Principles and applications of perceptual mapping techniques in culinary research and menu development

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Outline

- The evolving food service industry
- Factors influencing research in the culinary field
- Fundamentals of perceptual mapping
- Applications of perceptual mapping:

    - perception of spice aromas

    - flavor and preferences for water

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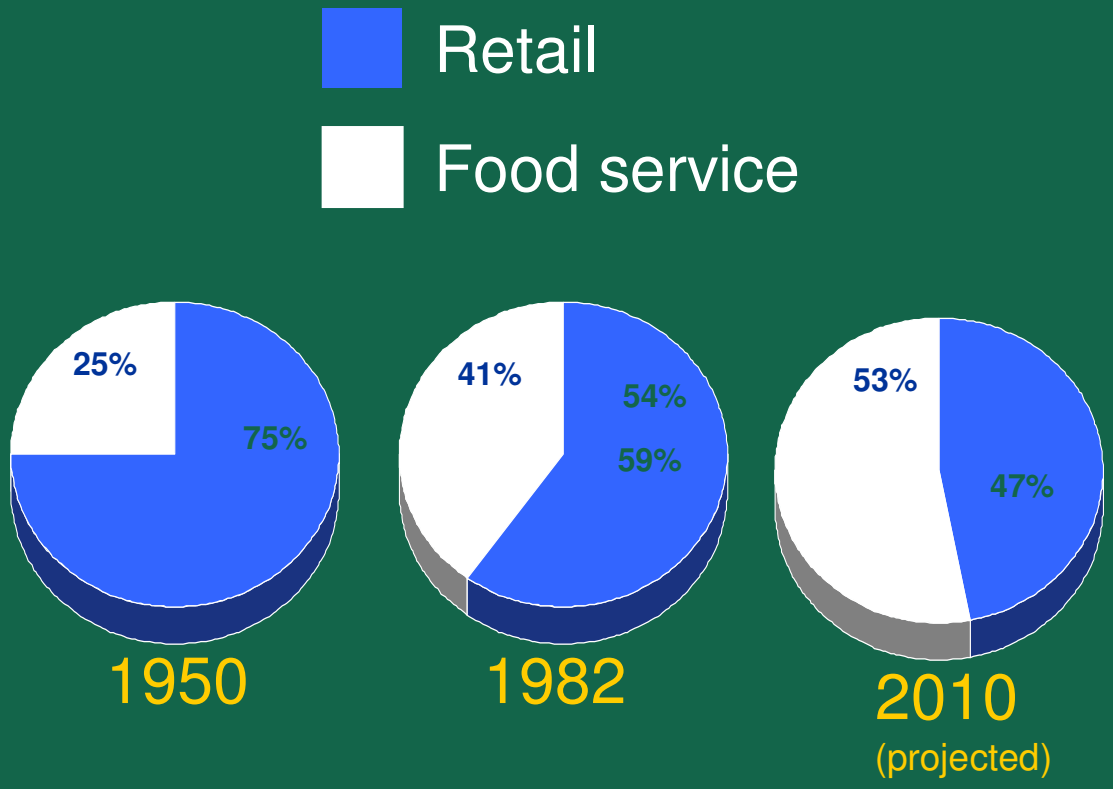
Eating out has become a behavioral norm

(Moskowitz, 2007)

Foodservice share of the consumer's food $ is increasing



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(Source: Technomic and NRA Fact Sheet, 2004)

Factors influencing research in the culinary field

- Increasingly cross-disciplinary field
- Technical challenges and advances
- In-context studies
- Critical evaluation of culinary medium

Fundamentals of perceptual mapping

- Psychophysical principles
- Data collection process
  - napping
  - sorting
- Underlying statistics

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Psychophysical principles of perceptual mapping

- Psychophysics
  - the study of the relation between physical stimuli and subjective experience (Stevens, 1975)
  - knowledge is obtained by understanding the patterns in nature (Moskowitz, 2010)

- Flavor is conceptual and is influenced by attention of the perceiver (Cain, 2010)

- It is difficult to articulate flavor percepts; mapping does not require preconceived vocabulary

Data collection process for perceptual mapping

- Individual panelists asked to place coded samples based on their own descriptive criteria:
  - in groups based on similarity (sorting)
  - on a two dimensional space relative to each other based on similarity (napping)
- Panelists are asked to provide sensory descriptors for the products
- The collective patterns in these groupings or spatial orientations are resolved by statistical programs

Napping gazpacho samples

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Underlying statistics for perceptual mapping

- Napping utilizes multi-factoral analysis (MFA)
- Sorting utilizes multi-dimensional scaling (MDS)
  - frequency of pairings of products
- Multiple regression analysis of perceived attributes is used to help interpret the dimensions product space.

Napping the aromas of Huajiao

- Background
  - increasing diversity of ingredients available to the food service industry that require evaluation
  - Huajiao is integral to a vital and emerging *Sichuan* cuisine.

- Objectives:
  - characterize aromas of huajiao samples from different regions in China
  - better understand general quality attributes of huajiao

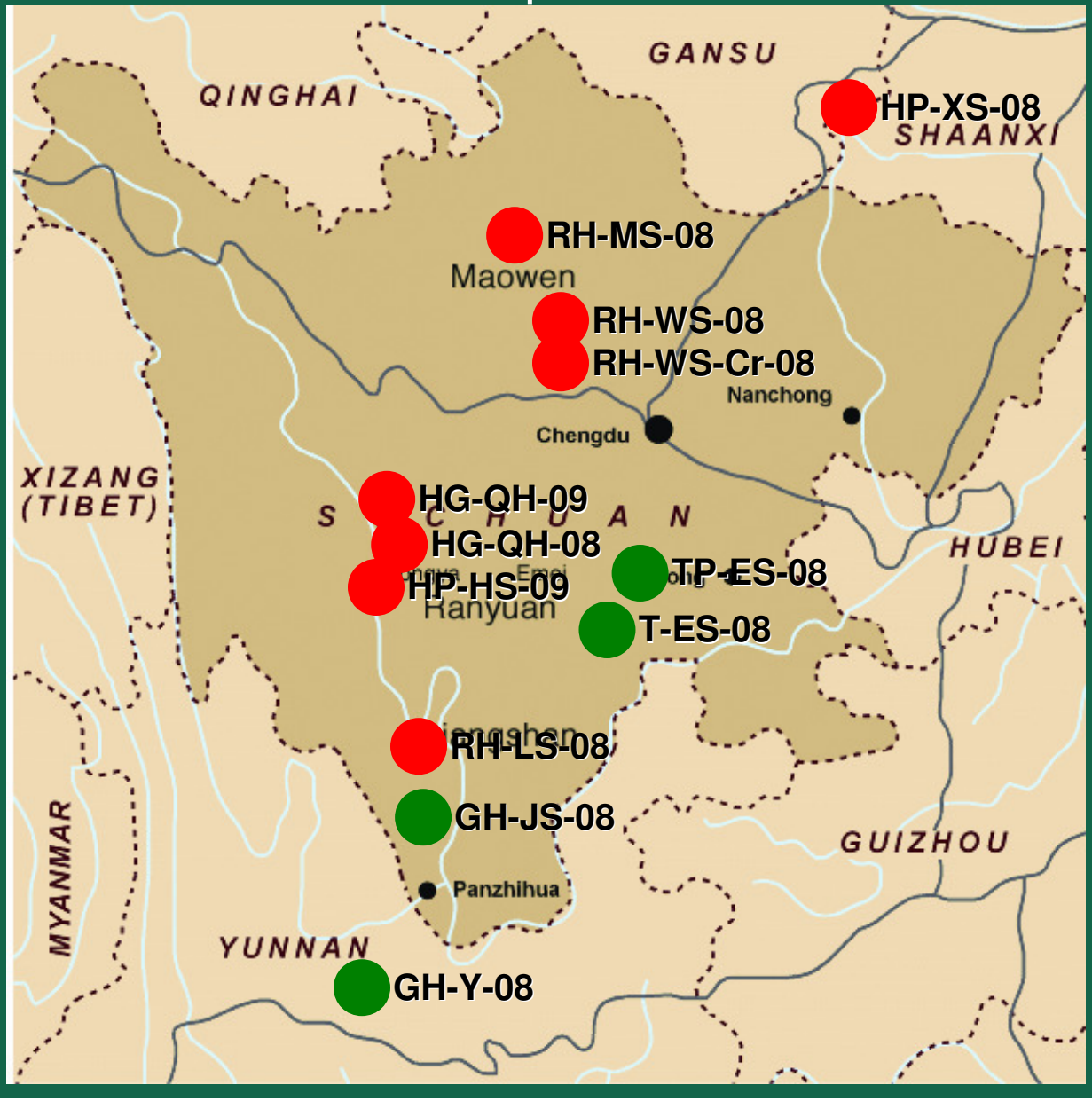
- Method:
  - 26 untrained panelists (17♂/9♀; Avg. age 45; CIA staff, students)
  - samples (blind) placed on 60cm X 60cm sheet: samples with similar aromas close and different aromas far apart
  - perceived aroma attributes recorded; no visual cues

Map of China

Source: Microsoft Encarta (2001), http://www.microsoft.com/products/Encarta

Origin of huajiao samples

Sichuan province



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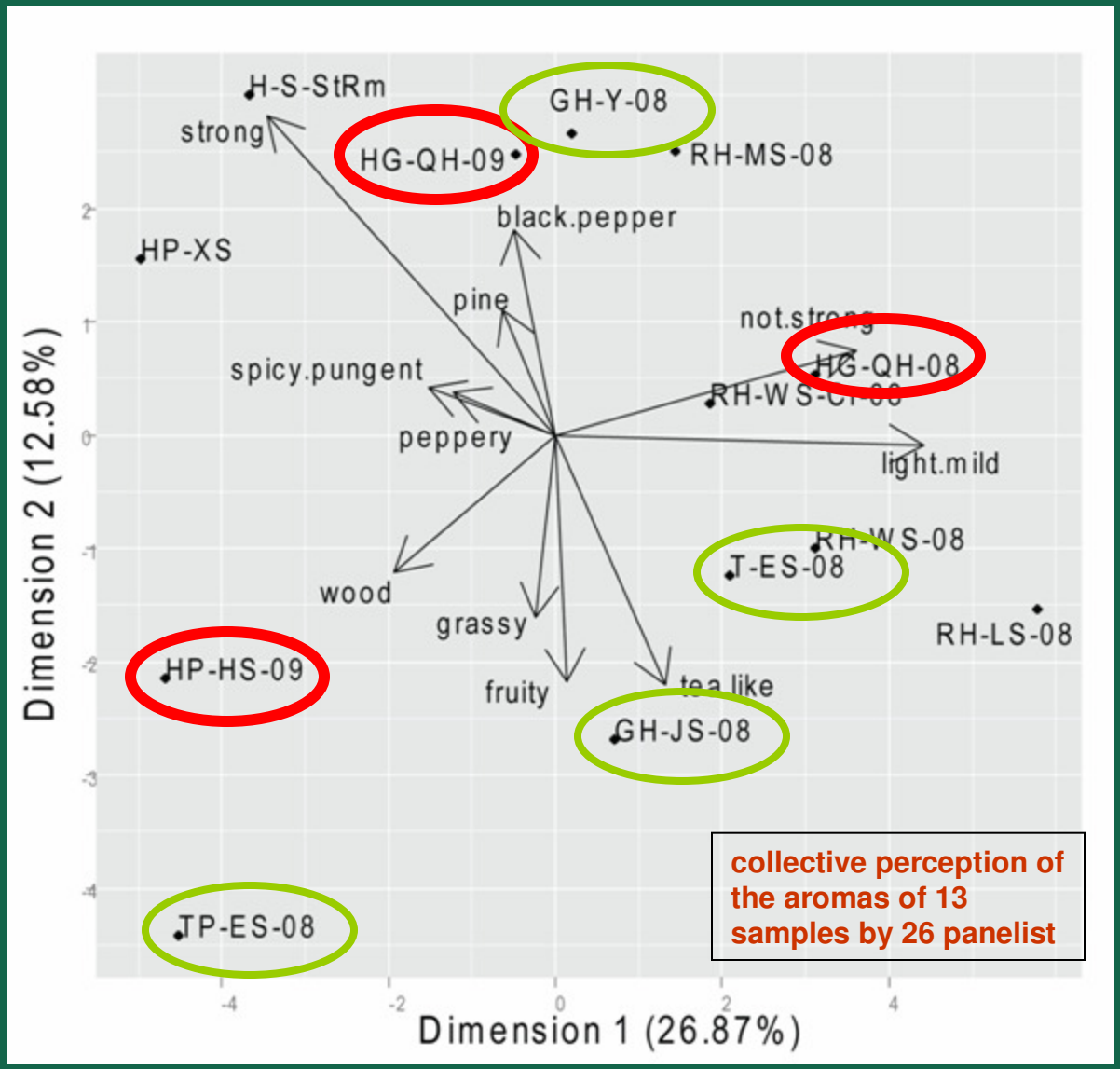
Variability of Huajioa quality

	Weights and measurements					Aroma descriptors						
Sample#	Sample origin and type (year harvested)	Gram/Tblsp. (stdev)	Husk/Tblsp (stdev)	Husk with seeds intact /Tbsp (stdev)	Diameter of husk (mm)	citrus	light/ mild	lemon	pine	tea-like	strong	wood
1	Mao Wen red dry huajiao (2008)	3.6 (0.1)	215 (8)	0	3.76 – 5.18	5	5	6	3	1	2	1
2	Hanyuan red dry huajiao (2009)	3.3 (0.6)	255 (5)	17 (4)	3.38 – 5.08	2	5	6	3	1	2	1
3	Red dry huajiao, distributed in USA (unknown)	3.4 (0.2)	161 (1)	14 (6)	4.09 – 6.60	1	0	1	4	0	8	3
4	Jin Yang green dry huajiao (2008)	4.6 (0.1)	186 (5)	59 (6)	3.68 – 5.82	1	5	2	2	5	0	2
5	Emei green dry huajiao (2008)	3.4 (0.2)	201 (10)	8 (1)	4.12 – 5.66	5	10	4	1	2	0	1
6	Yunnan green dry huajiao (2008)	4.5 (0.1)	188 (4)	67 (11)	3.99 – 5.82	4	5	3	2	2	2	2
7	Hanyuan huajiao powder (2009)	5.6 (ND)	N/A	N/A	N/A	9	1	7	3	2	4	6

Perceptual map of huajiao aromas using napping



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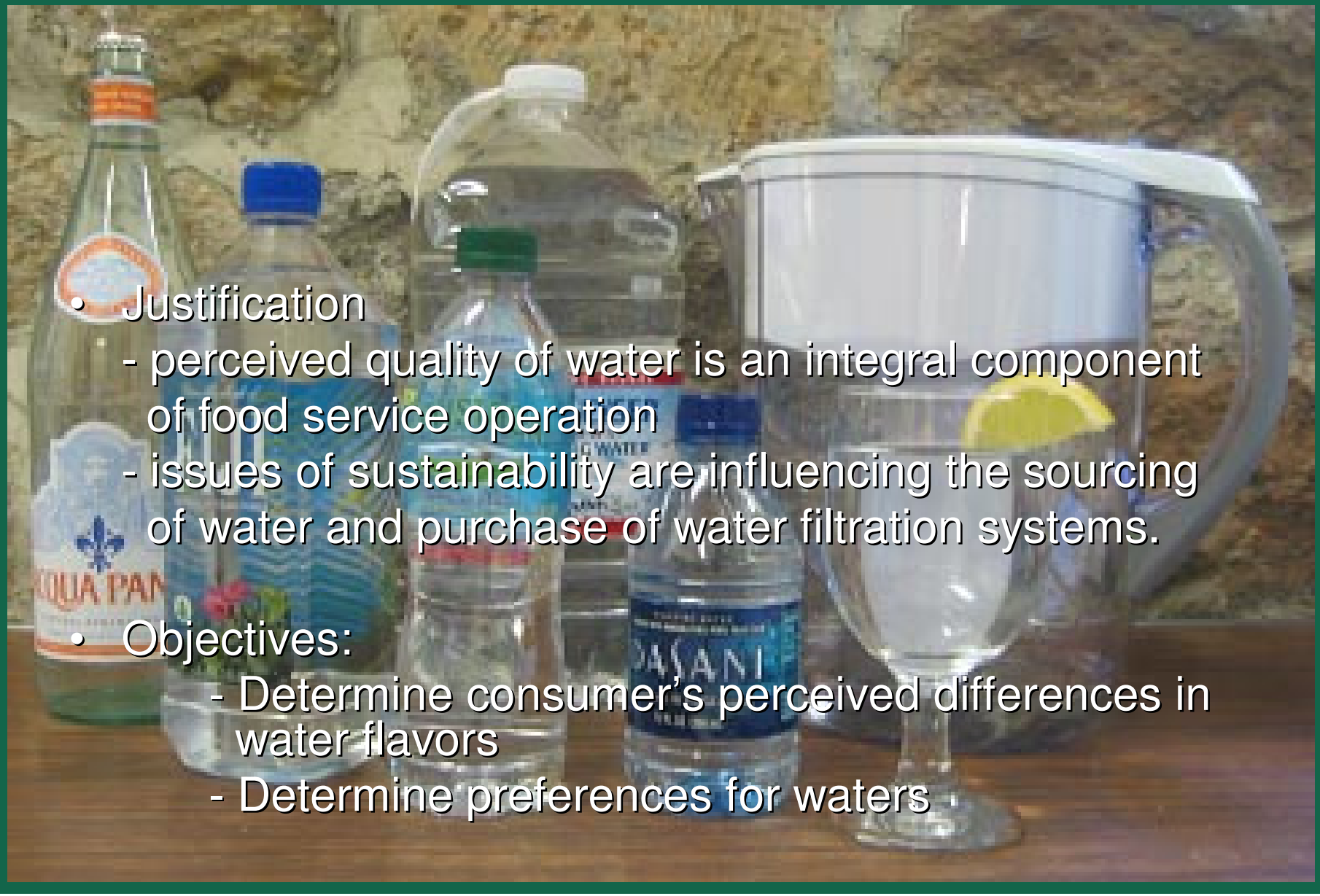
Summary of Huajiao napping

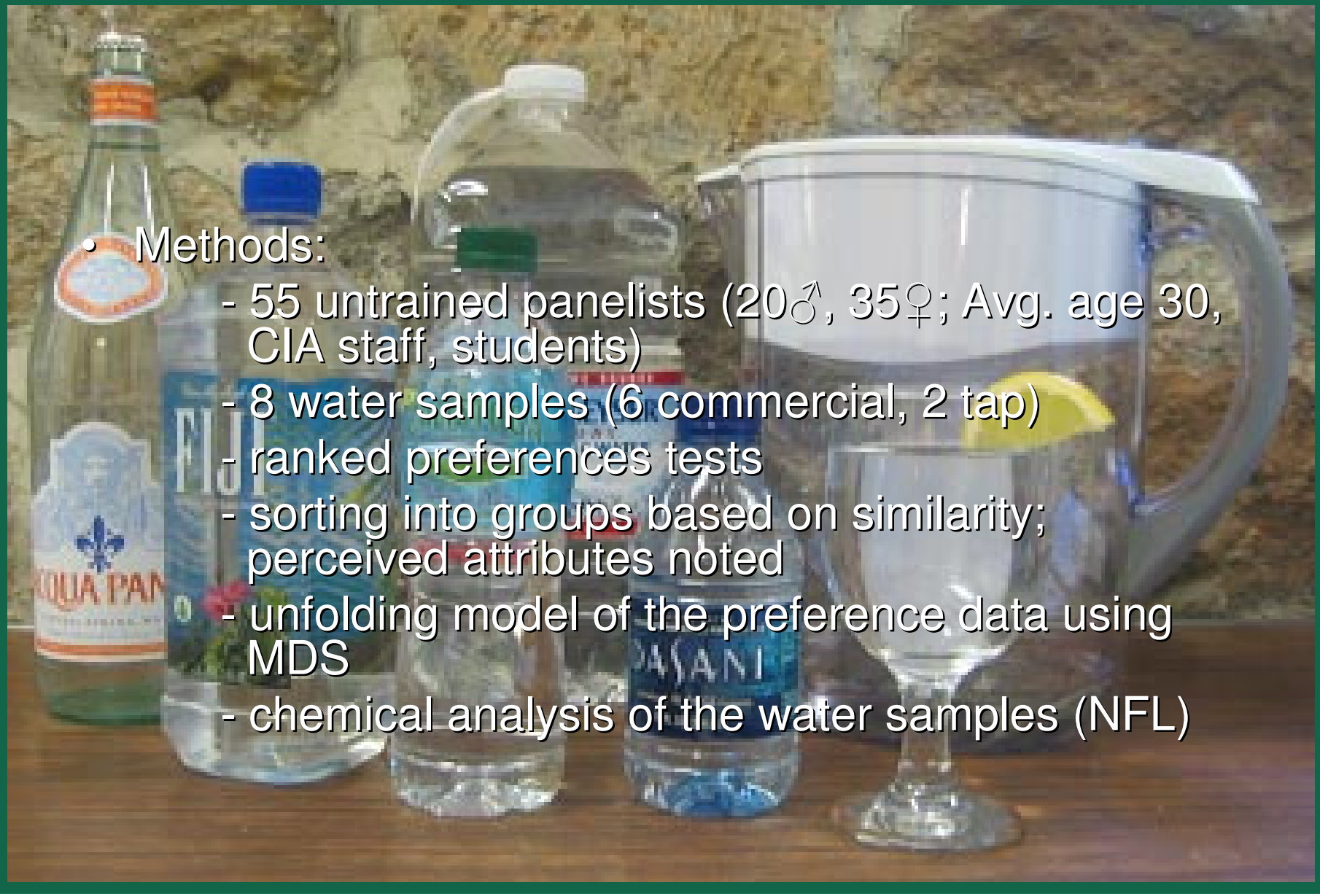
- 39% of the variability amongst 13 samples can be described by 2 aroma dimensions by an untrained panel
- 11 aroma attributes correlate significantly with the samples; dimension 1 being a mild/not strong characteristic.
- Additional dimensions can be explored
- Chefs can use this information to help them incorporate the product's flavor profile into food service and retail applications
- Culinary educators can use this information introduce students to the diversity of a spice that is integral to a major Asian cuisine style

Assessing the flavor differences and preferences for water



- Justification
  - perceived quality of water is an integral component of food service operation
  - issues of sustainability are influencing the sourcing of water and purchase of water filtration systems.
- Objectives:
  - Determine consumer's perceived differences in water flavors
  - Determine preferences for waters

Assessing the flavor differences and preferences for water



- Methods:
  - 55 untrained panelists (20♂, 35♀; Avg. age 30, CIA staff, students)
  - 8 water samples (6 commercial, 2 tap)
  - ranked preferences tests
  - sorting into groups based on similarity; perceived attributes noted
  - unfolding model of the preference data using MDS
  - chemical analysis of the water samples (NFL)

Physiochemical analysis of water samples

Sample	pH	Chloride (mg/l)	TDS (mg/l)	Nitrate (mg/l)	Calcium (µg/l)	Sodium (µg/l)
C1	7.60	9.2	238	0.5	16,000	15,700
C2	7.54	46.4	227	0.6	3,750	44,400
C3	6.09	4	21	0.3	97.8	857
C4	7.42	1.2	110	0.4	5,440	10,100
C5	8.25	8.4	151	0.9	30,200	6,710
C6	6.06	0	0	0	0	0
T	7.14	8.2	106	0.3	4113	13067
FT	6.51	8.35	100	0.3	250	12650

Ranked preferences for 8 waters revealed 2 major product segments

Water	Rank sum
C4[a]	199
C3[a]	206
C5[a]	214
FT[a]	218
C1[a]	228
C2[a,b]	274
C6[b,c]	310
T[c]	367

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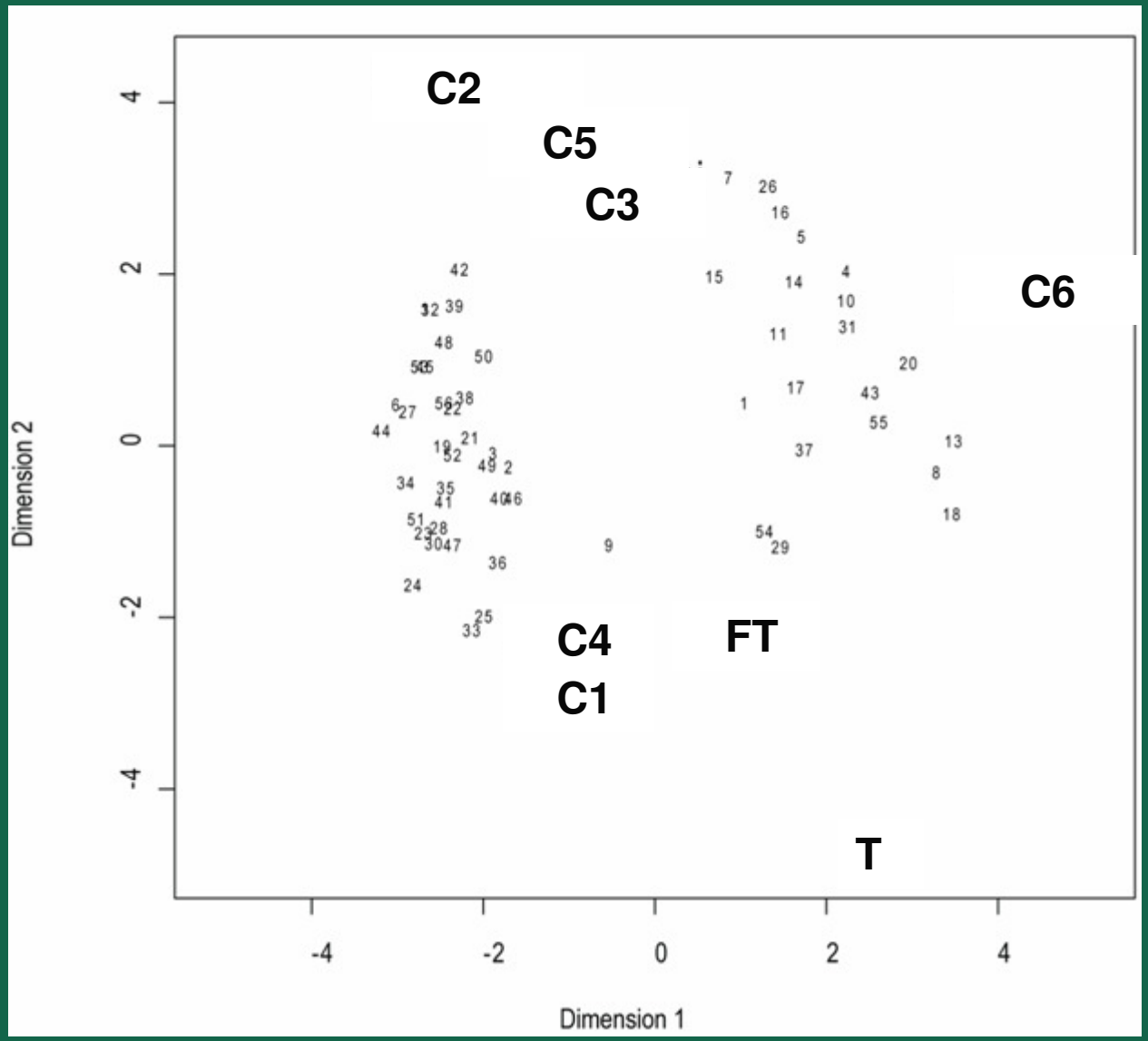
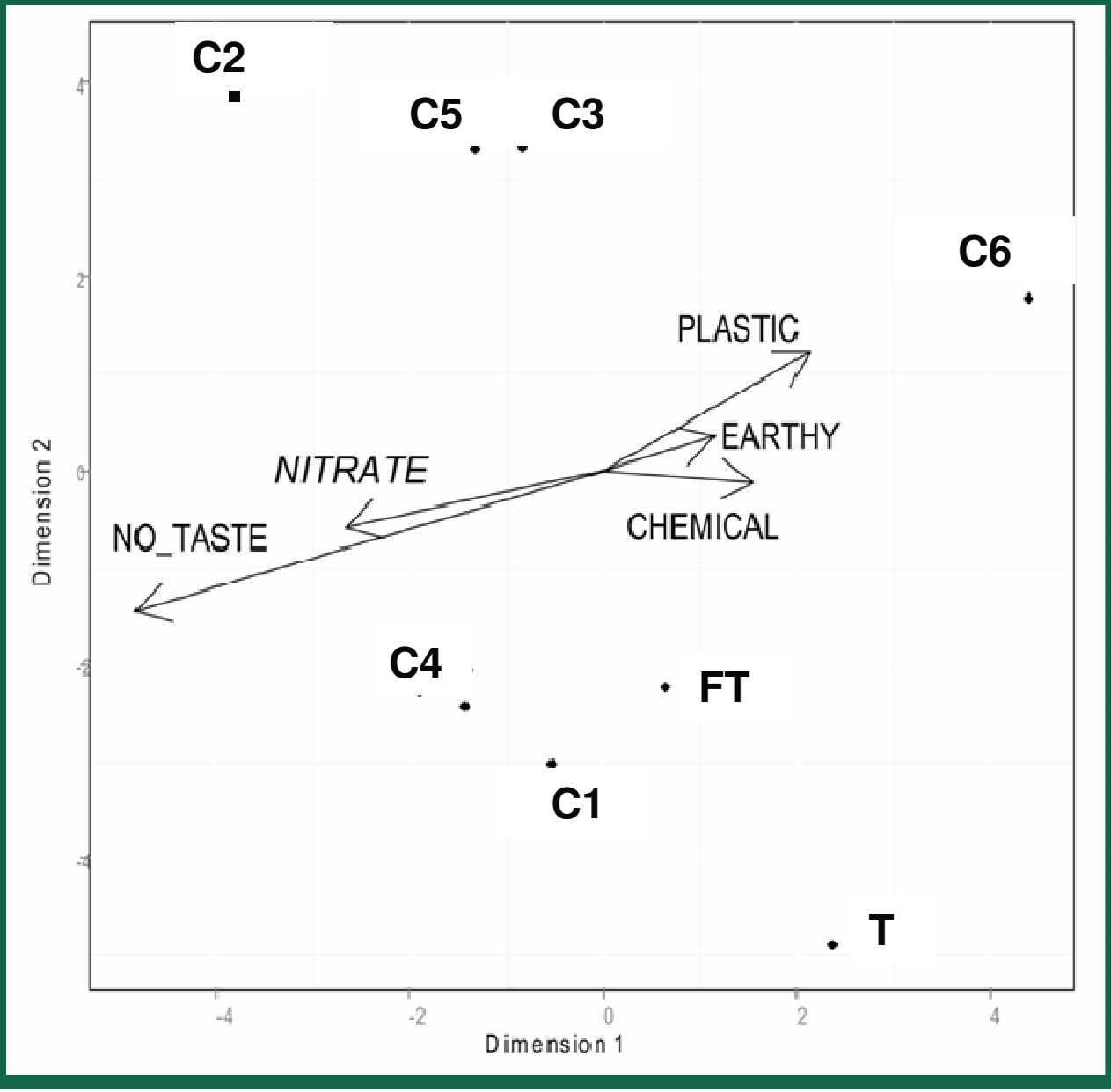
Waters with different superscripts are significantly different ($p<0.05$)

Joint configuration plot of waters and panelists based on preference



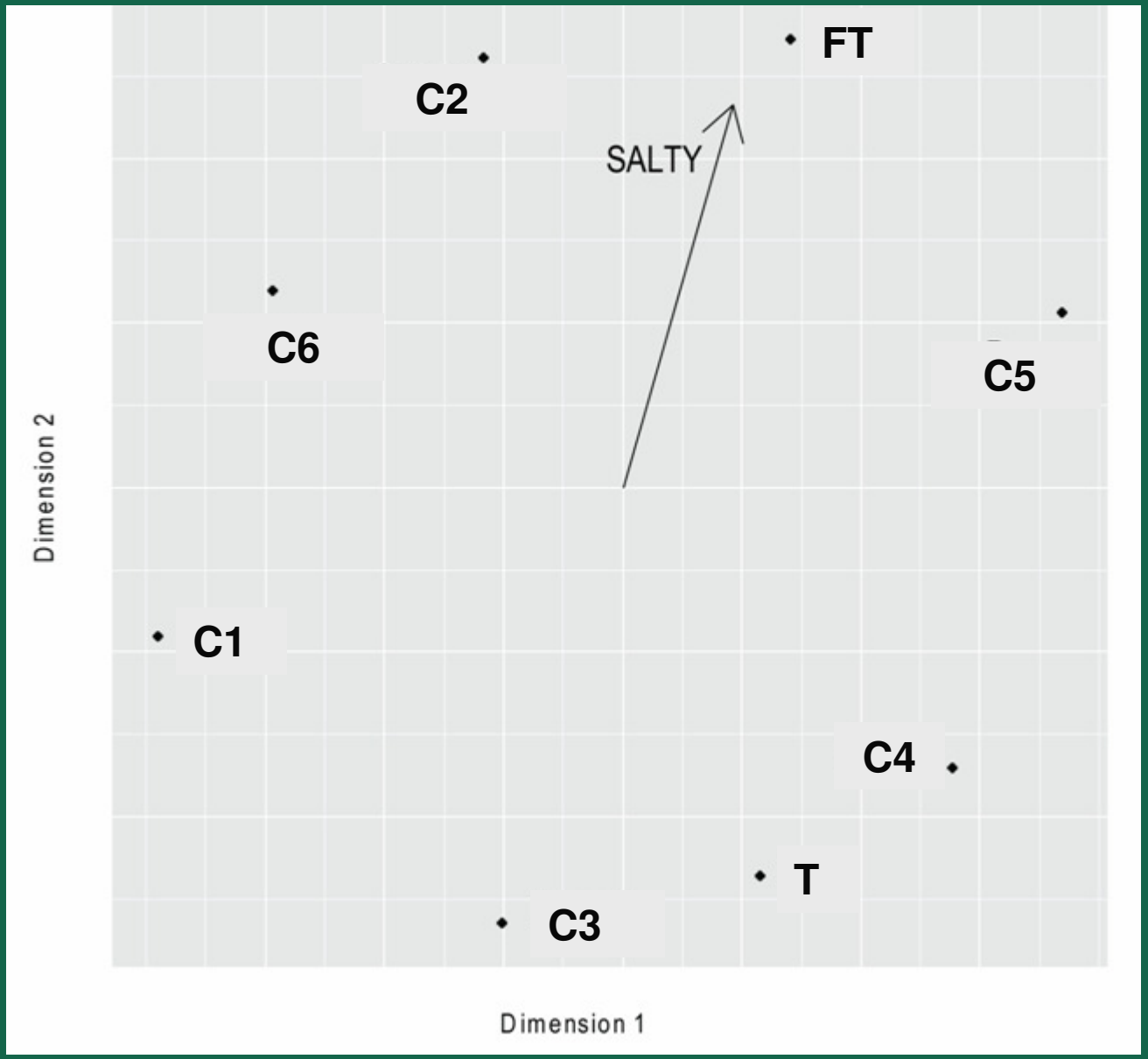
Consumers (small #'s) plotted near waters they prefer

Attribute regression



Consumers divided into 2 major groups those that prefer no-taste/nitrate and those that prefer plastic/earthy/chemical

Sorting of waters and significant (p<0.02) consumer perceived attribute



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Summary of perceptual mapping of water

- Two consumer segments were revealed with regard to preferences for drinking waters
- Besides dissolved nitrates, none of the physiochemical components were associated with consumer perceptions of water flavor
- Filtration of tap water significantly changes consumer perception of preferences

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Summary

- Perceptual mapping revealed that huajiao samples have significant aroma characteristics that distinguish them from each other
- Consumer segments related to preferences for water were revealed through perceptual mapping that would not have been revealed by standard preference ranking analysis.
- Culinary educators and professionals can use perceptual mapping to gain insight into the flavors of their ingredients and their consumers.
- Perceptual mapping provides a method for measuring perceived differences between foods without extensive training of panelists to develop descriptors
- Perceptual mapping generates a lot of data and requires extensive analysis

Acknowledgments

Lauren Koller

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For more information on culinary research at The CIA:
http://menuscience.ciachef.edu/research/mrfdi