that irradiation produced off-odor volatile compounds and promoted lipids oxidation in raw and cooked turkey meat products. The flavour of meat product is a key factor determining consumers' acceptance. Aldehydes, alcohols and ketones have been proved to be three groups of dominant volatile compounds of dry-cured meat products (Ventanas et al., 2008).Ahn, et al. (2000) studied and discovered that irradiation could promote some sulfur compounds' formation, and the meat products underwent irradiation tend to generating more volatile compounds.

Dry-curing and ripening are important processing steps for many traditional meat products such as dry-cured ham and dry-cured loin because these steps are critical for the formation of flavor compounds that determined the sensory quality of these products. However, research on the volatile compounds of dry-cured turkey ham processed following similar method of dry-cured ham has not been reported yet. The objective of this study was to investigate the changes of volatile compounds during dry-cured turkey ham processing.

II. MATERIALS AND METHODS

2.1. Processing of dry-cured turkey hams and sampling

Sixty raw turkey hams were purchased from a local grocery store, Five of them were taken as raw

material. The rests were salted with 3% sodium chloride (NaCl) (w/w). After curing for 10 days at 0℃ 70% relative humidity (*RH*).These turkey hams were kept for 5 days at 14-15 ℃ and 65% *RH* for low-temperature dehydration, for 10 days at temperature from 16 ℃ to 21 ℃ (rose at 0.5 ℃/ day) and 60-50% *RH* for drying-ripening.

The central fractions of the turkey hams were taken as samples for volatile compounds analysis at five process points (raw turkey ham, end of salting, end of low-temperature dehydration, drying-ripening 5 days, drying-ripening 10 days). Five hams were randomly sampled at every processing point, and stored immediately at –40 ℃ until analysed.

2.2. Volatiles analysis

Volatiles analysis was carried out using the method described by Nam et al.(2003). The identification of volatiles was achieved by comparing mass spectral data with those of the Wiley library and authentic standards whenever available. The peak area (ion counts$\times 10^4$) was reported as the amount of volatiles released from the samples.

2.3. Statistical analysis

The analysis of variance (ANOVA) and Duncan's multiple-range test were carried out using the SAS 8.2 software (SAS Institute Inc., 2001), and the principle component analysis was performed using STATISTICA 7.0 software (Statsoft Inc, 1984-2004, Tulsa, OK, USA).

III. RESULTS AND DISCUSSION

3.1 Volatile Compounds during the processing of tuukey ham

43 volatile compounds were identified in turkey ham during the processing, which was much less than that detected in Jinhua ham by Huan et al.(2005) and in Iberian dry-cured loin by Ventanas, et al. (2008).The volatile compounds can be concluded as follow chemical classes: aldehydes (12 kinds), alcohols (9 kinds), ketones (7 kinds), alkanes (7 kinds), and a little carboxylic acids, esters, furans, sulfur compounds and nitrogen-containing compounds.15 volatile compounds were identified at raw stage, 28 at the end of salting, 21 at the end of low temperature dehydration, and 27 both at the fifth day and the tenth day of drying-ripening.

Aldehydes was a kind of important volatile compounds in dry-cured meat products because of their relatively low odor thresholds, and accounted for 26.95% in the ripened dry-cured turkey ham. Alcohols were the most abundant volatile compounds and accounted for 58.95% in the ripened dry-cured turkey ham. However, alcohols were deemed to be unimportant for the flavor characteristic of dry-cured meat product because of their relatively high odor threshold. Cyclohexanone and six methyl ketones were identified during the whole processing, and no linear ketones were identified in this study.

3.2 Changes of important volatile compounds of dry-cured turkey ham during processing

Hexanal origined from the oxidation of ω-6 unsaturated fatty acids, and its flavour note was described as grass-like scent. Hexanal was the most abundant and important volatile compounds among all the determined aldehydes in dry-cured turkey ham. Its content increased initialy with process going and reached the peak at the end of salting, and increased again with temperature rise during post-phase of ripening (Table 1). 2-methyl-propanal, 2-methyl-butanal and 3-methyl-butanal were the important branched aldehydes, which were degradation products of valine, isoleucine and leucine via Strecker degradation and thought to be correlated with the aged flavour in dry-cured ham (Zhou & Zhao, 2007). Their contents increased significantly (P<0.05) with the process time and temperature rise during the whole processing.

1-hexanol was an abundant volatile compounds in ripened turkey ham, but was deemed unlikely to contribute to flavor characteristic.3-methyl-butanol and 2-methyl-1-propanol, which origined from the degradation of 3-methyl-butanal and 2-methy-propanal, were abundant in ripened turkey ham. In contrast to the linear alcohol, these branched alcohols could be deemed to have an important impact on the flavour characteristic of dry-cured turkey ham (Zhang et al., 2009). 3-methyl-butanol and 2-methyl-1-propanol began forming when drying-ripening temperature rose to 15℃ and their

contents reached the peak at the end of drying-ripening 5 days in this study (Table 1)

Table 1 Content (U. area/10^4)of Volatile compounds of dry-cured turkey ham during whole processing

Compounds	Processing Steps				
	Raw	End of salting	End of low temperature dehydration	drying-ripening 5 days	drying-ripening 10 days
Total Aldehydes	2535±0.0^{e}	328124±616^{a}	80008±980^{c}	46777±18^{d}	94029±50^{b}
2-methyl-propanal	0.0±0.0^{d}	219.8±4.3^{c}	0.0±0.0^{d}	1554.0±50.5^{a}	1428.7±8.5^{b}
3-methyl-butanal	0.0±0.0^{e}	491.2±6.2^{d}	1461.4±35.1^{c}	24698.7±77.4^{a}	4104.0±21.0^{b}
2-methyl-butanal	0.0±0.00^{c}	0.0±0.0^{c}	0.0±0.0^{c}	2459.0±43.3^{b}	2736.3±45.1^{a}
hexanal	1384±20^{e}	261005±56^{a}	67115±39^{b}	14506±36^{d}	56706±64^{c}
Total Alcohols	11677±0.0^{e}	52906±492^{d}	128616±230^{c}	316225±192^{a}	205680±304^{b}
2-methyl-1-propanol	0.0±0.0^{c}	0.0±0.0^{c}	0.0±0. 0^{c}	6897.7±52.6^{a}	3162. 7±51.7^{b}
3-methyl-butanol	0.0±0.0^{d}	0. 0±0. 0^{d}	2409.2±61.9^{c}	31693±26. 9^{a}	7774. 3±13.9^{b}
1-hexanol	158.1±0. 0^{e}	4381.2±36^{c}	19020.5±54^{a}	5566. 7±59^{b}	2173. 3±64.3^{d}
Total Ketones	24835±0.0^{c}	85219±188^{a}	14386±40^{e}	32937±153^{b}	20914±147^{d}
Total Alkanes	6425±101^{e}	34915±182^{b}	57687±387^{a}	14726±33^{d}	24480±67^{c}

$^{a-e}$Indicate the differences reached extremely significant level (α=0.01)

3.2. Principal component analysis results

Figure 1 shows that the first principal component (PC1) was dominated by aldehydes (8 kinds), carbohydrates (4 kinds), 1-pentanol, ethanol and 3-octanone, and explained 38.13% of the total variance of volatile compounds in turkey hams during processing. The second principal component (PC2) was mainly determined by alcohols(5 kinds), ketones(3 kinds), branched aldehydes(3 kinds) and ethyl acetate, and explained 24.80% of the total variance. The third principal component (PC3) explained 20.63% of the total variance, and was determined by ethanal,2-butanone, 2-pentanone, tetrahydro-furan, cyclohexane,1-butanol, and 2-methy-l-butanoic acid. The fourth principal component (PC4) was dominated by hydrocarbons (6 kinds),1-hexanol,2-heptanone, chloroform and piperidine, and explained 16.43% of the total variance.

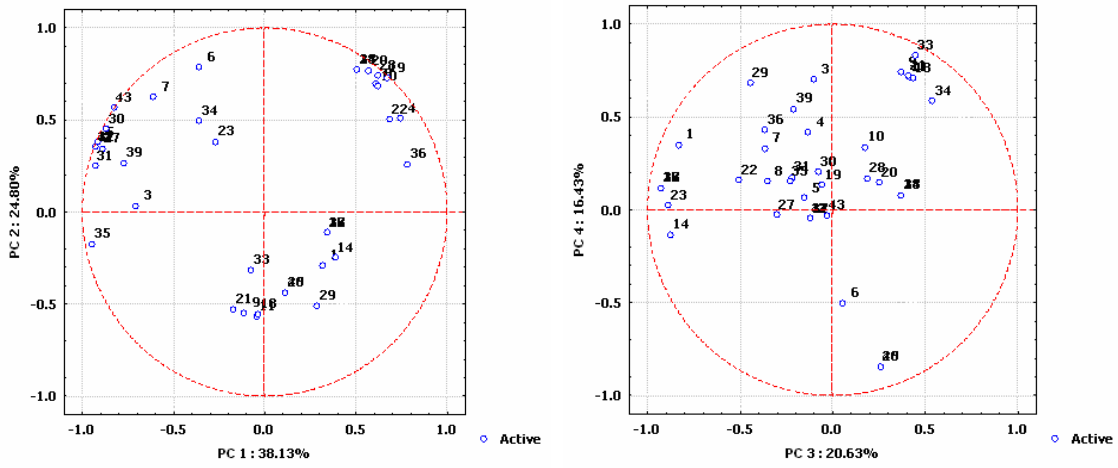

Figure 1 Principal component loading plot of principal component analysis of volatiles in ripened turkey ham

IV. CONCLUSION

43 volatile compounds of dry-cured turkey ham were identified during processing. The main chemical classes were aldehydes(12 kinds), alcohols(9 kinds) and ketones(7 kinds). Hexanal was the dominant volatile flavour compound, and reached the peak at the end of salting. 2-methyl-propanal, 2-methyl-butanal and 3-methyl-butanal were the most important and abundant branched aldehydes, and

reached the maximal level after drying-ripening 5 days. The first principal component was mainly dominated by 8 aldehydes, 4 carbohydrates, and explained 38.13% total variance of volatile compounds in ripened turkey hams. The second principal was mainly dominated by 5 alcohols, 3 ketones and 3 branched aldehydes, and explained 24.80% of the total variance.

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