Sensory Characteristics and Consumer Acceptance of Mechanically-harvested California Black Olives (2008-2009)

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Outline

I. Design of the study
   a) Design of the study and specific aims
   b) Materials (Sampling)

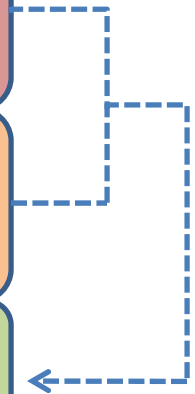**II. Descriptive Analysis (DA)**
   a) Methods
   b) Results & Findings

III. Consumer Acceptability test
   a) Methods
   b) Findings

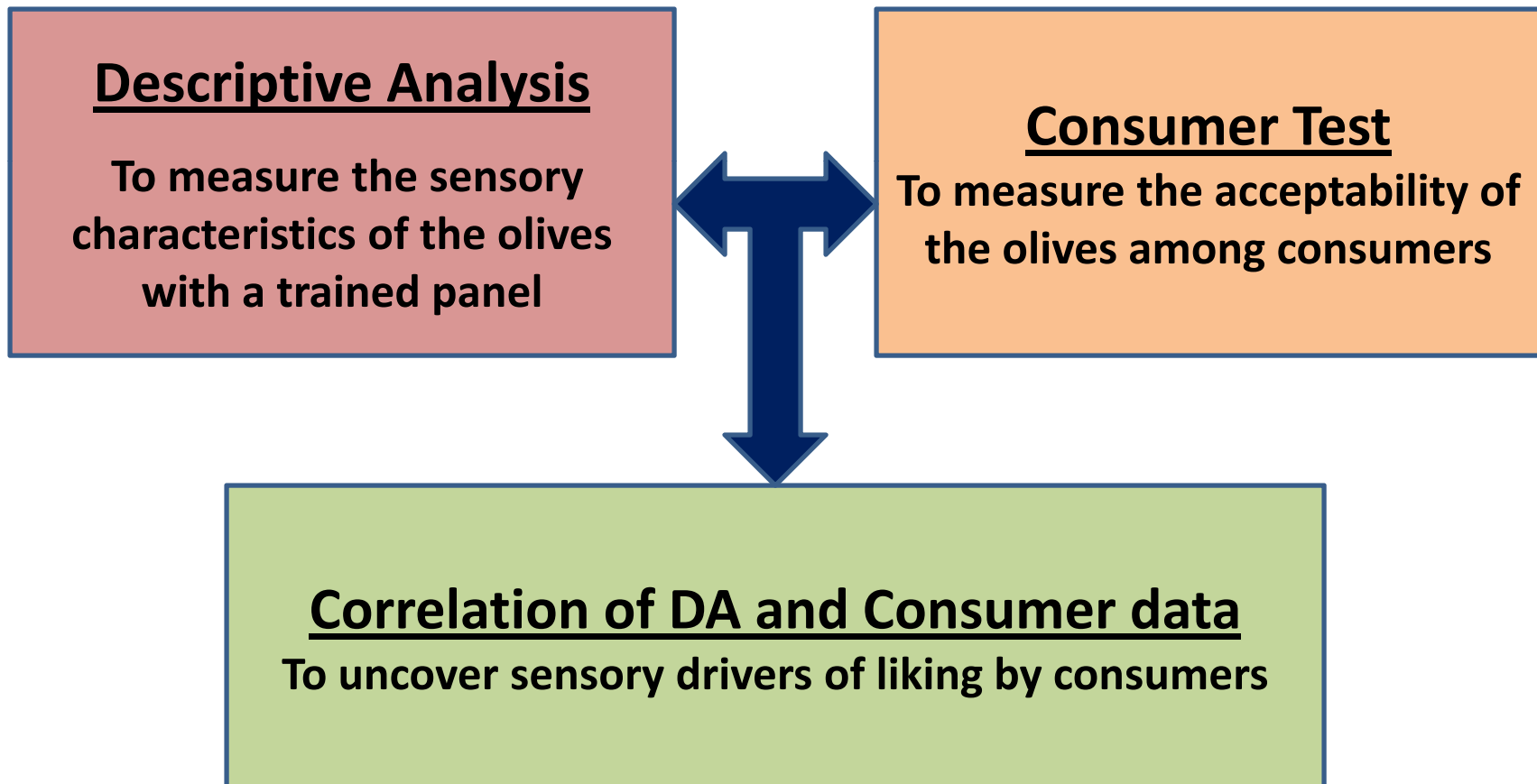**IV. Correlation of Descriptive Analysis and Consumer data**
   a) Findings

V. Conclusions of the study

Design of the study

a) Design of the study and specific aims

<u>Descriptive Analysis</u>

To measure the sensory characteristics of the olives with a trained panel

<u>Consumer Test</u>

To measure the acceptability of the olives among consumers

<u>Correlation of DA and Consumer data</u>

To uncover sensory drivers of liking by consumers

Materials (Experimental design and sampling plan)

| Row #1 | Row #2 | Row #3 | Row #4 | Row #5 | Row #6 |

Each row was randomly assigned to either "hand harvest" or "machine harvest" — **Harvesting method**

x

Half were treated at "Processor A" and the other half at "Processor B" — **Processor** ⟶ "Commercial olives" from each Processor

x

Half were processed as "fresh olives" and the other half as "stored olives" — **Processing method**

8 differently treated olives/ row	2 commercial olives
*Olives from different rows (#1-6) which went through the same treatment were **pooled together**	*The olives were standard products to be compared against mechanically-harvested ones

Table 1. Ten olive samples

Sample abbreviation	Processor	Commercial	Harvesting method	Processing method
A_Comm	A	Commercial	-	
A_Hand_F		-	Hand	Fresh olives
A_Hand_S				Stored olives
A_Mach_F			Machine	Fresh olives
A_Mach_S				Stored olives
B_Comm	B	Commercial	-	
B_Hand_F		-	Hand	Fresh olives
B_Hand_S				Stored olives
B_Mach_F			Machine	Fresh olives
B_Mach_S				Stored olives

Descriptive Analysis

To quantify the sensory attributes of the olives

Methods

- **Panel**: 8 trained panelists (2M, 6F; from U.C. Davis, CA, USA)
- **Training sessions**:
  - The panel developed 31 descriptors and selected references for flavor-related attributes (Table 2).
  - Concept alignment was achieved through group and individual training sessions.

Methods (Continued)

- **Individual Evaluation**: in triplicate
- **Presentation order:** Randomized complete block design
- **Serving**: 3 olives/ cup (i.e. 2 whole olives + 1 olive sliced in half), at room temperature (20°C)
- **Scale**: line scale with labels at each end of the scale (e.g., 'low' and 'high'or 'dull' (low end) and glossy (high end) for 'glossy' attribute).

Methods (Continued)

Table 2. Descriptors for olives

	Attribute	Reference		Attribute	Reference
Smell (Aroma)	Painty	Correction fluid	**Taste/ Flavor**	Sweetness	Sucrose solution
	Briny	Black olive brine		Saltiness	Na Cl solution
	Ocean-like	Green seaweed + anchovy*		Umami	MSG + brine
	Fermented	Sauerkraut		Bitterness	Caffeine solution
	Canny	Keys, cans		Roasted	Roasted sunflower seeds
	Earthy	Potting soil*		Buttery	Melted butter + brine*
	Sautéed Mushroom	Sautéed Mushroom*		Ripeness	Unripe ---- Ripe
	Dried Fruit	Dried Prune	**Texture/ Mouthfeel**	Firmness	
	Floral	Chrysanthemum tea		Juicy/ Moist release	
Appearance	Size	Small ---- Large		Crumbly	
	Oval	Round ---- Oval		Fibrous	
	Surface roughness	Smooth ---- Rough		Mouth coating	
	Glossy	Dull ---- Glossy		Briny after-taste	
	Skin brownness	Black ---- Brown		Lasting flavor	
	Flesh Brownness	Black ---- Brown		Astringent	
	Flesh greenness	Black ---- Green			* Mixed with olives

Reference samples

'Earthy'
= Soil + olives

'Ocean-like'
= Green seaweed +
anchovy + olives

Descriptive Analysis Results

- We can use multivariate statistics (e.g., principal component analysis) to **compare the samples across all sensory attributes** and to produce a map of the samples in relation to the sensory attributes in the descriptive analysis (i.e., a **sensory map**).

- This analysis shows that **there was no difference in the sensory profile of the olives between harvesting methods**.

Principal component analysis of the descriptive analysis data showing the attributes (axes D1 and D2: 80.29 % of variance)
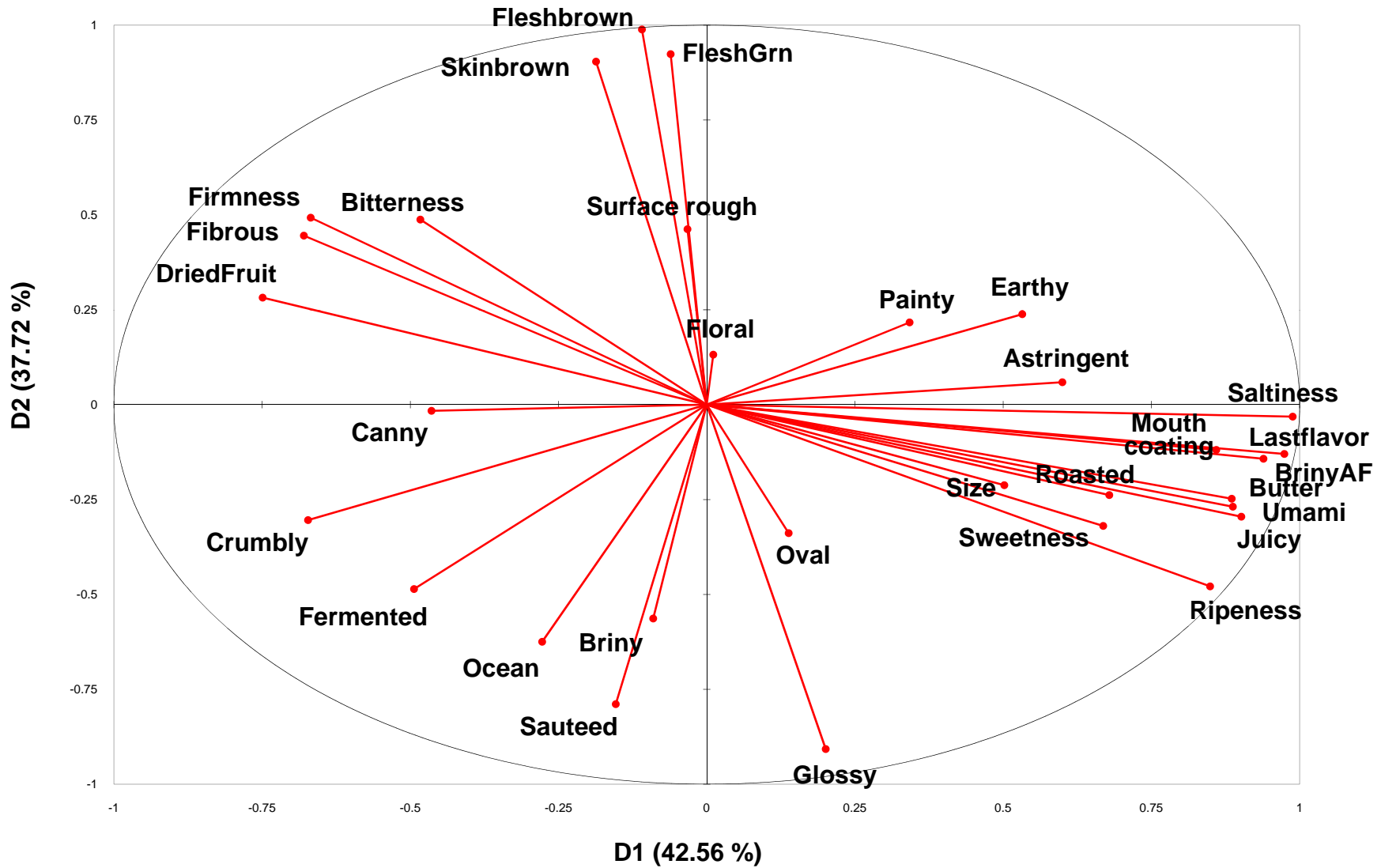
Results. Principal component analysis of the descriptive analysis data showing the products (axes D1 and D2: 80.29% of variance)
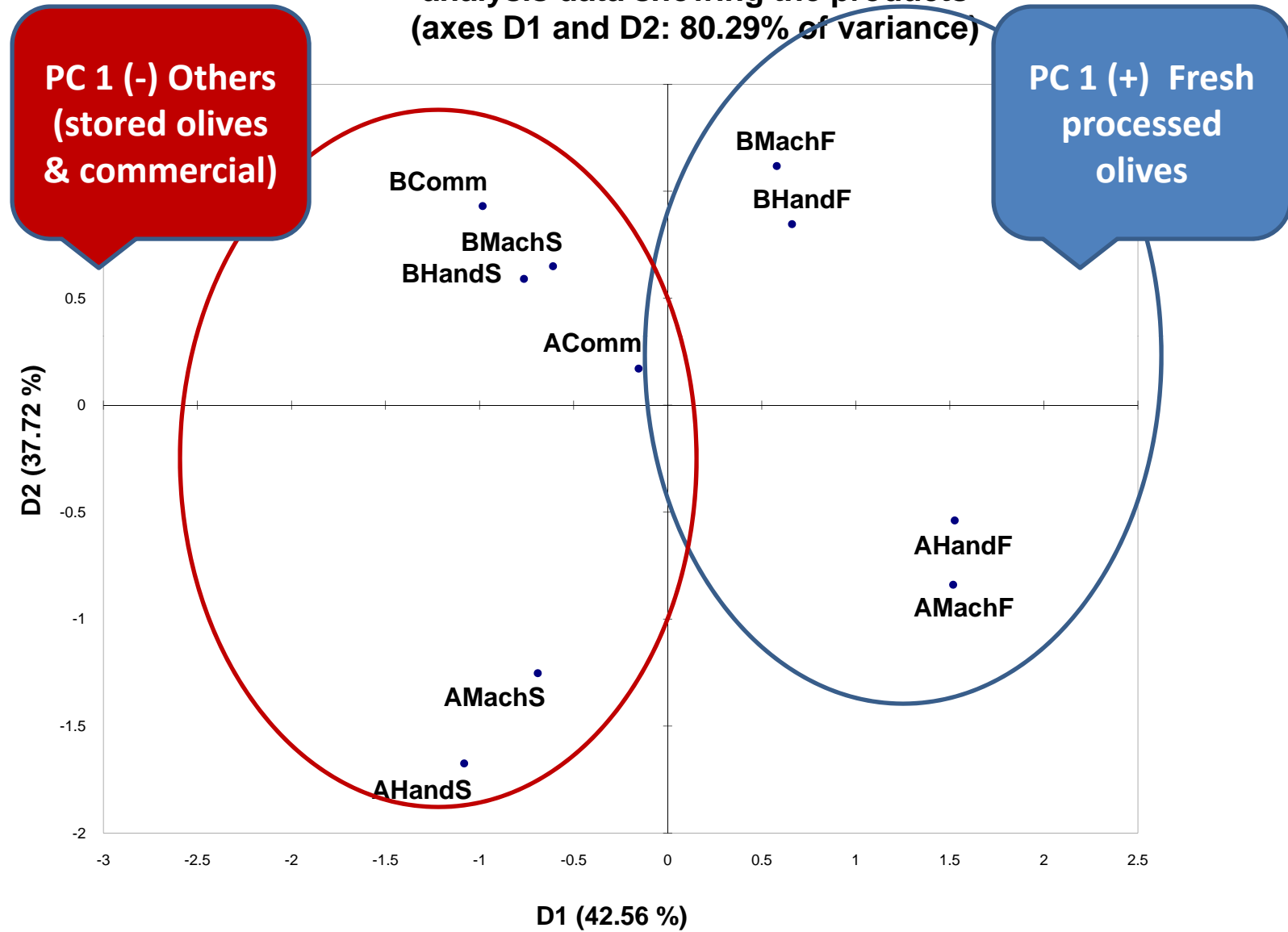
Results. Principal component analysis of the descriptive analysis data showing the products (axes D1 and D2: 80.29% of variance)
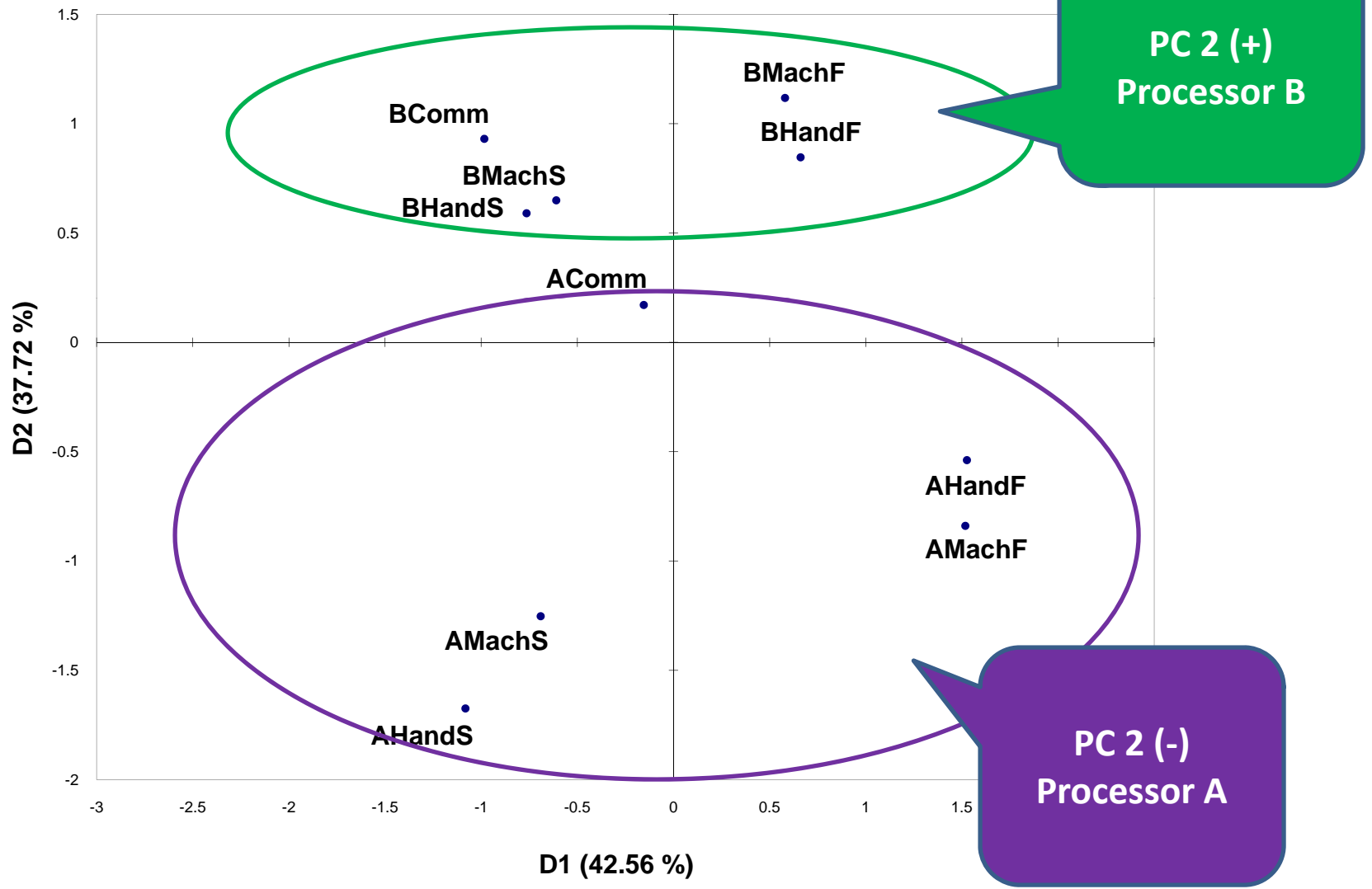
Results. Principal component analysis of the descriptive analysis data showing the products (axes D1 and D2: 80.29% of variance)
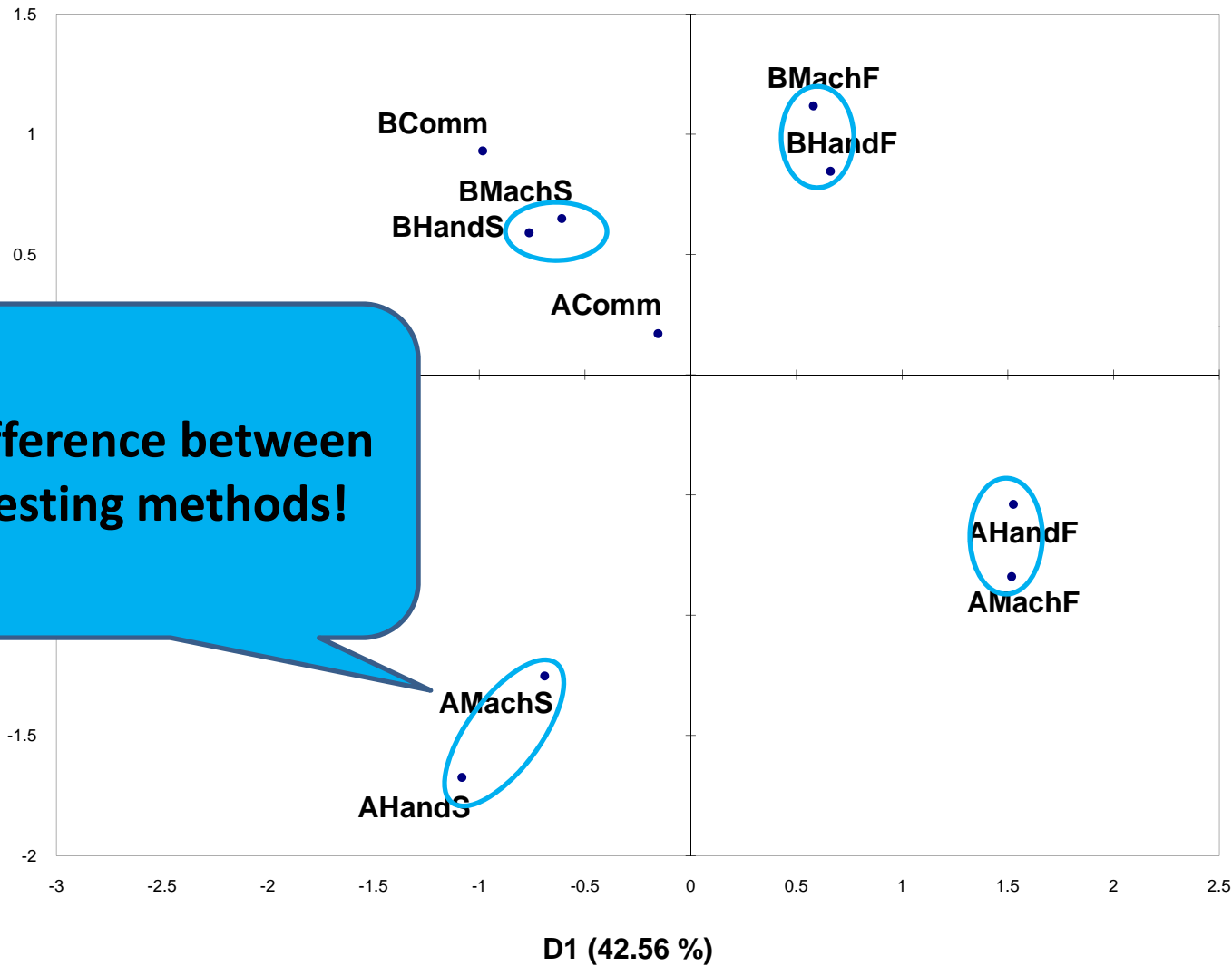
Descriptive Analysis Results (Continued)

	In the principal component biplot, the axis contrasts…
PC 1 (+)	Saltiness, Umami, Buttery, Ripeness Briny after-taste, Lasting flavor Juicy, Mouth-coating
PC 1 (-)	Dried Fruit Firmness, Fibrous, Crumbly
PC 2 (+)	Colors (skin brownness, flesh brownness, flesh greenness)
PC 2 (-)	Sautéed Mushroom, Ocean-like, Briny, (slight) Fermented Glossy

Descriptive Analysis Results (Continued)

- The biggest difference was seen between **processing methods** - fresh processed vs. others (commercial & stored), primarily along PC 1.

- A **processor difference** was observed as the next biggest source of variation, primarily along PC 2.

- The difference between **harvesting methods** was minimal!

- **Surface roughness** was the only sensory attribute for which a significant ($P<0.05$) difference was found between hand- and machine-harvested olives.

Consumer Test

To measure the acceptability of the samples among American consumers

Methods

- Dates: Tested on Picnic day at UC Davis (April 18th) and from June 25th to July 3rd
- N = 100
- Recruitment pool: Picnic Day visitors and Davis Farmers' Market customers
- Screening criteria

Over 18 years of age

American or US Resident

Users and likers of black olives

Methods (Continued)

- Tested 11 samples (10 treatments + 1 primer)

  Note that the first sample was used as a primer to avoid 'first order effect' (i.e., people tend to rate the first sample higher)
- Presentation order: Randomized complete block design
- Rated: **Overall degree of liking**

  Liking for appearance, flavor (taste and smell) and texture
- Scale: modified 9-point hedonic scale
- Exit Survey (Usage and Demographics questions)
- Serving: 2 whole olives/ sample @ Room Temp (20 °C)

  Crackers and water were provided for cleansing palate.

*Due to some missing data points, Least Square means were used for imputation.

Consumers were seated and brief instructions were given

Then consumers evaluated the olive samples.

Sample presentation (with crackers and water for rinsing palate)

When the test was done, we gave them some goodies and thanked them for their participation.

Results (N=100 consumers)

Fig. III-1. Overall degree of liking
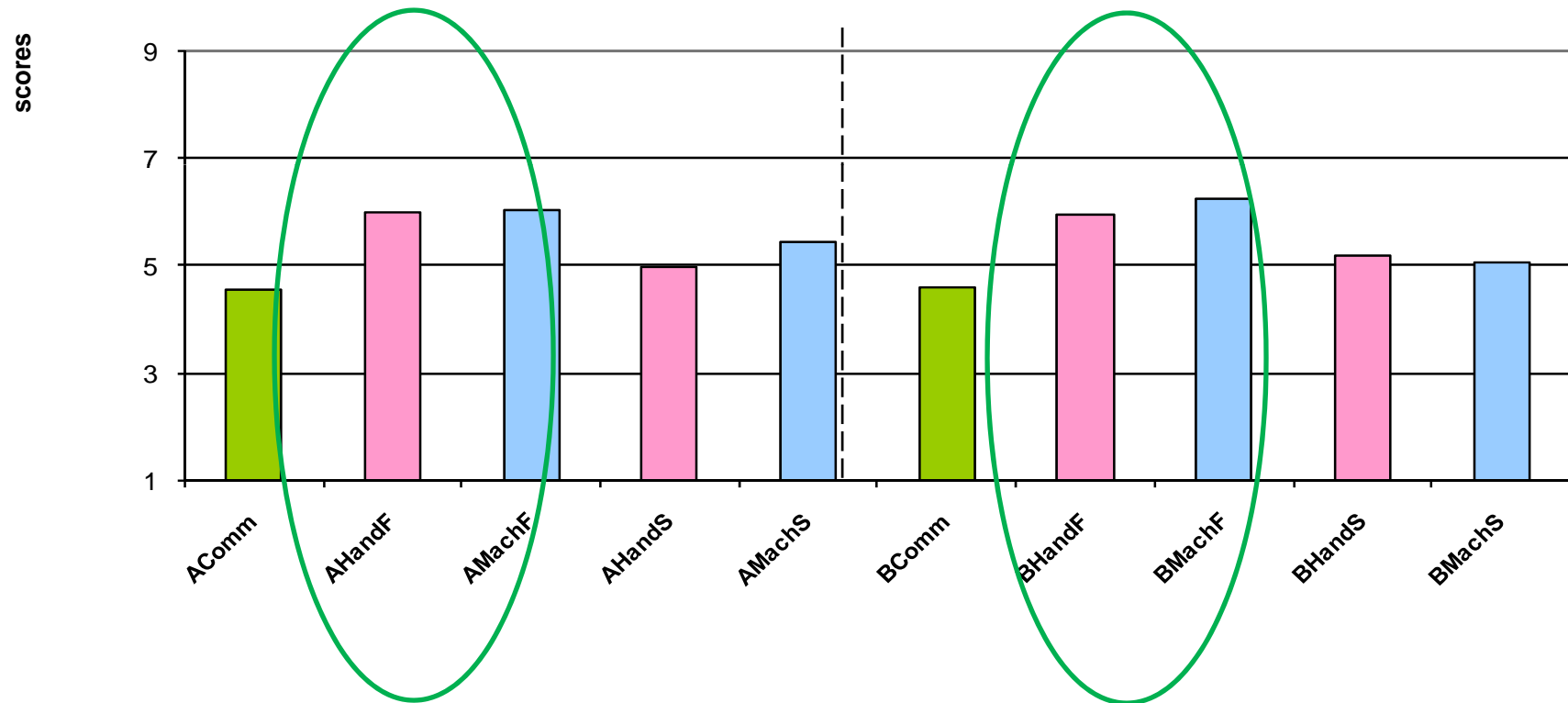
On average, fresh processed black olives
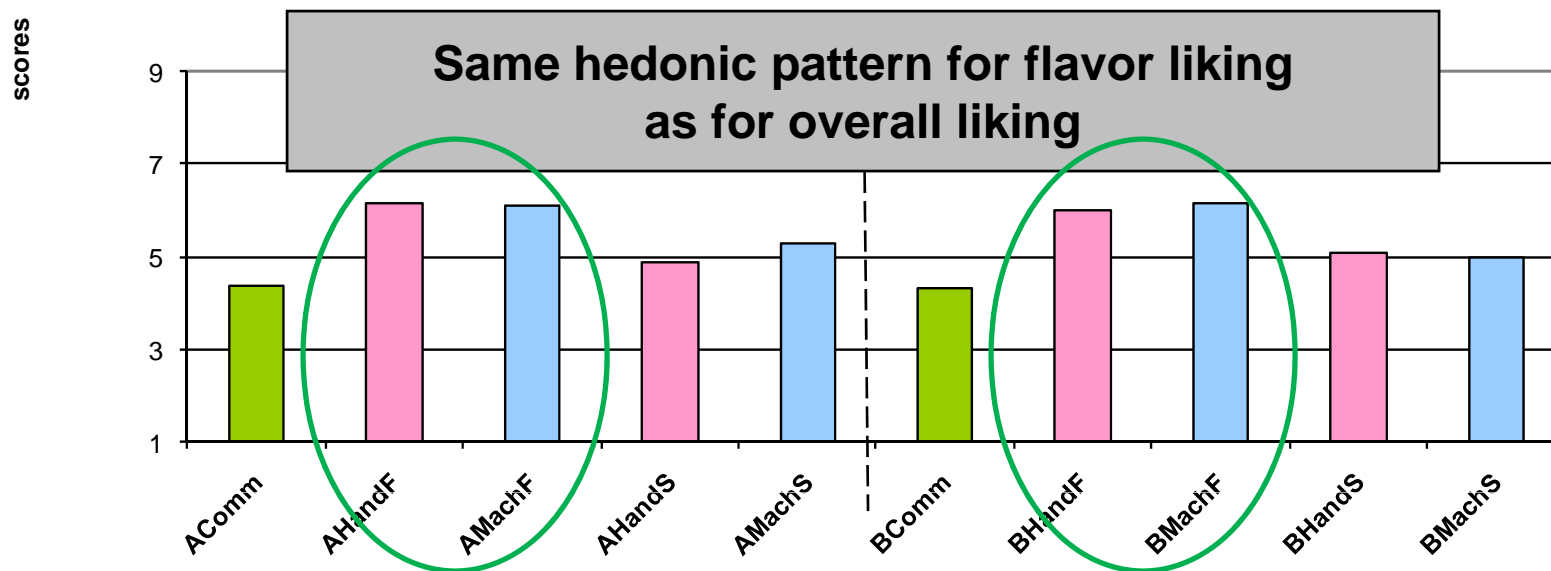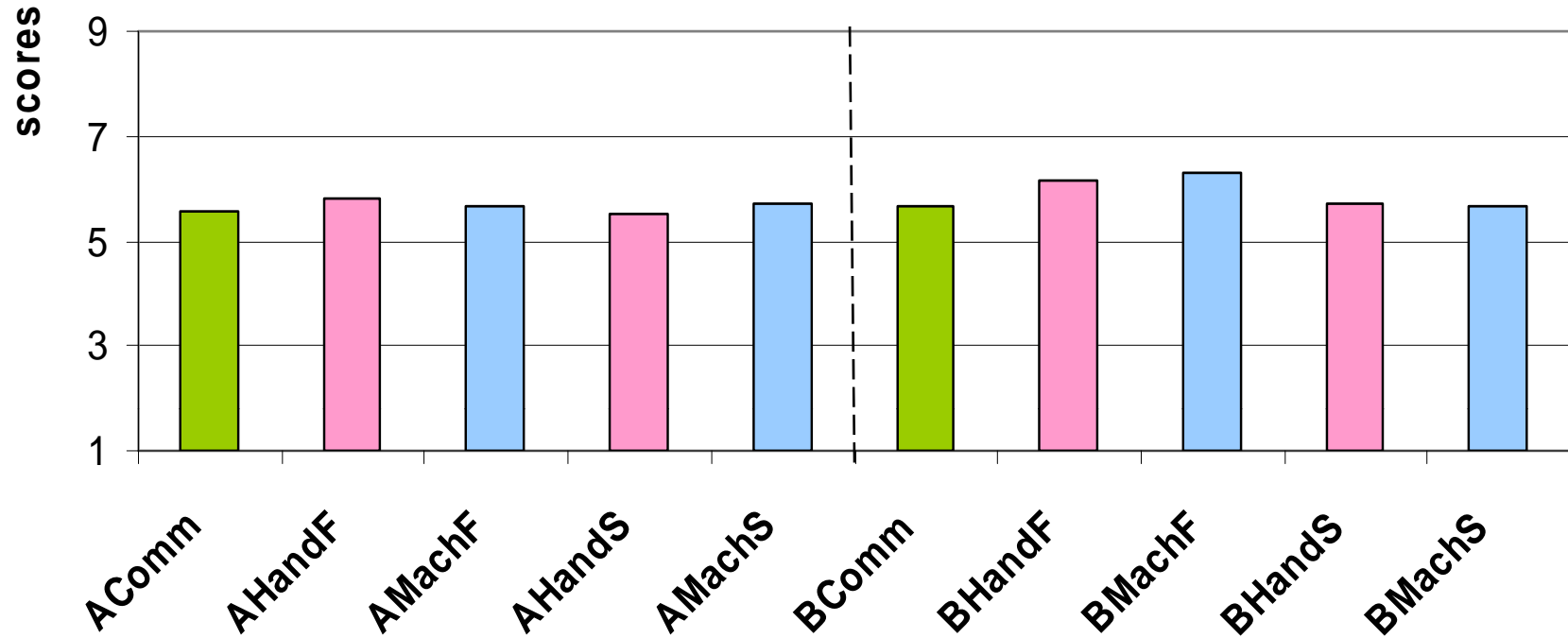were liked the most.

Fig. III-2. Appearance liking

No significant difference was observed among the olive samples for appearance liking.

Fig. III-3. Flavor liking

Same hedonic pattern for flavor liking as for overall liking

AComm AHandF AMachF AHandS AMachS BComm BHandF BMachF BHandS BMachS
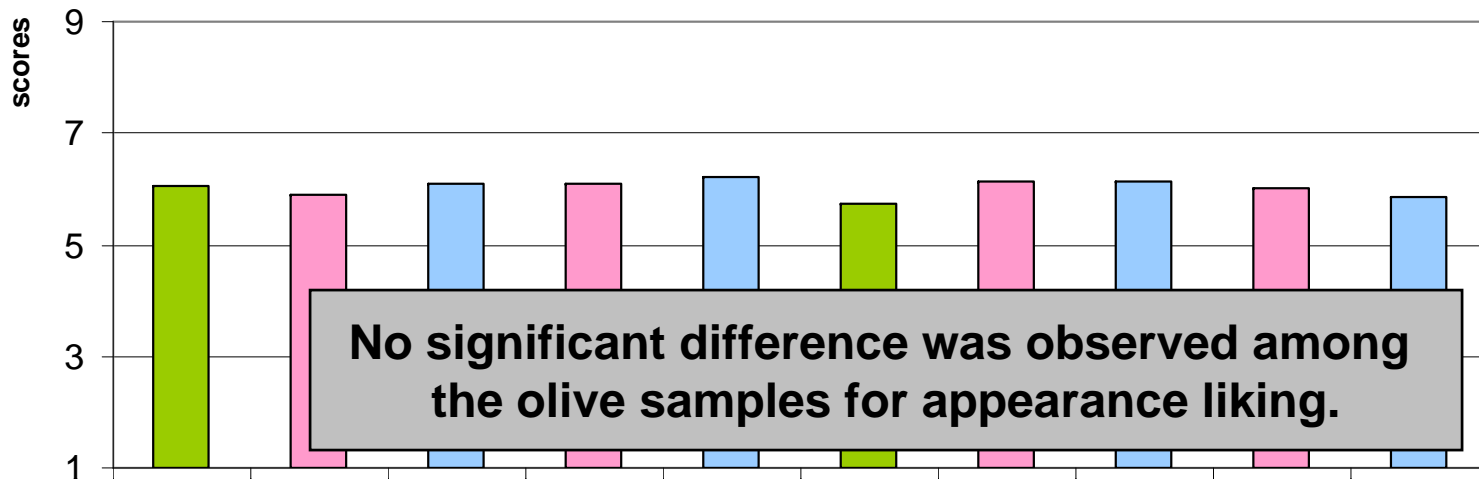
Fig. III-4. Texture liking

No difference was observed among the samples
for texture liking except for a slightly higher liking for
'Fresh processed' and 'Processor B' olive textures.

Correlations between overall degree of liking and liking for specific attributes

Variables	overall liking	app liking	flavor liking	texture liking
overall liking	**1**	**0.457**	**0.861**	**0.648**

Values in bold are significantly different from 0 with a significance level alpha=0.05

Internal preference map of 100 individual consumers based on overall degree for liking for 10 olives
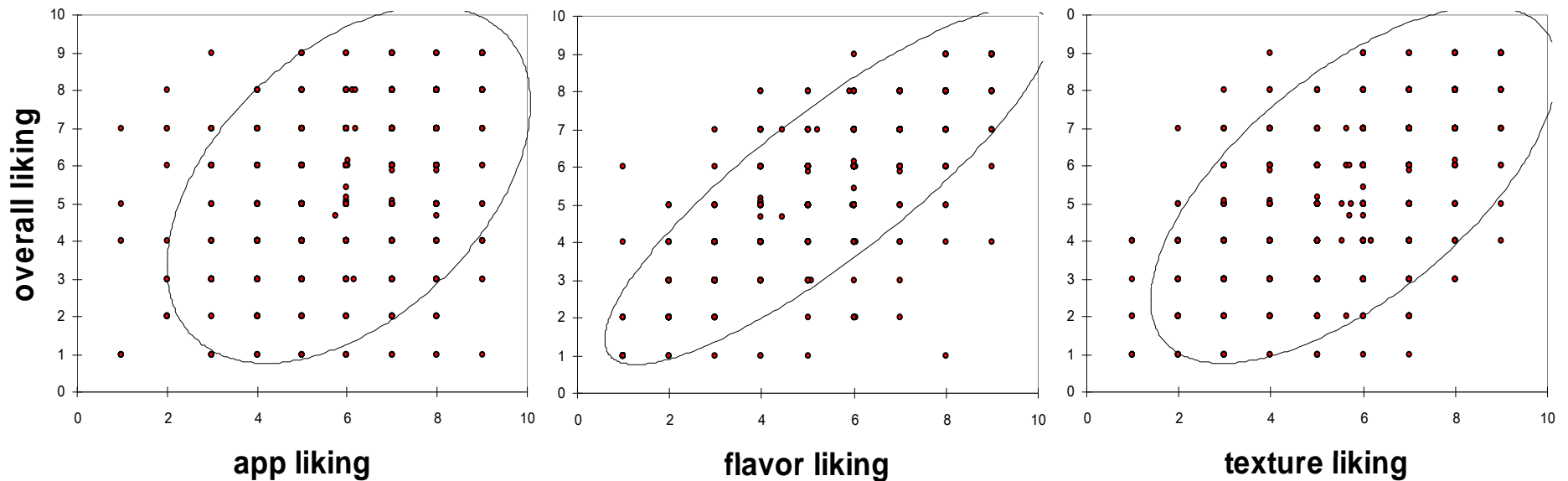
Variables (axes F1 and F2: 41.45 %)
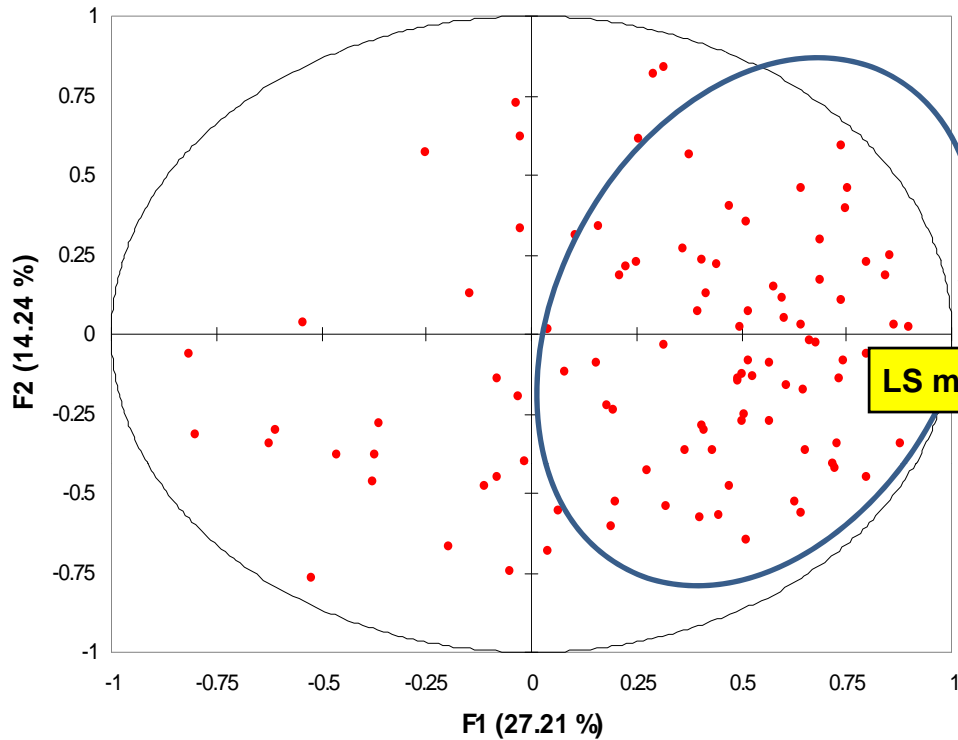
F2 (14.24 %)

LS mean

(27.21 %)

Observations (axes F1 and F2: 41.45 %)

AComm

BComm

AHandF

AMachF

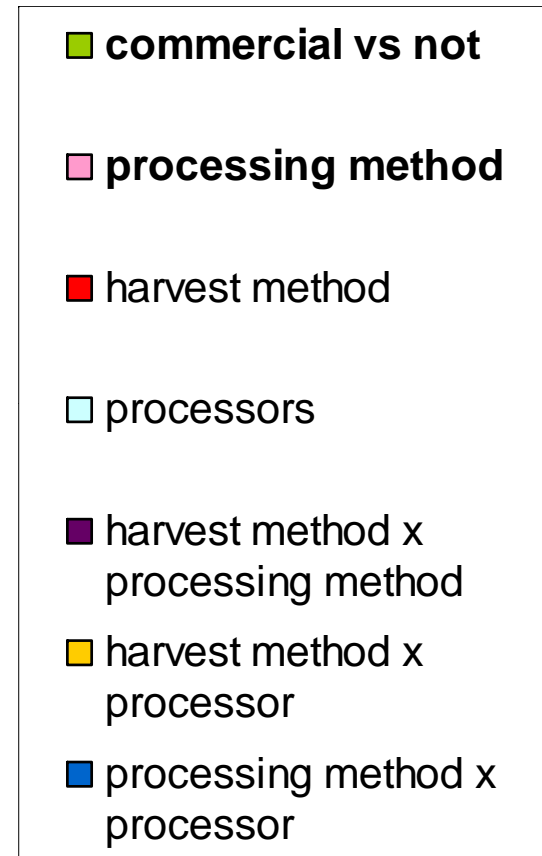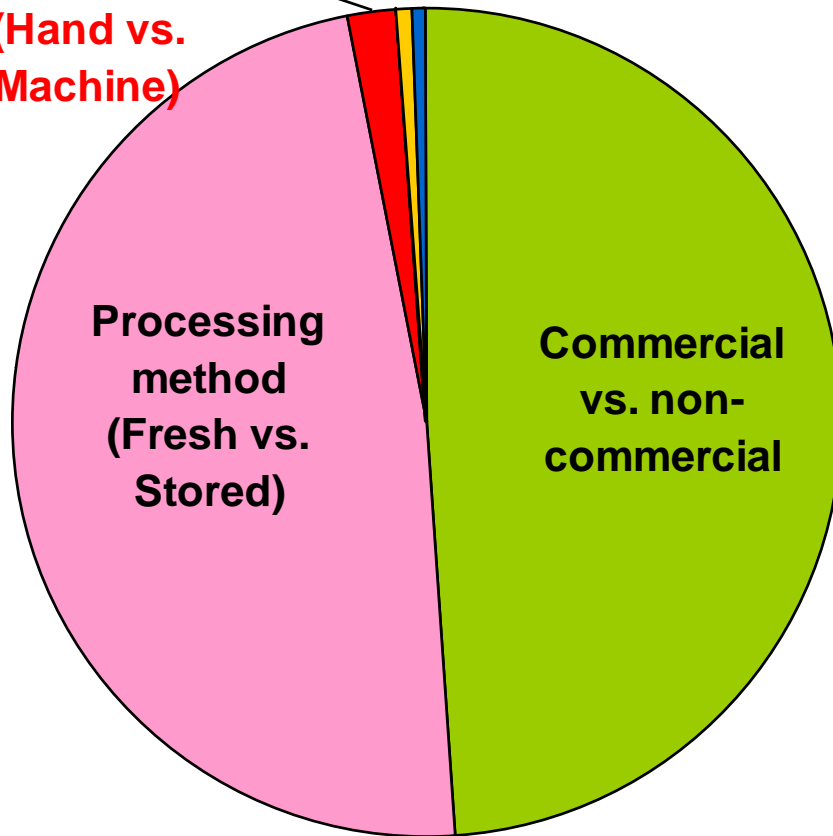BHandS

BMachS

BMachF

AHandS

BHandF

AMachS

F1 (27.21 %)
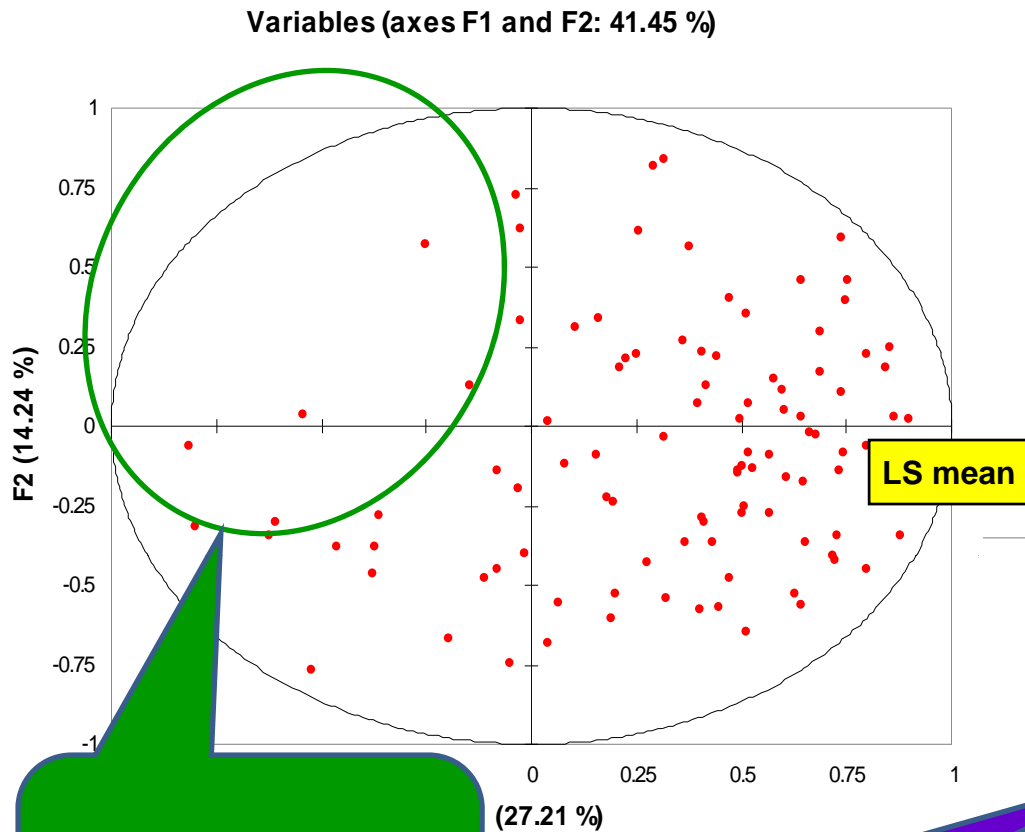
Few consumers in this area

Commercial olives were liked the least
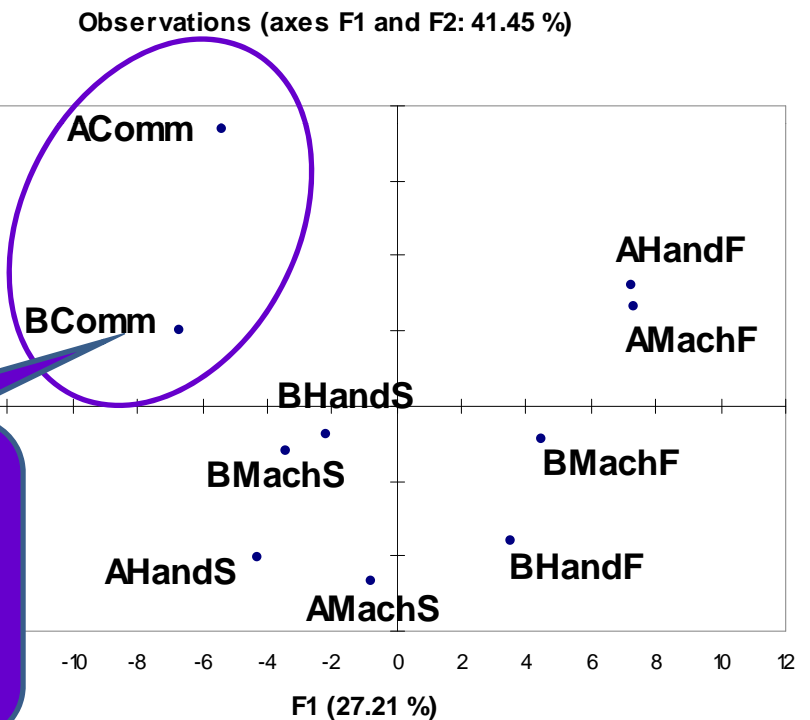
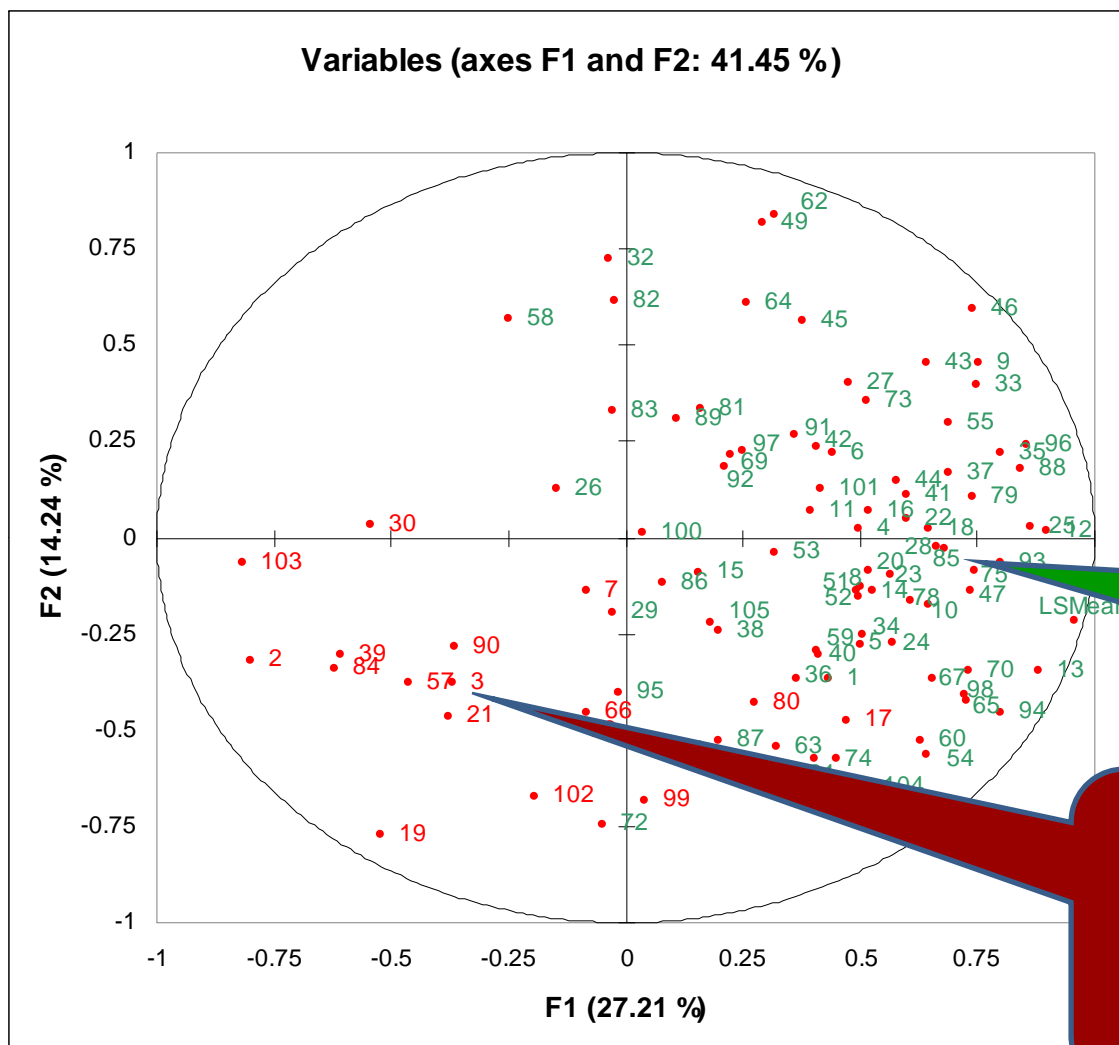Internal preference map of 100 individual consumers based on overall degree of liking for 10 olives

Harvest method (Hand vs. Machine)

Processing method (Fresh vs. Stored)

Commercial vs. non-commercial

Legend:
- commercial vs not
- processing method
- harvest method
- processors
- harvest method x processing method
- harvest method x processor
- processing method x processor

Partitioning of product variance (F-value) for overall degree of liking (N=100)

Results (Continued)

- A majority of consumers liked olives that were **<u>fresh</u>** processed vs. others (commercial & stored before processing)

- **<u>Commercial</u>** olives were liked the least.

- Flavor liking had the highest correlation with overall degree of liking and appearance liking was the least correlated.

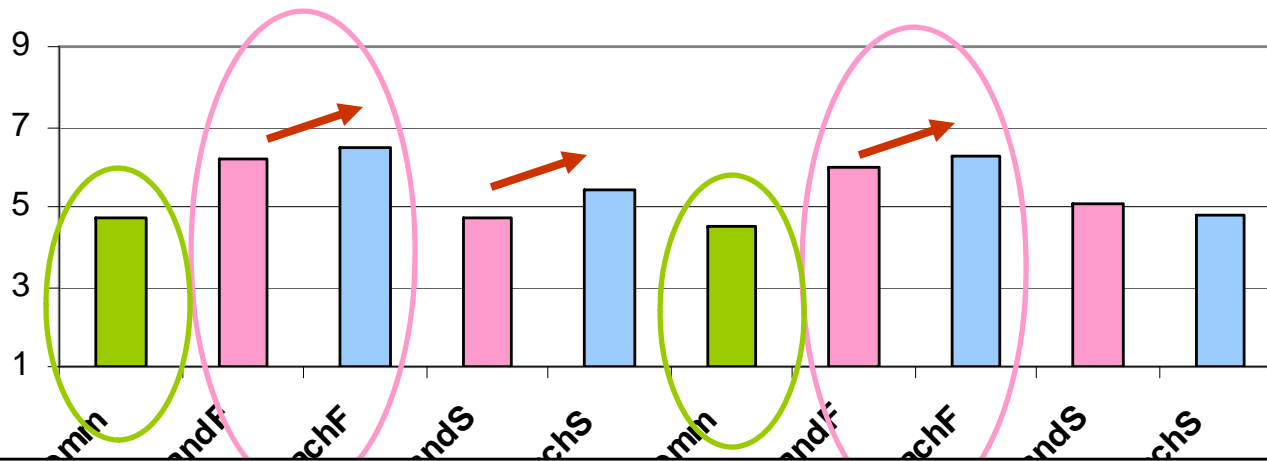- **There was no significant difference in overall acceptability between <u>harvesting methods (Hand vs. Machine)</u>.**

Internal preference map of individual consumers with indication of segmentation (Average linkage method) based on overall degree of liking

Fig III-8. Overall degree of liking (GP1; N=83)

1. Fresh processed olives are liked most
2. Commercial ones are liked least
3. Mechanical harvested olives are liked slightly more

Fig III-9. Partitioning of 'product' source of variation (F-value) on overall degree of liking for GP1 (N=83)

Processing method (Fresh vs. Stored)

Commercial vs. non-commercial

harvest method

- harvest method
- processing method
- processors
- harvest method x processing method
- harvest method x processor
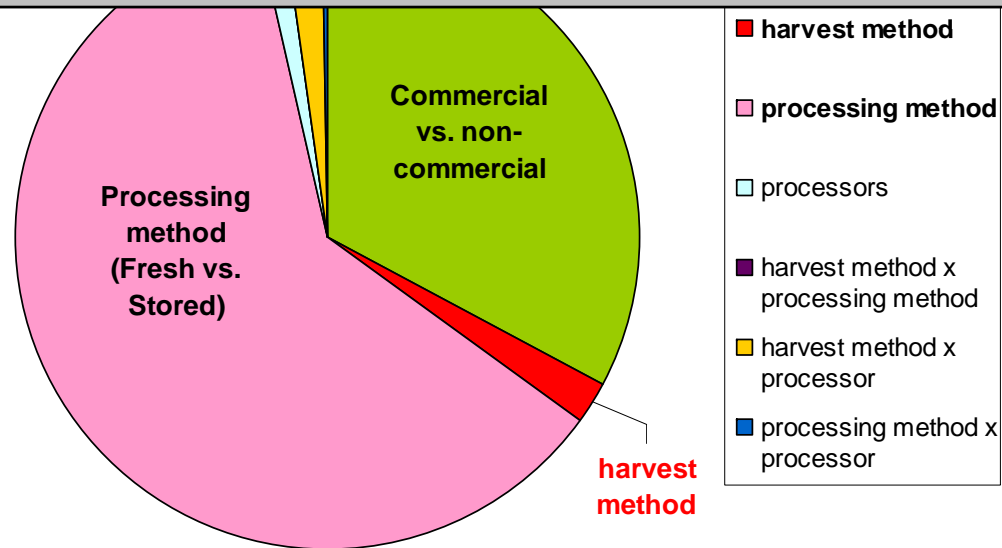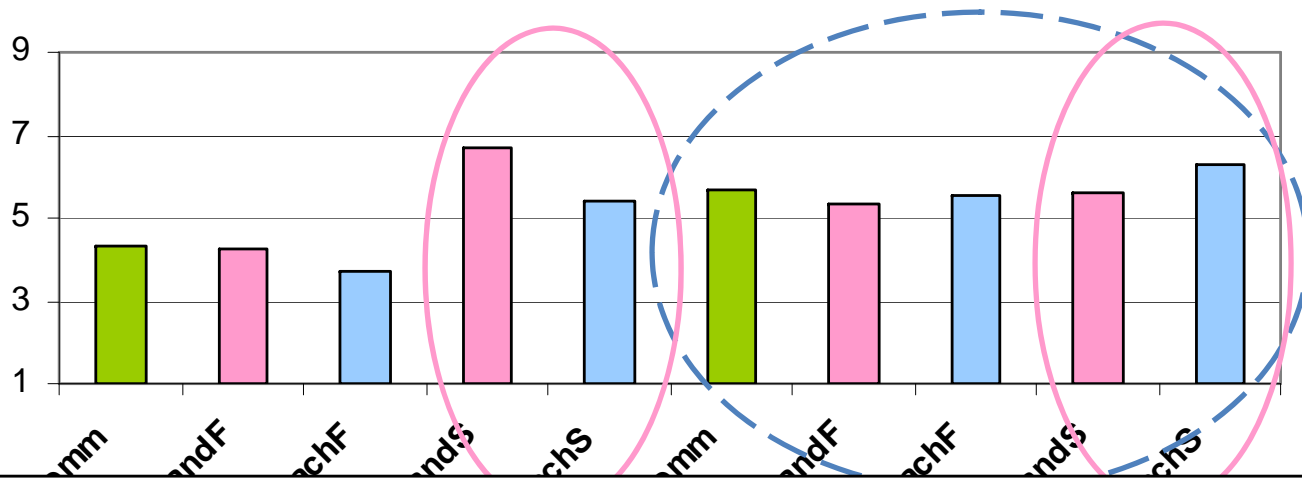- processing method x processor

Fig III-10. Overall degree of liking (GP2, N=17)

1. Stored processed olives are liked most
2. Processor B was liked more than Porcessor A
3. Interactions among source of variations

Fig III-11. Partitioning of 'product' source of variation (F-value) on overall degree of liking for GPs (N=17)
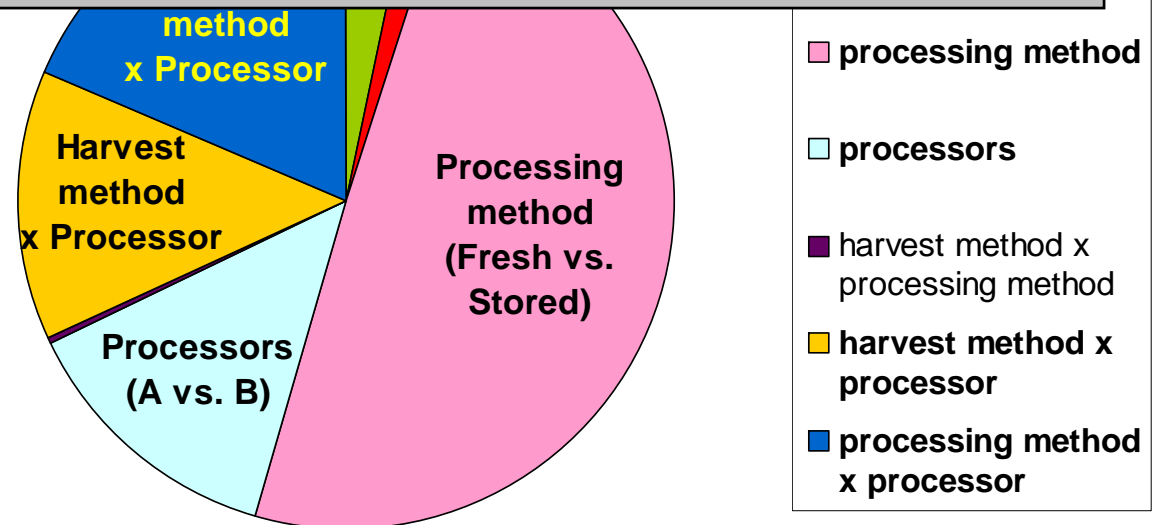

- processing method
- processors
- harvest method x processing method
- harvest method x processor
- processing method x processor

Table III-2. Pearson's correlation coefficients to overall degree of liking

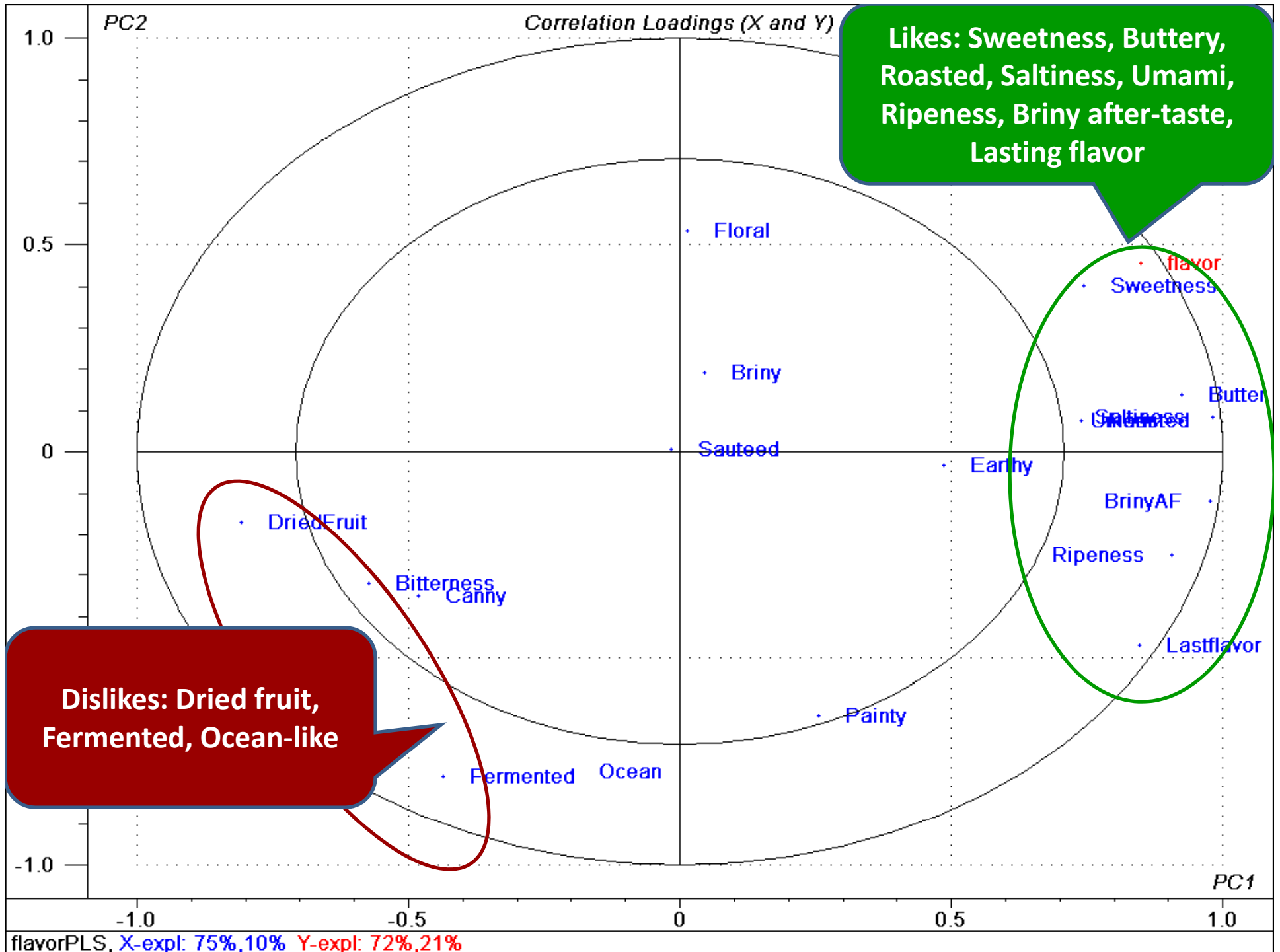|	overall liking	app liking	flavor liking	texture liking
Overall liking Total (N=100)	1	0.457	0.861	0.648
Overall liking GP1 (N=83)	1	0.463	0.856	0.615
Overall liking GP2 (N=17)	1	0.405	0.889	0.773

Values in bold are different from 0 with a significance level alpha=0.05

**GP2 consumers were more affected
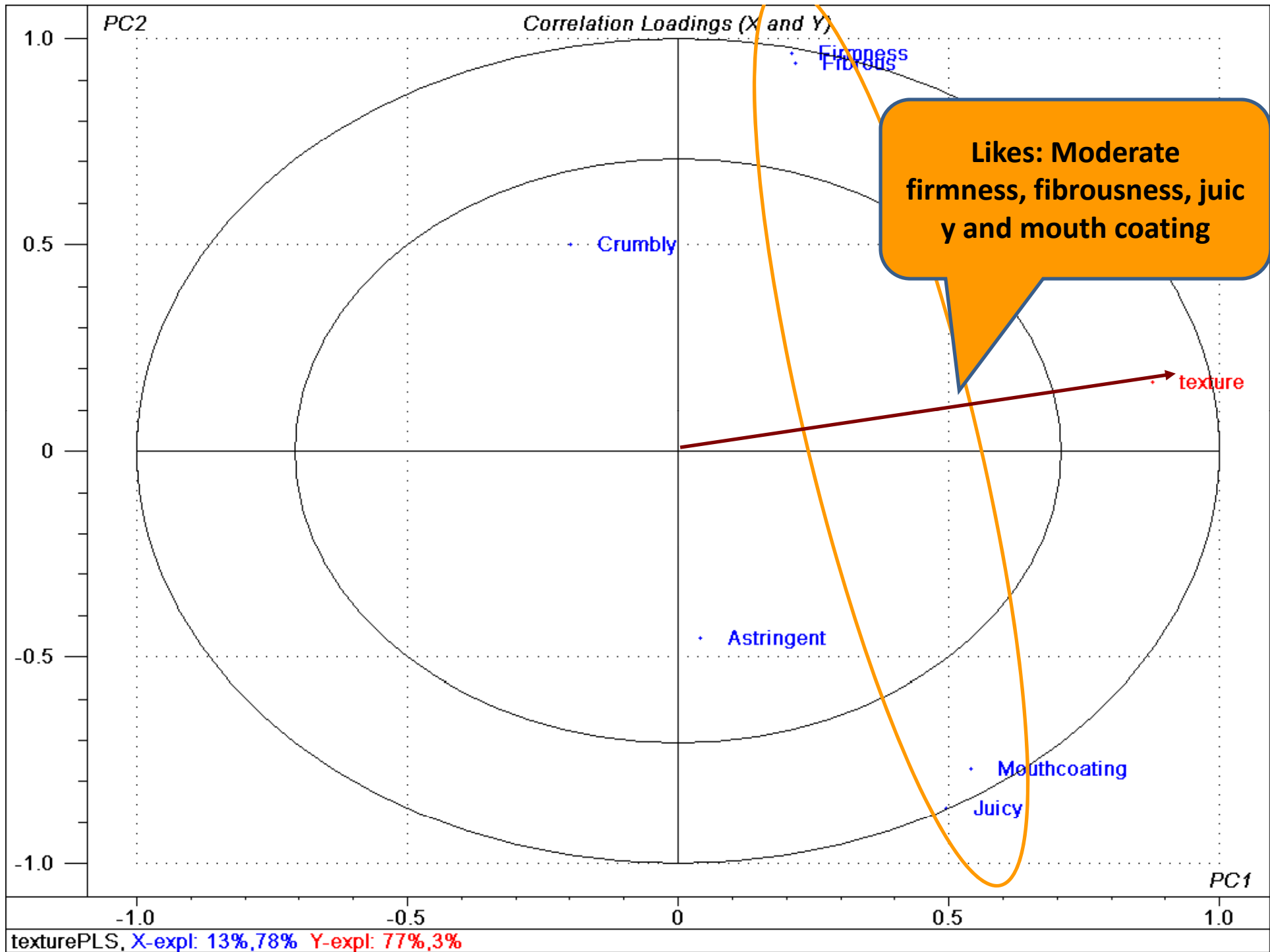by texture liking than GP1 consumers.**
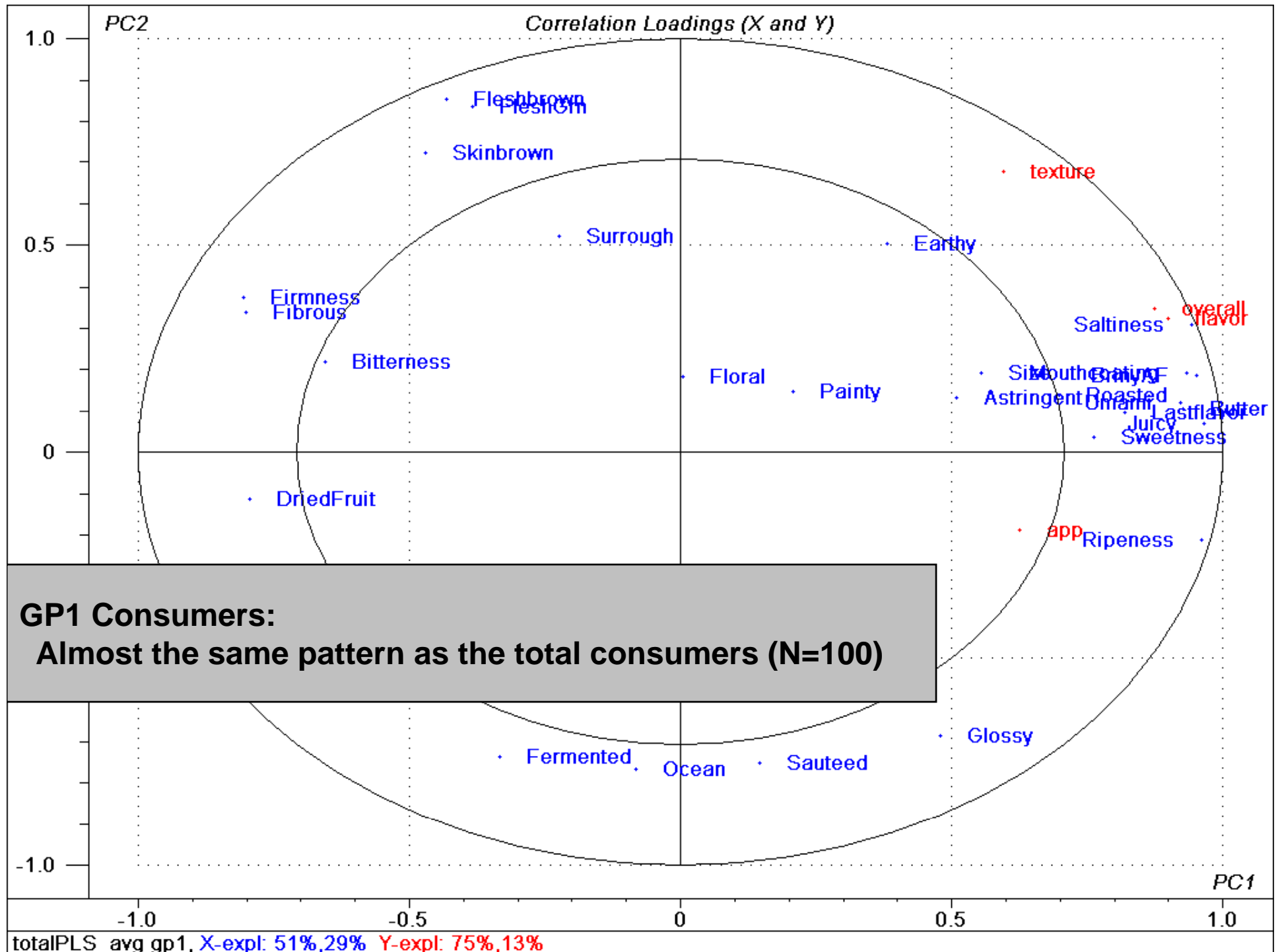
Sensory Drivers of Liking

To identify sensory drivers of liking for the two consumer segments by relating the descriptive analysis and consumer data sets
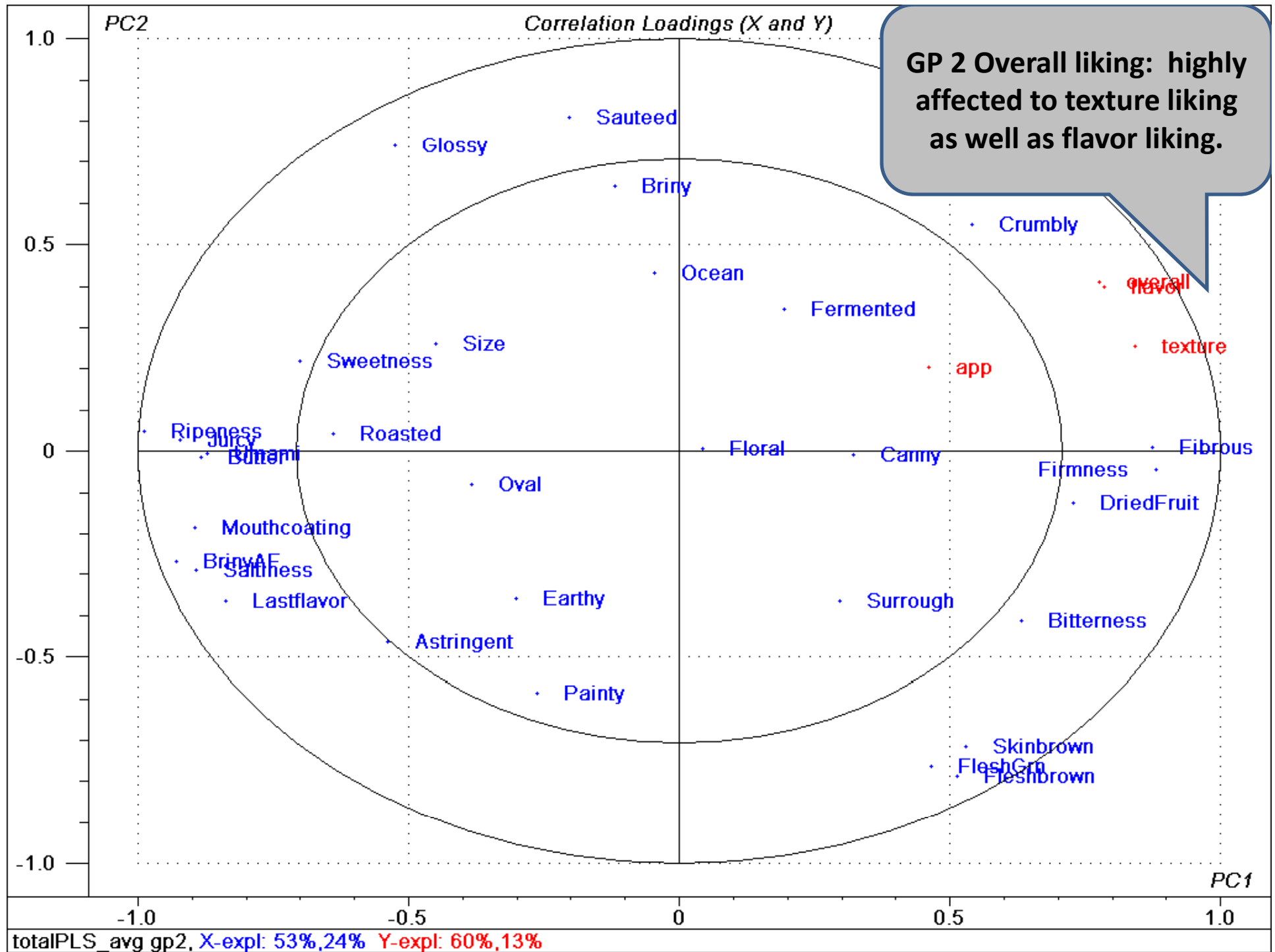
GP1 Consumers:
  Almost the same pattern as the total consumers (N=100)

totalPLS_avg gp1, X-expl: 51%,29% Y-expl: 75%,13%

Correlation Loadings (X and Y)

GP 2 Overall liking: highly affected to texture liking as well as flavor liking.
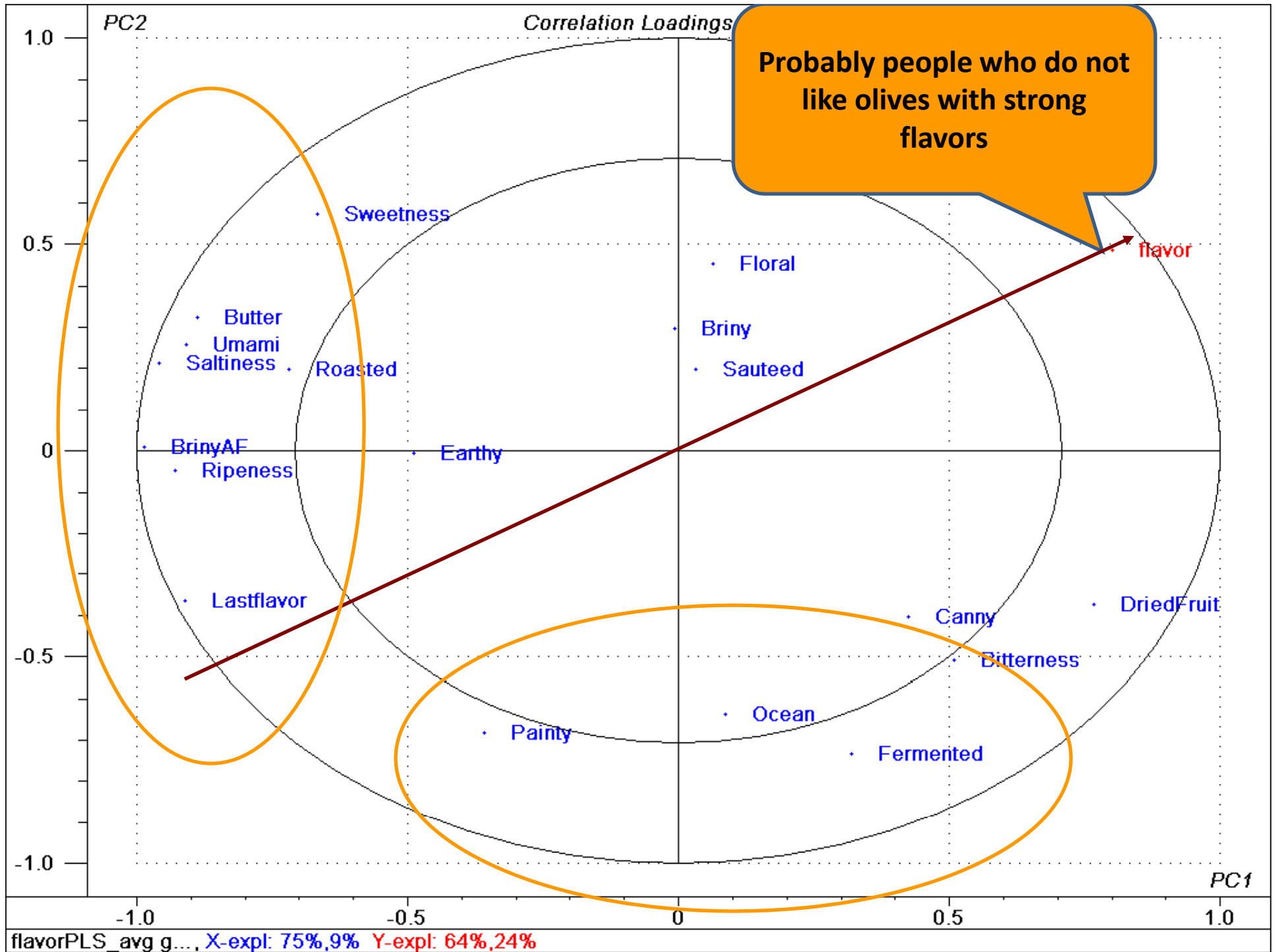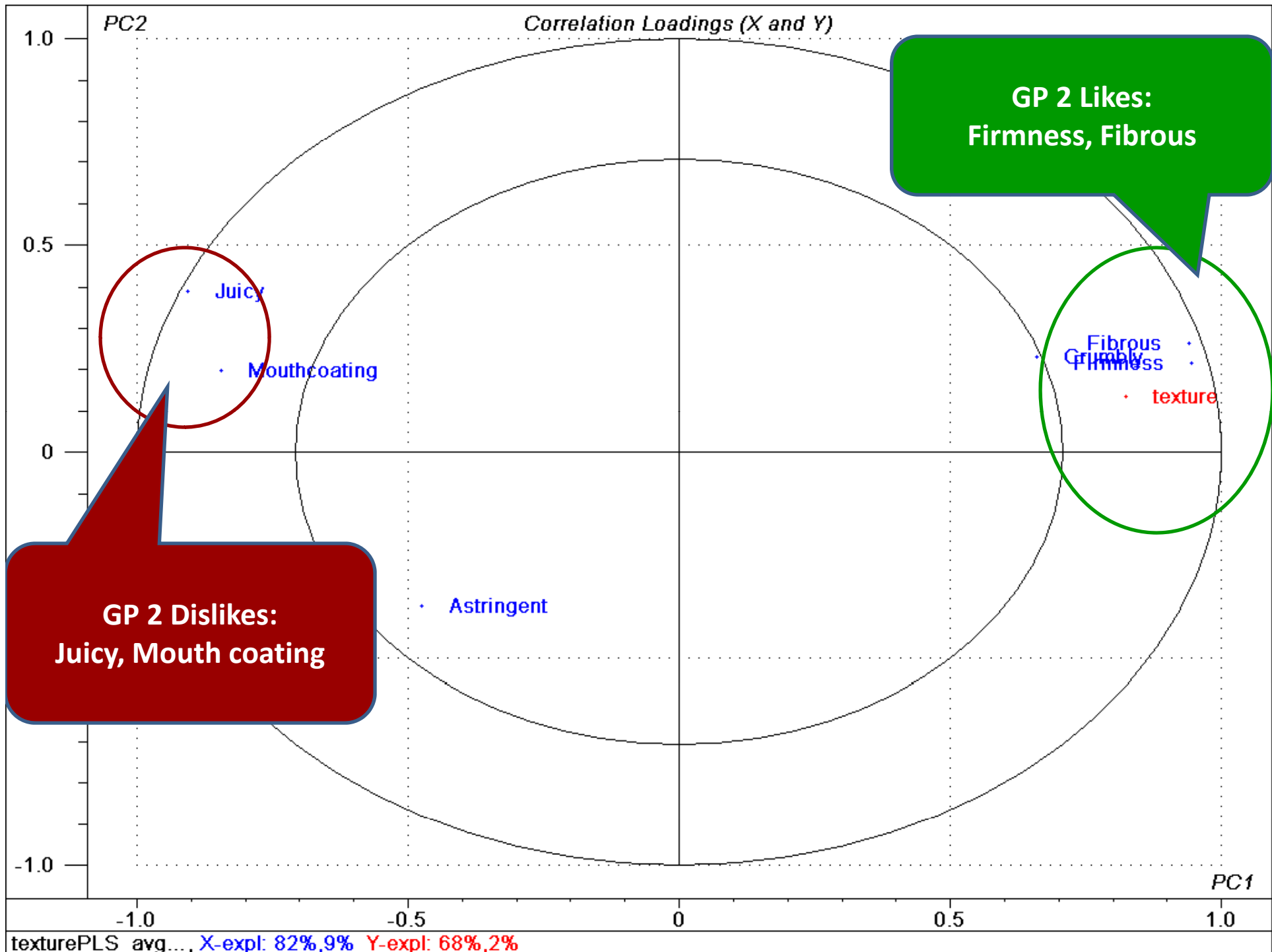
totalPLS_avg gp2, X-expl: 53%,24% Y-expl: 60%,13%
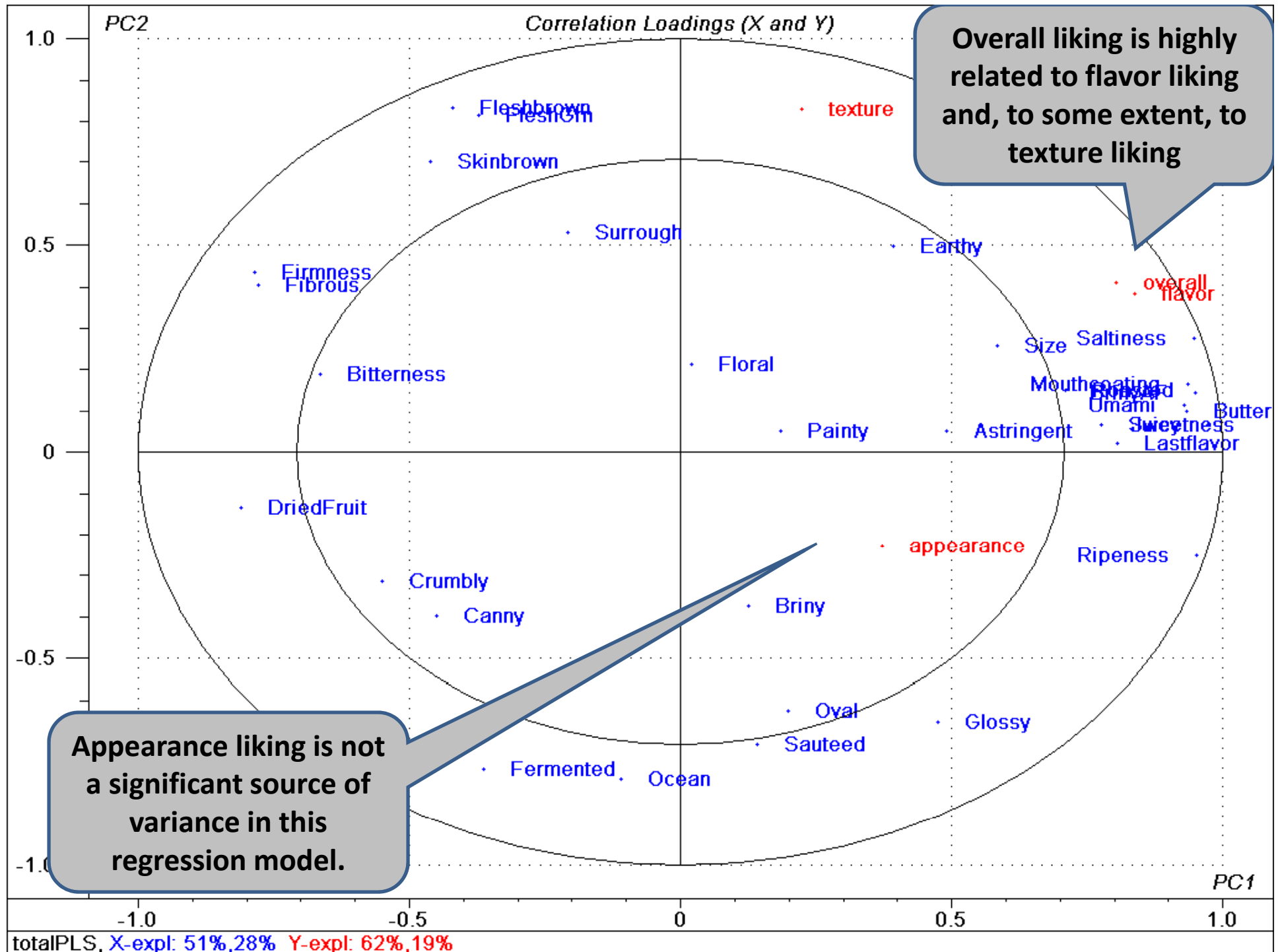
Results (Continued)

Regression model of consumer liking onto DA attributes (N=100)

	Drivers of likes and dislikes
Flavor	Likes: Sweetness, Buttery, Roasted, Saltiness, Umami, Ripeness, Briny after-taste, Lasting flavor
	Dislikes: Dried fruit, Fermented, Ocean-like
Texture	Moderate firmness, fibrousness, juicy and mouth coating
Appear-ance	Not a significant source of variance in this regression model.

Results (Continued)

Regression model on DA and GP 1 Consumers (N=83)

	Drivers of likes and dislikes
Flavor	**Likes: Sweetness, Buttery, Roasted, Saltiness, Umami, Ripeness, Briny after-taste, Lasting flavor**
	Dislikes: Dried fruit, Fermented, Ocean-like
Texture	**Moderate but slightly stronger juicy and mouth coating**
Appear-ance	**Not a significant source of variance in this regression model.**

Results (Continued)

Regression model on DA and GP 2 Consumers (N=17)

	Drivers of likes and dislikes
Flavor	Does not like olives with strong flavor intensity
Texture	Likes: Firmness, fibrousness
	Dislikes: Juicy and mouth coating
Appear-ance	Not a significant source of variance in this regression model.

Conclusions

- **No significant difference in the sensory profiles of hand- and mechanically-harvested olives**

- **No significant difference in consumer liking of hand- and mechanically-harvested olives**

- **Mechanical harvesting can produce table olives of similar sensory quality to traditional hand harvesting.**

Conclusions

- **Fresh processed olives differ in sensory quality with olives processed after storage and they are liked significantly better by consumers.**

Acknowledgements

- **USDA**
- **Musco and Bell Carter**
- **Descriptive analysis panelists**
- **Consumers**