

Analysis of volatile compounds in *Shochu*

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Abstract

To characterize the flavor of *Shochu-otsu* and foreign white spirits, we analyzed 27 volatile compounds by head space gas chromatography using direct or SPME method and 2 volatile compounds by enzymatic analysis among 28 *Shochu-otsu*, 3 *Shochu-kou*, 2 Blended *shochu* and 13 foreign white spirits. Acidity, TBA-value and pH were also determined.

In cluster analysis using these 32 elements, *Shochu-otsu* was distinguished from the other spirits. In a stepwise discriminant analysis procedure using acetic acid, ethyl acetate, 3-methyl-1-butanol and 1-dodecanol, they were classified into three groups: *Shochu-otsu*, Light spirits (*Shochu-kou*, Blended *shochu*, Vodka and White Rum) and *Bai chiew* (Chinese liquor). And it was possible to classify *Shochu-otsu* into six raw material categories by a discriminant analysis using methanol, 1-propanol, 2-methyl-1-propanol and ethyl octanoate.

Introduction

Shochu is a traditional distilled liquor in Japan. There are two types of *Shochu*: *ko* and *otsu*. *Ko* is made mainly from molasses and is distilled continuously, while *otsu* is made from various raw materials - Sweet potatoes, Rice, Barley, Buckwheat, Brown sugar or *Sake* cake and is distilled once by pot still. Therefore, *otsu* has unique flavor.

In this work, we present that the flavor of *Shochu-otsu* is distinguishable from *Shochu-ko* and foreign white spirits.

Profiles of the samples

Sample code	Group	Indication (Raw materials)	Origin	Alcohol(%)
1-5	01.Kansho	<i>Shochu-otsu</i> (Sweet potatoes)	Japan	25
6-9	02.Awamori	<i>Shochu-otsu</i> (Rice)	Japan	30
10	02.Awamori	<i>Hanasaki</i> Spirits (Rice)	Japan	60
11-14	03.Kome	<i>Shochu-otsu</i> (Rice)	Japan	25
15-20	04.Mugi	<i>Shochu-otsu</i> (Barley)	Japan	25
21-23	05.Soba	<i>Shochu-otsu</i> (Buckwheat)	Japan	25
24-25	06.Kokuto	<i>Shochu-otsu</i> (Brown Sugar)	Japan	30
26	06.Kokuto	<i>Shochu-otsu</i> (Brown Sugar)	Japan	25
27	07.Sakekasu	<i>Shochu-otsu</i> (<i>Sake</i> cake)	Japan	35
28	07.Sakekasu	<i>Shochu-otsu</i> (<i>Sake</i> cake)	Japan	25
29	07.Sakekasu	<i>Shochu-otsu</i> (<i>Ginjo sake</i> cake)	Japan	20
30	08.Blended *(Kansho)	<i>Ko-otsu konwa Shochu</i> (Sweet potato)	Japan	25
31	08.Blended *(Mugi)	<i>Ko-otsu konwa Shochu</i> (Barley)	Japan	25
32-34	09.Ko	<i>Shochu-ko</i>	Japan	25
35	10.Bai chiew	Kweichow Moutai	China	53
36	10.Bai chiew	Wuliangchun	China	45
37	10.Bai chiew	Fen chiew	China	53
38	10.Bai chiew	Kaoliang chiew	China	62
39	11.Vodka	Russia	50	
40	11.Vodka	Russia	40	
41	11.Vodka	Zubruca Vodka	Czech	40
42	12.White Rum	Jamaica Rum	Jamaica	40
43	12.White Rum	19 Rum	Trinidad & Tobago	40
44	12.White Rum	Caribbean Rum	USA	40
45	13.Gin	London Dry Gin	UK	40
46	13.Gin	Holland Jenever	Nedellands	35
47	13.Gin	Steinhager	Germany	38
48	14.Others	Batavia Arac	Nedellands	40
49	14.Others	Tequila Blanco	Mexico	40
50	14.Others	Pirassununga	Brazil	40

* Blended *shochu* are a mix of *Shochu-ko* and *Shochu-otsu*.

Methods

1 pH
 2 Acidity
 3 TBA (2-Thiobarbituric acid reaction) value

Enzymatic analysis
 4 Acetic acid
 5 Acetaldehyde

32 Elements

Direct headspace analysis conditions
 GC column : HP-INNOWAX 30m x 0.32mm x 0.25um
 GC oven : 40 (4min) to 85 at 5 /min (hold 2min)
 GC carrier : Helium, 2.0ml/min GC detector : FID, 240
 Headspace vial oven: 50 , 30min

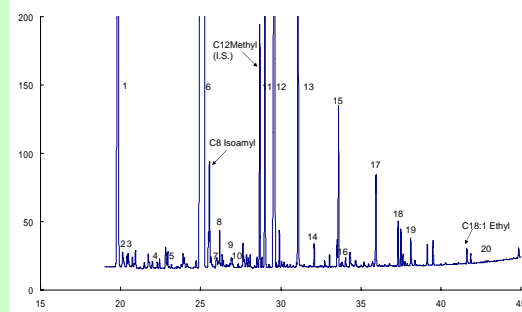
SPME headspace analysis conditions
 Fiber : 85um Polyacrylate (Supelco)
 GC column : HP-INNOWAX 30m x 0.25mm x 0.25um
 GC oven : 40 (7min) to 230 at 5 /min (hold 5min)
 GC carrier : Helium, 1.5ml/min GC detector : FID, 240
 Extraction: 45 , 20min Desorption: 240 , 5min

6 Methanol
 7 1-Propanol
 8 Isobutanol
 9 Isoamylalcohol
 10 Ethyl acetate
 11 Isoamyl acetate
 12 Ethyl Hexanoate (C6Ethyl)

Alcohol content was adjusted to 15% in the head space analysis.

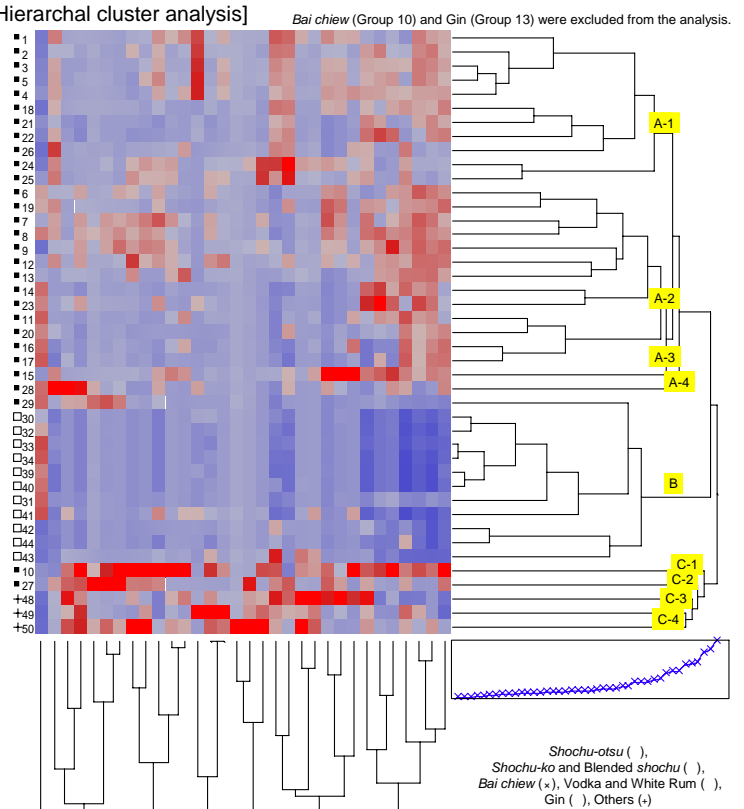
Peak: Compounds (20)
 1: Ethyl Octanoate (C8Ethyl),
 2: Isoamyl Hexanoate (C6Isoamyl)
 3: Furfural
 4: Ethyl Nonanoate (C9Ethyl)
 5: 1-Octanol
 6: Ethyl Decanoate (C10Ethyl)
 7: Diethyl Succinate
 8: Ethyl-9-decanoate
 9: Ethyl Undecanoate (C11Ethyl)
 10: 1-Decanol
 11: Phenylethyl acetate
 12: Ethyl Dodecanoate (C12Ethyl)
 13: 2-Phenylethanol
 14: 1-Dodecanol
 15: Ethyl Myristate (C14Ethyl)
 16: Octanoic acid (C8)
 17: 1-Tetradecanol
 18: Ethyl Palmitate (C16 Ethyl)
 19: Ethyl-9-hexadecanoate
 20: Ethyl Linoleate (C18:2Ethyl)
 *These amounts were the ratios of each peak area to the I.S. peak.

[SPME Gaschromatogram of the No.4 *Shochu*]



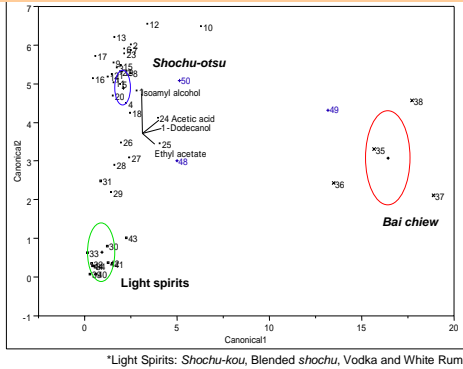
Result

[Hierarchical cluster analysis]

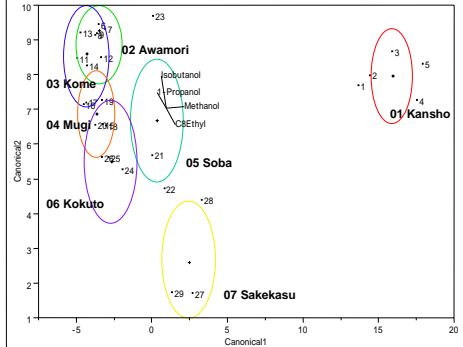


[Discriminant analysis]

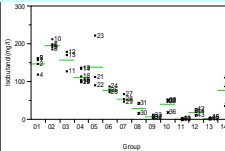
Canonical Plot of Discrimination among *Shochu-otsu*, *Bai chiew* (Chinese liquor) and Light spirits *



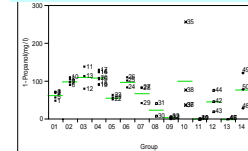
Canonical Plot of Discrimination among *Shochu-otsu* groups



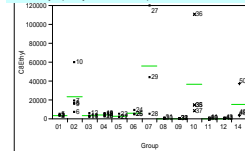
Isobutanol (2-methyl-1-propanol)



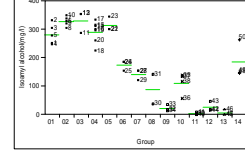
1-Propanol



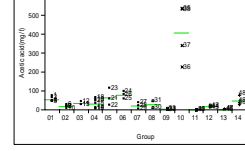
C8 Ethyl (Ethyl octanoate)



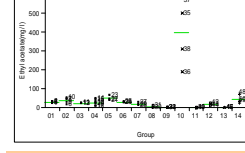
Isoamyl alcohol (3-methyl-1-butanol)



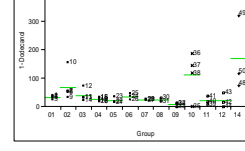
Acetic acid



Ethyl acetate



1-Dodecanol



Methanol

