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Influence of Different Drying Methods on Aroma Compounds in Hami-Melon Using Headspace Solid Phase Micro Extraction

JIN-FENG BI*, YUAN-YUAN, SHA-SHA BAI and PEI WANG

Institute of Agro-Food Science and Technology, Chinese Academy of Agricultural Sciences, Key Laboratory of Agriculture Product Processing and Quality Control of MOA, Beijing 100193, P.R. China

*Corresponding author: E-mail: bijinfeng2010@gmail.com

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This study aimed to analyze the influence of three different drying methods on aroma compounds in hami-melon and explore the optimal drying method for hami-melon. Headspace solid phase micro extraction coupled with gas chromatography-mass spectrometry (GC-MS) was used to identify the aroma compounds in the dehydrated hami melon samples by hot air drying, vacuum-freezing drying and explosion puffing drying. The experimental results showed that (1) aroma compounds in fresh samples mainly consist of esters (14.3 %), alcohols (43.9 %), aldehydes (27.1 %) and acids; (2) the content of the aroma compounds in the dehydrated samples changed due to the drying treatment; (3) much ketones were produced in the samples dehydrated by hot air drying and made them taste like being cooked; (4) more acids were produced and the great loss of alcohols happened in the samples dehydrated by vacuum-freezing drying and the flavour of these samples changed significantly; (5) most of hami-melon special aroma compounds remained in the samples treated by explosion puffing drying, including ethanol, 3-nonen-1-ol, ene aldehydes and so on. It was obviously that different drying methods had significantly impact on the aroma compounds of the hami melon. Due to the great loss of hami-melon special aroma compounds in the processing of hot air drying and vacuum-freezing drying, the explosion puffing drying was the optimal drying method for hami melon.

Key Words: Headspace solid phase micro extraction, Gas chromatography-mass spectrometry, Hami-melon.

INTRODUCTION

Hami melon (*Cucumis melo* L. var. *inodorus* Jacq.) is the most important melon crop grown in the northwestern provinces of China. There are more than 100 cultivars which are adapted only to areas with long, dry growing seasons. Hami-melon has a rich of amino acids, essential glucose, fructose and trace elements iron, zinc, calcium and a variety of fiber necessary for human body^{1,2}. In recent years, the total yield of hami melon is increasing dramatically year by year due to more and more cultivation regions. However, market need for fresh melon has been nearly saturated, which makes the melon price fall in recent years. So the deep-processing of hami melon is urgently needed to solve the problem of excessive supply of fresh fruit. Drying treatment as an important method in the modern food industry has been widely used³. More and more researches have focus on the drying processing of hami melon in recent years. The drying methods mainly include hot air drying, vacuum-freezing drying and explosion puffing drying. Different drying methods have respective advantages and disadvantages. The traditional hot air drying technology developed rapidly, but it is too slow and has the poor product

quality issue. The vacuum-freezing drying make quality of products better, but it requires too much time cost, energy consumption and expensive equipment⁴⁻⁶. The explosion puffing drying is a new type of fruit and vegetable drying technology in recent years, which combines the advantages of hot air drying and vacuum-freezing drying. The products treated by this new technology remain their natural characteristics and taste crisp. The new technology also requires a lower production cost. However, the mechanism of the technology is still not very clear and needs to explore further⁷⁻⁹.

Melon fruit quality is a multivariate attribute that depends on visual appearance, textural properties, taste and aroma¹⁰⁻¹³. Volatile compounds are major determinants of melon fruit quality perceived by consumers, whose acceptance of melon is driven most often by sweetness, sourness and also by an acceptable aroma bouquet or the presence of volatiles¹⁴. Most of the aromatic compounds are esters, but aldehydes, alcohols or sulphur-derived compounds have been identified by headspace solid-phase microextraction and analyzed by gas chromatography-mass spectrometry (GC-MS)¹⁵. The compounds metabolized into aromas are diverse (fatty acids, amino acids, phenols and terpenoids)¹⁶, meaning different biochemical

pathways for aroma production, such as lipid peroxidation, aldehyde conversion into alcohols, methylerythritol 4-phosphate and mevalonate pathways, fermentation, *etc.*^{17,18}.

Temperature and other factors always lead to the loss of aroma compounds in hami melon during the processing. So the key point of hami melon's drying processing is to maintain its original flavour, *i.e.*, to make the loss of aroma compounds as less as possible. At present few research are working on this problem. This study aimed to analyze the influence of three different drying methods on aroma compounds in hami-melon and explore the optimal drying method for hami-melon and explore the optimal drying method for hami-melon.

In this study, headspace solid phase micro extraction coupled with gas chromatography-mass spectrometry (GC-MS) was used to identify the aroma compounds in the dehydrated hami-melon samples by hot air drying, vacuum-freezing drying and explosion puffing drying. Solid phase micro extraction (SPME) was chosen because it is rapid, less laborious and relatively inexpensive and does not require solvents, purge and trap, preconcentration or vigorous extraction and heating, which may alter endogenous compounds.

EXPERIMENTAL

The melon samples studied were No. 86 Hami melon, a variety planted in Xinjiang Uigur Autonomous Region, PR China. All melon samples were fully ripe without any quality deterioration or decay. They all stored at 10 °C before processing.

Sample preparation

Preparation by explosion puffing drying: Cut the peeled fresh melon raw materials into the pieces of 1 cm × 2 cm × 3 cm. Place these slice samples in the oven set at 80 °C for pre-drying of 6 h. Then soften the samples at low temperature in a confined space for 24 h. Next, put the softened samples into the expansion tank of the explosion puffing drier (QDPH10-1, Qinde Ltd., Tianjin, China). Make the temperature of the expansion can rise slowly to the expansion temperature 90 °C by hot steam. At the same time, adjust the expansion pressure to 0.2 MPa and open vacuum pump to reach the pressure range between -0.01 and -0.098 MPa. 10 min later, open the pressure relief valve (the material in the can is expanding instantly and vacuumed), cool the tank to 70 °C by pouring the cooling water into the steam pipe and vacuum dry for 90 min. After 90 min, cool the tank to 20-25 °C for 5-10 min. At last, open the ventilation valve and fetch the samples from the tank after the resumption of atmospheric pressure. The moisture content of the termination product is controlled at 5 %.

Preparation by hot air drying: Cut the peeled fresh melon raw materials into the pieces of 1 cm × 2 cm × 3 cm. Put these slice samples in the electric blast drying oven (DHG-9123A, Jing Hong Laboratory Instrument Co. Ltd., Shanghai, China) for 12 h drying with the temperature at 70 °C and wind velocity at 2.3 m/s. The moisture content of the termination product is controlled at 5 %.

Preparation by vacuum-freezing drying: Cut the peeled fresh melon raw materials into the pieces of 1 cm × 2 cm × 3 cm. Freeze these slice samples in the freeze dryer (Virtis, USA). Then dry the frozen samples in the vacuum-freezing drying

device with the temperature set at -45 °C and the vacuum degree at 0.1 kPa for 16 h. The moisture content of the termination product is controlled at 5 %.

Solid phase micro extraction analysis: A 75 µm of carboxen/polydimethylsiloxane (CAR/PDMS) fibre (Supelco, Bellefonte, PA, USA) was used in this study, which was preconditioned in the injection port of GC as indicated by the manufacturer. Each sample was put into a 50 mL headspace vial and sealed with a Teflon silicon septum. The vial was left at 60 °C in a thermal block for 1 h to equilibrate the headspace. Next, an SPME fibre was exposed to the headspace while maintaining the sample for 40 min. The compounds absorbed by the fibre would be identified and quantified by GC/MS.

GC-MS parameters and analysis: After extraction, the contents of the SPME fibre adsorbed by the fibre were desorbed in the injection port of GC/MS (Finnigan MAT 8230 GC/MS, Palo Alto, CA, USA) for 3 min at 250 °C under 35 kPa with a splitless injection mode. The compounds were separated in a HP-1 capillary column (30 m × 0.25 mm internal diameter, 1 mm of film thickness). During desorption, the oven was held at 35 °C a further 2 min. Then the temperature was raised at 4 °C min⁻¹ to 60 °C and at 8 °C min⁻¹ to 140 °C again. Finally, the temperature was raised at 12 °C min⁻¹ to 230 °C and hold for 8 min.

Volatiles were detected by electronic impact ionization at 70 eV and ions were scanned from m/z 33 to m/z 450. The components were identified by comparison of mass spectra and retention time data with those of authentic samples and complemented with NIST GC-MS Library and Wiley Library. Volatile compounds were quantified by calculating the peak area.

RESULTS AND DISCUSSION

Aroma compounds of the fresh hami-melon samples:

The total ion spectra are shown in the Fig. 1. Using SPME with the fresh samples, we identified 44 aroma compounds, shown in the Table-1, including 17 esters, 8 alcohols, 12 aldehydes and 7 other substances. The relative percentages of the compounds were 14.3 % (esters), 43.93 % (alcohols), 27.1 % (aldehydes) and 14.67 % (other substances), respectively.

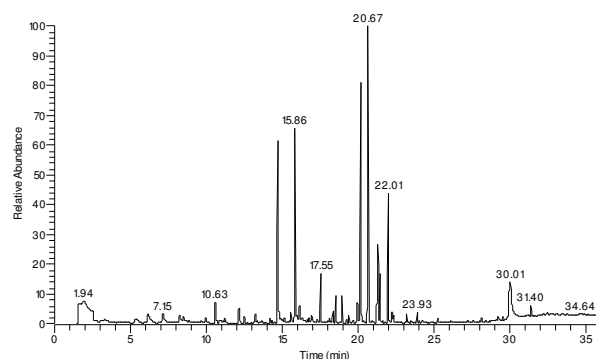


Fig. 1. Total ion spectra from fresh hami-melon samples

Based on the peak shape and relative percentage, the volatile compounds in No. 86 hami-melon mainly consisted of methyl acetate, ethyl acetate, acetic acid phenylmethyl ester, 1-nonanol, 3-nonen-1-ol, 3,6-nonadien-1-ol, hexanal,

TABLE-1
VOLATILE COMPOUNDS IDENTIFIED IN FRESH HAMI-MELON

Chemical name	Retention time	Relative amount	Chemical name	Retention time	Relative amount
Esters					
Methyl acetic acid ester	2.52	1.17	6-Nonen-1-ol	21.27	1.18
Ethyl acetate	3.10	0.24	<i>cis</i> -6-Nonen-1-ol	21.33	3.79
1-Methylethyl acetic acid ester	3.22	0.17	3,6-Nonadien-1-ol	22.01	6.30
Methyl propanoic acid ester	3.33	0.69	2,6-Nonadien-1-ol	22.35	0.64
Methyl butanoic acid ester	4.75	0.27	Aldehydes		
2-Propenyl acetic acid ester	5.39	1.03	Hexanal	7.15	1.57
2-Methyl-butyl acetate	8.28	0.81	Octanal	12.52	0.46
3-Methyl-butyl-1-propanoate	9.99	0.43	2-Heptenal	13.38	0.20
Hexyl acetic acid ester	11.13	1.16	Nonanal	14.73	9.62
3-Hexen-1-ol acetate	13.20	0.39	4-Nonenal	15.59	0.56
4-Methylcyclohexanol acetate	15.17	0.31	6-Nonenal	15.86	9.40
Ethenyl acetic acid ester	16.26	0.17	Furfural	16.18	1.25
Octyl acetic acid ester	16.35	0.32	Decanal	16.79	0.25
Nonyl acetic acid ester	18.37	0.58	2-Nonenal	16.97	0.29
Phenylmethyl acetic acid ester	21.46	2.60	Benzaldehyde	17.30	0.16
B-Phenylethyl acetate	23.21	0.48	2-Nonenal	17.55	2.12
Octadecyl decanoic acid ester	32.22	0.20	<i>trans</i> -2- <i>cis</i> -6-Nonadienal	18.56	1.22
Alcohols					
1-Hexanol	14.24	0.23	Others		
1-Octanol	18.13	0.24	2-Pentyl furan	10.98	0.22
4-Nonen-1-ol	18.95	1.18	3-Hydroxytetrahydrofuran	28.16	0.18
6-Nonen-1-ol	19.41	0.36	<i>cis</i> -3-Decene	11.26	0.36
1-Nonanol	20.20	14.10	1-Hydroxy-2-propanone	13.27	0.47
3-Nonen-1-ol	20.67	15.91	Hexadecanoic acid	30.01	7.33
			Oleic acid	32.48	0.28

nonanal, 6-nonenal, furfural, 2-nonenal, *trans*-2-*cis*-6-nonadienal, hexadecanoic acid, nonadienol and *cis*-6-nonen-1-ol. These compounds accounted for 87.660 % of the total volatiles. Acetic acid phenylmethyl ester and ethyl acetate were the major aroma components in hami-melons; 1-nonanol and 3-nonen-1-ol could make the melon smell fresh¹⁹; nonanal and 6-nonenal made the melon smell like citrus fruit²⁰. The equilibrium of esters and aldehydes made the fresh No. 86 hami-melon present typical melon aroma.

Aroma compounds of the sample prepared by explosion puffing drying: The total ion spectra are shown in the Fig. 2. We identified 33 aroma compounds, shown in the Table-2, including 9 alcohols, 7 esters, 4 aldehydes, 3 ketones, 3 alkanes, 2 acids and 5 others. The relative percentages of the compounds were 26.47 % (alcohols), 11.74 % (esters), 3.04 % (aldehydes), 7.68 % (ketones), 1.66 % (alkanes), 27.18 % (acids) and 6.14 % (others), respectively.

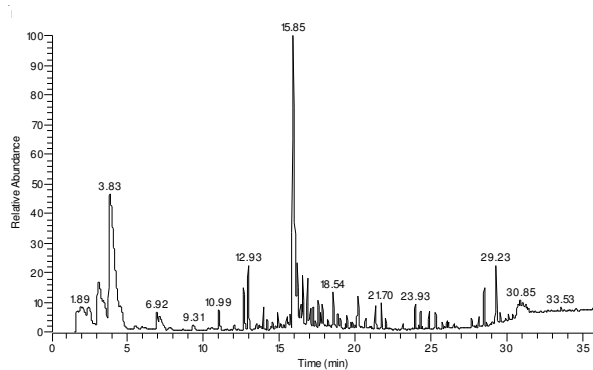


Fig. 2. Total ion spectra from the sample prepared by explosion puffing drying

From the Table-2, main compositions in the sample consisted of alcohols, 3-methyl-1-butanol, 3-nonen-1-ol, ethyl acetate, butyl acetate, 16 octadecenoic acid methyl ester, hexanal, 4-hydroxy-2-butanone, 3-hydroxy-2-butanone, 1-hydroxy-2-acetone, acetic acid, 2-furancarboxaldehyde and 2,3-butanediol. The sample contained much more alcohols, esters, acids and ketones than other aroma compounds. Most of special aroma compounds in hami-melon remained in the samples, including ethyl acetate, acetic acid butyl ester, 3-nonen-1-ol, acetic acid, *etc.*

Aroma compounds of the sample prepared by hot air drying: The total ion spectra are shown in the Fig. 3. We identified 38 aroma compounds, shown in the Table-3, including 8 alcohols, 6 esters, 5 aldehydes, 8 ketones, 4 alkanes, 5 acids and 2 others. The relative percentages of the compounds were 24.37 % (alcohols), 14.13 % (esters), 3.21 % (aldehydes), 12.82 % (ketones), 2.56 % (alkanes), 26.44 % (acids) and 1.67 % (others), respectively.

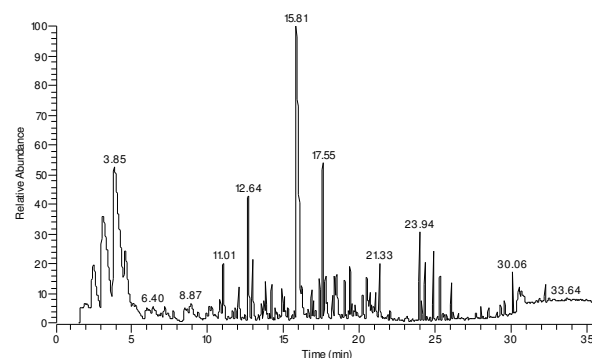


Fig. 3. Total ion spectra from the sample prepared by hot air drying

TABLE-2
VOLATILE COMPOUNDS IDENTIFIED IN PUFFING PRODUCT

Chemical name	Retention time	Relative amount	Chemical name	Retention time	Relative amount
Alcohols			Nonanal	14.88	0.53
Ethanol	3.82	21.81	2,4-Decadienal	23.14	0.23
1-Butanol	9.31	0.52	Ketones		
3-Methyl-1-butanol	10.99	1.33	4-Hydroxy-2-butanone	3.38	2.33
1-Pentanol	12.02	0.35	3-Hydroxy-2-butanone	12.63	2.20
3-Methyl-2-ethyl pentanol	17.20	0.48	1-Hydroxy-2-acetone	12.93	3.15
1-Octanol	20.19	0.63	Alkanes		
3-Nonen-1-ol	20.67	0.30	3-Ethyl octane	16.40	0.51
Benzene methanol	24.29	0.49	3-Ethyl octane	17.68	0.46
Benzene ethanol	24.86	0.56	1-Methyl-1-hydroxy cyclohexane	19.00	0.31
Esters			1,1,2,3-Tetramethyl cyclohexane	21.99	0.38
Ethyl acetate	3.08	7.04	Acids		
Butyl acetic acid ester	6.92	1.42	Acetic acid	15.85	26.32
2-Hydroxy ethyl acetic acid	14.55	0.23	Hexadecanoic acid	31.04	0.86
Butyrol acetone	19.45	0.46	Others		
Nerol acetone	23.93	0.63	2-Furan carboxaldehyde	16.17	2.48
Methyl 16-octadecenoic acid ester	30.85	1.25	2-Furan methanol	20.13	1.00
Ethyl 9-octadecenoic acid ester	31.18	0.71	1,3-Butanediol	17.82	0.91
Aldehydes			2,3-Butanediol	18.54	1.22
Hexanal	7.11	1.87	1,2-Butanediol	18.83	0.53

From Table-2, main aroma compounds in the sample consisted of alcohols, ester, ketones and alkanes, which included ethyl acetate (10.52 %), ethanol (16.64 %), 3-methyl-1-butanol, butanediol, 3-nonen-1-ol, 1-phenyl ethanol, 1-phenyl ethanal, 2-pentanone, 3-hydroxy-2-butanone, 1-hydroxyacetone, 5,9-dimethyl-5,9-sebacic ketene, 2-methyl propionic acid, 2-methylbutyric acid, hexadecylic acid and 2-furanc arboxaldehyde. The loss of special aroma compounds in hami-melon, including alcohols, esters and aldehydes, happened in the process of hot air drying, while much ketones were produced in the same process.

Aroma compounds of the sample prepared by vacuum-freezing drying: The total ion spectra are shown in the Fig. 4. We identified 41 aroma compounds, shown in the Table-4, including 8 alcohols, 8 esters, 5 aldehydes, 5 ketones, 9 alkanes, 4 acids and 2 others. The relative percentages of the compounds were 8.81 % (alcohols), 7.45 % (esters), 3.89 % (aldehydes), 7.33 % (ketones), 9.29 % (alkanes), 39.08 % (acids) and 2.08 % (others), respectively.

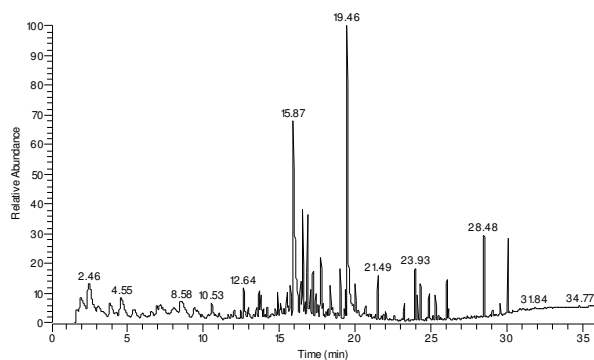


Fig. 4. Total ion spectra from the sample prepared by vacuum-freezing drying

From Table-2, main aroma compounds in the sample consisted of acetic acid, butanoic acid, 4-methyl-hexanoic acid, 2-methyl propionic acid, ethyl acetate, 3-methyl butane,

benzyl acetate, ethanol, 3-methyl-2-ethyl-pentanol, hexanal, 2-pentanone, 3-hydroxy-butanone, 2-amino-butane and 3-ethyl-octane. The loss of special aroma compounds in hami-melon, including alcohols, esters and aldehydes, happened in the process of vacuum-freezing drying.

Comparison of aroma compounds in samples treated by different drying methods: The relative amount of the aroma compounds in different treated samples are shown in Fig. 5. The figure shows that (1) the loss of esters was the most in the sample prepared by vacuum-freezing drying; (2) most of special aroma compounds in hami-melon remained in the sample prepared by explosion puffing drying; (3) the loss of alcohols happened in all these three drying methods, especially the vacuum-freezing drying; (4) the great loss of alcohols happened in all these three drying methods; (5) the gain of ketones was the most in the sample prepared by hot air drying that why it tasted like being cooked; (6) the gain of acids was the most in the sample prepared by vacuum-freezing drying.

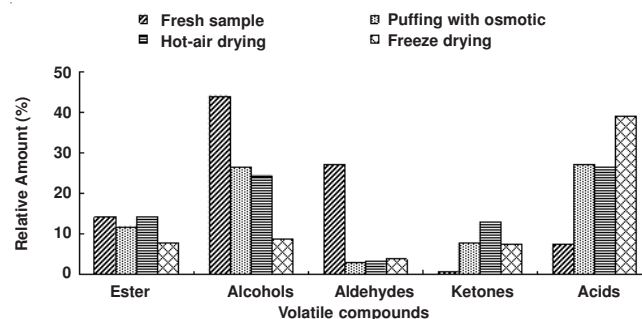


Fig. 5. Per cent of hami-melon's flavour content with different processing

Wan *et al.*²², believed that 3,6-nonadien-1-ol, 6-nonenol, benzyl alcohol and furans are the main composition in hami-melon. Some others believed that 9 carbon fatty alcohols and aldehydes are the main composition in hami-melon¹⁵. However, the results of this study shows that the aroma compounds in

TABLE-3
VOLATILE COMPOUNDS IDENTIFIED IN HOT-AIR DRYING PRODUCT

Chemical name	Retention time	Relative amount	Chemical name	Retention time	Relative amount
Esters			Ketones		
Ethyl acetic acid ester	3.07	10.52	2-Pentanone	4.57	2.75
2-Methyl-ethyl nutanoic acid ester	6.39	0.85	5-Methyl-2-heptanone	11.62	0.33
2-Methyl propyl-3-oxobutanoic acid	7.71	0.37	3-Hydroxy-2-butanone	12.64	4.46
Pentyl formic acid ester	12.04	1.07	1-Hydroxyacetone	12.95	1.93
2-Methyl-5-hydroxy-3-hexene methyl	17.70	0.74	6-Methyl-5-hepten-2-one	13.79	1.03
2-Methyl Methyl	21.04	0.58	2-Decanone	16.84	0.58
Alcohols			5,9-Dimethyl-5,9-sebacic ketene		
Ethanol	3.85	16.64	Citrylidene acetone	19.70	0.37
3-Methyl-1-butanol	11.01	2.25	Acids		
1-Hexanol	14.20	0.77	1-Dodecene acid	11.80	0.41
2,3-Butanediol	17.82	0.50	Acetic acid	15.81	20.27
1-Nonanol	20.20	0.44	2-Methyl propionic acid	18.36	1.26
3-Nonen-1-ol	20.67	0.69	2-Methyl butyric acid	20.45	1.87
Benzyl alcohol	24.30	0.94	Hexadecylic acid	30.51	1.32
Benzene ethanol	24.86	1.17	Alkanes		
Aldehydes			Dodecane	10.78	0.84
Hexanal	7.14	0.55	2,3-Octanedione	13.52	0.48
Heptanal	10.24	0.61	Tetradecane	15.05	0.46
Nonanal	14.89	0.66	1-Methyl-1-hydroxy cyclohexane	19.01	0.78
Decanal	16.93	0.38	Others		
Phenyl acetaldehyde	17.35	1.01	2-Furan carboxaldehyde	16.18	1.01
			1-Decene	6.12	0.66

TABLE-4
VOLATILE COMPOUNDS IDENTIFIED IN VACUUM-FREEZING DRYING PRODUCT

Chemical name	Retention time	Relative amount	Chemical name	Retention time	Relative amount
Esters			Ketones		
Ethyl acetate	3.05	1.27	2-Pentanone	4.55	3.21
2-Methyl propyl acetic acid ester	5.43	0.94	3-Hydroxy-2-butanone	12.64	1.54
3-Methyl-1-butanol acetate	8.58	1.38	2-Heptenal	13.51	0.65
Hexyl acetic acid ester	12.43	0.42	1-Hydroxy-2-acetone	12.94	0.55
Diacetate-1,2-ethanediol	17.85	0.52	6,10-Dimethyl-5,9-11,2-enone	23.93	1.38
Nonyl acetic acid ester	18.48	0.45	Acids		
Phenyl methyl acetic acid ester	21.49	1.35	Acetic acid	15.87	18.73
Phenylethyl acetate	23.23	0.51	4-Methyl hexanoic acid	17.71	3.56
Alcohols			2-Methyl propanoic acid	18.32	1.61
Ethanol	3.83	2.21	Butanoic acid	19.46	15.18
3-Methyl butane-1-thiol	12.02	0.59	Alkanes		
1-Hexanol	14.19	0.44	Tetradecanoic	6.55	0.46
3-Methyl-2-propyl-1-pentanol	17.20	1.19	3,5-Dimethyl undecane	8.03	1.03
3,4-Dimethylcyclohexanol	19.01	1.74	3,6-Dimethyl decane	8.79	0.65
3-Nonen-1-ol	20.67	0.54	Dodecane	9.39	0.97
Benzyl alcohol	24.29	1.01	2,3-Dimethyl decane	9.61	0.61
Benzene ethanol	24.85	1.09	2-Butanamine	13.67	1.37
Aldehydes			2-Cyclohexyl undecane	15.05	0.70
Hexanal	7.17	0.69	3-Ethyl octane	16.40	1.53
Nonanal	14.88	0.82	2,4-Diacetoxy pentane	20.00	0.85
Benzaldehyde	17.35	0.47	Others		
Phenyl acetaldehyde	19.68	0.94	1-Propoxy octane	6.92	0.95
2-Decenal	19.81	0.44	6-Methyl-5-hepten-2-one	13.78	1.13

fresh No. 86 hami-melon mainly consisted of esters, alcohols and aldehydes, which included acetic acid methyl ester, ethyl acetate, 1-nonanol, 3-nonen-1-ol and 6-nonyl aldehyde. In comparison with other studies, the different results might be due to the variety of the hami-melon, the processing methods and analysis approaches.

The aroma components are different in the samples prepared by different drying methods. In the samples prepared

by explosion puffing or hot air drying, the content of esters decreased slightly and that of alcohols and aldehydes dramatically lessened, while that of ketones and acids increased noticeably. It may be due to the decomposition and oxidation of esters under high temperature and Maillard reaction, which produced ketones. The more acids might be produced by the oxidation of alcohols and aldehydes or by the hydrolyzation of esters²⁰⁻²². The sample experienced low temperature in the

process of vacuum-freezing drying. However, it still contained much ketones due to the high temperature in the headspace treatment which made the changes of aroma compounds happened in the pre-treatment.

Conclusion

The aroma compounds in fresh No. 86 hami-melon mainly consisted of esters (14.3 %), alcohols (43.9 %), which mainly included nonanol and 3-nonen-1-ol and aldehydes (27.1 %), which mainly included nonyl aldehyde and 6-nonyl aldehyde. The equilibrium of esters and aldehydes made the fresh No. 86 hami-melon present typical melon aroma. It was obviously that different drying methods had significantly impact on the aroma compounds of the hami melon. The drying treatment made the loss of the aroma compounds in No. 86 hami-melon, especially for esters, alcohols and aldehydes. Much ketones were produced in the samples dehydrated by hot air drying and made them taste like being cooked. More acids were produced and the great loss of alcohols happened in the samples dehydrated by vacuum-freezing drying and the flavour of these samples changed significantly. Most of hami-melon special aroma compounds remained in the samples treated by explosion puffing drying, including ethanol, 3-nonen-1-ol, ene aldehydes and so on. Due to the great loss of hami-melon special aroma compounds in the processing of hot air drying and vacuum-freezing drying, the explosion puffing drying was the optimal drying method for hami melon.

REFERENCES

1. K. Yabumoto and W.G. Jennings, *J. Food Sci.*, **42**, 32 (1977).
2. M.G. Moshonas, P.E. Shaw, E.A. Baldwin and W. Yuen, *Lebensm.-Wissen. Technol.*, **26**, 577 (1993).
3. G.H. Crapiste and E. Rotstein, *Design and Performance Evaluation of Dryers*, Boca Raton: CRC, pp. 125-166 (1997).
4. C.M. Zmamer, *Food Technol.*, **49**, 64 (1995).
5. Z.H. Wang and G. Chen, *Ind. Eng. Chem. Res.*, **39**, 775 (2000).
6. A.I. Varnalis, J.G. Brennan and D.B. MacDougall, *J. Food Eng.*, **48**, 361 (2001).
7. A. Andres, C. Bilbao and P. Fito, *J. Food Eng.*, **63**, 71 (2004).
8. K.S. Jayaraman, V.K. Gopinathan, P. Pitchamuthu and P.K. Vijayaraghavan, *J. Food Technol.*, **17**, 669 (1982).
9. J.F. Sullivan and J.C. Craig, *Food Technol.*, **38**, 52 (1984).
10. J.C. Beaulieu and E. Baldwin, In ed.: O. Lamikanra, *Flavour and Aroma of Fresh Cut Fruits and Vegetables*, Fresh Cut Fruits and Vegetables, Science, Technology and Market, Boca Ratón, Fla: CRC Press LLC pp. 391-425 (2002).
11. J.M. Obando-Ulloa, E. Moreno, J. García-Mas, B. Nicolai, J. Lammertyn, J.A. Monforte and J.P. Fernández-Trujillo, *Postharvest Biol. Technol.*, **49**, 27 (2008).
12. J.E. Pardo, A. Alvarruiz, R. Varón and R. Gómez, *J. Food Quality*, **23**, 161 (2000).
13. M.J. Villanueva, M.D. Tenorio, M.A. Esteban and M.C. Mendoza, *Food Chem.*, **87**, 179 (2004).
14. J.C. Beaulieu and J.M. Lea, *J. Agric. Food Chem.*, **54**, 7789 (2006).
15. D. Kourkoutas, J.S. Elmore and D.S. Mottram, *Food Chem.*, **97**, 95 (2006).
16. E. Baldwin, In ed.: M. Knee, *Fruit Flavor, Volatile Metabolism and Consumer Perceptions*, Fruit Quality and its Biological basis, Sheffield, UK: Sheffield Academic Press Ltd., pp. 89-106 (2002).
17. J.C. Beaulieu and E. Baldwin, In ed.: O. Lamikanra, *Flavour and Aroma of Fresh Cut Fruits and Vegetables*, Fresh Cut Fruits and Vegetables, Science, Technology and Market, Boca Ratón, Fla: CRC Press LLC, pp. 391-425 (2002).
18. Y. Ma, X. Hu, J. Chen, F. Chen, J. Wu, G. Zhao, X.J. Liao and Z.F. Wang, *Food Sci. Technol. Int.*, **13**, 259 (2007).
19. S.G. Wyllie and D.N. Leach, *J. Agric. Food Chem.*, **40**, 253 (1992).
20. Y.K. Ma, *Effects of Thermal and Nonthermal Processing on Aroma Substances, Enzymes and Bacteria in Hami Melon Juice [D]*, College of Food Science & Nutritional Engineering, China Agricultural University, Beijing (2004).
21. O.R. Fennema, *Food Chemistry*, CRC Press, edn. 3 (1996).
22. X.C. Wan, J. Tang, F. Tang and X.L. Ding, *J. Nanjing Agric. Univ.*, **20**, 93 (1997).