

FINAL PROJECT REPORT

MAFF Project Code:

HH9919STF

Project Title:

Consumer preference and sensory profiling of pears.

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The UK pear industry is under increasing pressure from imported pears. For it to successfully compete with this competition, a clearer understanding of consumers' preferences along with which sensory attributes drive preference for both UK and imported pears is essential. No consumer directed methodology has yet been used to gain an understanding of the UK pear market. This project used a consumer directed, scientific method to begin investigating this problem.

Objectives:

1. To examine differences in preference between pear varieties.
2. To identify key sensory attributes that control preference.
3. To identify any segmentation in preference that exists amongst consumers.

Method:

One hundred and fourteen consumers participated in the study. They tasted 11 pears, available on the market at the time of the study, and scored them for liking using nine-point category scales. They also completed a short usage/demographic questionnaire. Alongside the consumer testing, a trained sensory panel tasted the pears and scored them for appearance, aroma, texture and flavour attributes. The consumer data was analysed using a technique called preference mapping, which gave a consensus map of the pears. The sensory data from the trained panel was analysed using principal components analysis. It was also projected onto the preference map.

Results:

Mean liking scores from the consumer testing showed that the Italian Conference and Abate Fétel pears were liked the most followed by the UK Concord and Portuguese Rocha. The pears that were least liked were the South African Williams and the UK Buerre Hardy.

Clear differences in preference between the pears was identified, with preference lying along one dimension. This dimension was a ripeness dimension; the more unripe pears (and least liked) at one end, with the attributes 'unripe', 'hard', 'tough', and the riper (liked) pears at the other end. The attributes that were controlling preference in this study were 'sweet', 'juicy' and 'pear flavour'. Consumers have a clear preference for pears that are ripe and are sweet, juicy and with a pear flavour. There was no segmentation of consumers.

From the sensory data three main dimensions were perceived. Dimension one is the same as the preference dimension; 'unripe', 'hard' to 'sweet', 'juicy'. Dimension two was 'green', 'shiny', 'defrosted' to 'brown specks', 'woody' and the third dimension was 'pear', 'pear drops' to 'watery', 'defrosted'.

Ripeness is an important factor in consumer preference of pears. It is recommended that the trial be repeated with indicators of ripeness used, also that it be run in the middle of the northern hemisphere pear season.

Scientific report

Introduction

The UK pear industry is under increasing pressure from imported pears. For it to successfully compete with this competition, a clearer understanding of consumers' preferences along with which sensory attributes drive preference for both UK and imported pears is essential. No consumer directed methodology has yet been used to gain an understanding of the UK pear market. This project used such a methodology to gain an initial insight into the pear market.

The objectives were:

1. To examine differences in preference between pear varieties.
2. To identify key sensory attributes that control preference.
3. To identify any segmentation in preference that exists amongst consumers.

The milestones were:

1. Examination of differences in preference between pear varieties.
2. Identification of key sensory attributes that control preference.
3. Identification of any segmentation in preference that exists amongst consumers.

All the objectives and milestones were met within two weeks of the target date.

Method

Consumers

One hundred and fourteen consumers (80 females and 34 males) participated in the study.

Samples

Eleven different pears, representing the range available on the market in February, were selected and were provided by Sainsburys plc. (see Table one). The pears were stored refrigerated at 3⁰C until approximately 12 hours before use, when they were removed from the fridge and left to reach room temperature ready for testing. Each sample was assigned a three digit numeric code and were presented to the consumers on a white paper plate.

Table one. Pears used - variety and country of origin.

Variety	Country of origin
Concord	<i>England</i>
Buerre hardy	<i>England</i>
Conference	<i>England</i>
Conference	<i>Italy</i>
Abate fatel	<i>Italy</i>
Comice	<i>Italy</i>
Packams	<i>Italy</i>
Conference	<i>Holland</i>
Rocha	<i>Portugal</i>
Williams	<i>South Africa</i>
D'anjou	<i>USA</i>
Dummy sample-Concord	<i>England</i>

Consumer testing

Consumer testing was carried out over a three consecutive days, with consumers attending one session at the Institute of Food Research lasting between 30 and 45 minutes. They received a 'dummy' sample first, to give a practice in using the rating scale and to balance out any first position effects. They then tasted the eleven pears in a randomised order, balanced for positional effects. Consumers received a quarter of a pear and were instructed to taste the pear in the way they would usually eat it; a knife was available if they usually used one. They scored the pears for 'liking' using nine-point category scales (see Appendix one). Inbetween each pear, consumers took a sip of water and ate a piece of cracker to cleanse their palate. After tasting the pears a short usage/demographic questionnaire was completed.

Sensory testing

At the same time as the consumer testing a trained panel of 11 panellists tasted the pears and the rated them for 42 attributes; covering appearance, odour, texture, flavour and afterswallow. The trained panel tasted the pears initially at a discussion session where the attributes were agreed upon. They then tasted all eleven pears three times. Panellists received the samples one at a time in a balanced order to minimise positional or first order carry over effects.

Data analysis

Principal components analysis (PCA) was used to analyse the sensory panel data and preference mapping was used to analyse the consumer preference data. The sensory and consumer data were linked together by projecting the sensory data onto the consumer preference map.

The preference mapping model uses the basic hypothesis that consumers are able to perceive products according to a common map based on their sensory characteristics. However since consumers may weigh these characteristics differently when forming their preference judgements the model also allows for individual differences. Internal preference mapping uses a mathematical technique closely allied to principal components analysis to produce a small number of preference dimensions along which the products are plotted. This summary is treated as an approximation to the underlying perceptual map which is the basis for consumers' preference assessments. The map is used to assess how well products are discriminated and also to look for segmentation among the consumers. Superimposing sensory attributes from a trained panel onto the preference map gives an insight into the product characteristics which drive preference.

Results

Consumers

A breakdown of the age and gender of the consumers is shown in Figure one. Seventy percent of the consumers who participated were female and there was a good distribution of ages over the desired age range of 18-60 years. Despite recruiting within this range, one consumer participated who was over 60 years.

The majority of consumers (77%) reported eating between 1-3 pears per week with 15% reporting to eat 4-6 per week. When asked whether they cut or peeled pears before they ate them, 54% said they cut them and 17% said that they peeled them.

Consumers were also asked how many pears they purchased per week and where they purchased the majority of their pears. Sixty three percent of consumers reported purchasing 1-4 pears per week. The remainder purchased 5-10 per week (22%), 11-15 per week (3%) or none (12%). The vast majority purchased most of their pears from supermarkets (94%).

Consumers were also asked the annual income of the household, along with the occupation of the head of the household. Results are shown in Figures 2 and 3 respectively. There was a good distribution of household incomes, but the social class distribution was skewed towards groups one and two.

Figure 1. Age and gender of consumers.

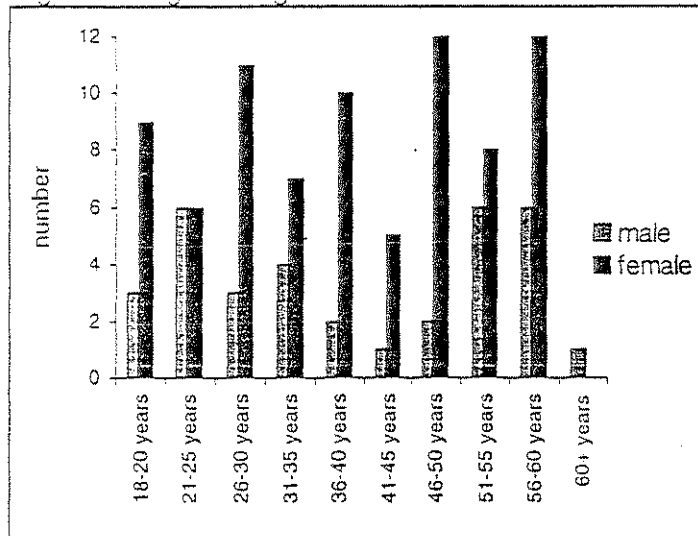


Figure 2 Income of consumers

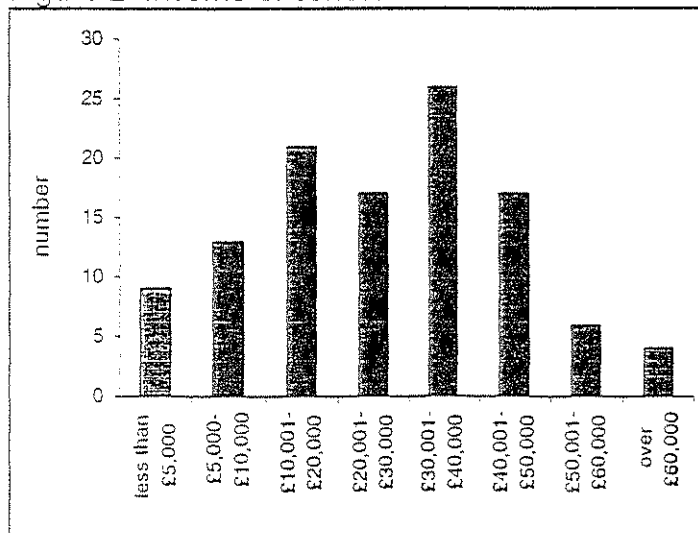


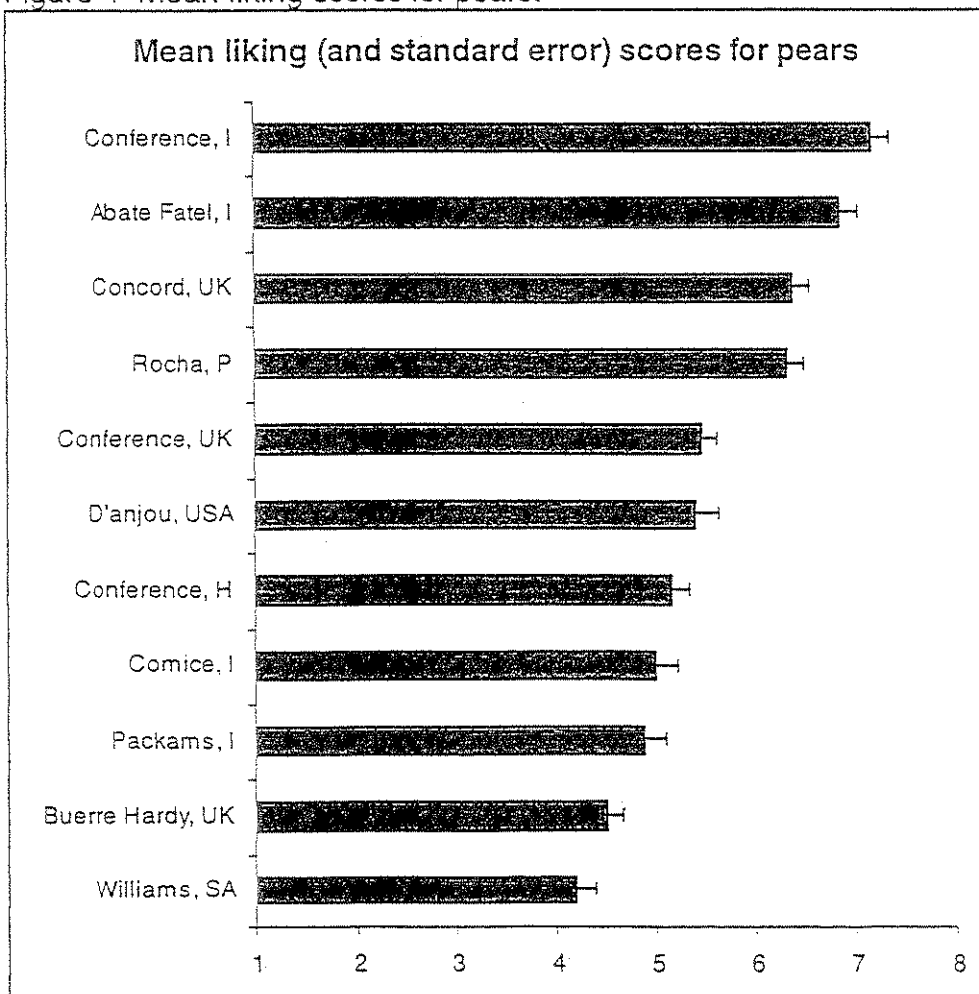
Figure 3 Social class of consumers.



Mean liking scores

The mean liking scores from the consumer testing are shown in Figure 4. The Italian Conference and Abate Fatel pears were liked the most, followed by the UK Concord and Portuguese Rocha. The South African Williams was liked the least, followed by the UK Buerre Hardy. When comparing the scores for the three Conference pears used, the Italian Conference was liked significantly more than either the UK or Dutch Conference.

Figure 4 Mean liking scores for pears.



Sensory data

The PCA plots for the position of the pears are shown in Figures 5 and 6. Three significant dimensions were found. Figure 5 shows dimensions one and two; these accounted for 37.5% and 18.8% of the variance respectively. Dimension one separates out the Italian Conference and Abate Fatel pears on the right and the Williams on the left. Dimension two separates out the D'anjou and Williams pears at the top from the Dutch Conference and Buerre Hardy at the bottom. Dimension three (Figure 6) accounted for 14.8% of the variance and separated the three Conference, Buerre Hardy and D'anjou pears on the right from the rest. Dimension four was not significant.

Figures 7 and 8 show the PCA plots for the sensory attributes. Figure 7 shows that dimension one comprises of 'juiciness', 'sweet', 'pear' attributes on the right and 'skin toughness', 'unripe pear', 'toughness/chewiness', 'hardness', 'density of flesh' attributes on the left. Dimension two comprises of 'shiny', 'green', 'grassy', 'pink blush', 'defrosted' attributes at the top and 'old sacks', 'brown specks', 'woody', 'russet' attributes at the bottom. Superimposing Figure 7 onto Figure 5 gives an indication of the important attributes for different pears. Dimension one shows that the Williams was perceived as 'unripe', 'hard', 'tough' by the sensory panel, whereas the Italian Conference and Abate Fatel were perceived as 'sweet' and 'juicy'. Similarly, dimension two shows that the D'anjou was perceived as 'green', 'grassy', 'defrosted' and the Buerre Hardy and Dutch Conference as 'woody', 'brown specks' and 'russet'. (see Appendix 2 for a description of the sensory attributes).

Figure 8 reveals a third dimension that is not orthogonal to the plot and has been drawn on. At the top are 'pear', 'pear drops' attributes and at the bottom 'watery' and 'defrosted'. Superimposing the attributes (Figure 8) onto the pears (Figure 6) reveals that the Concord and Williams scored highly for the 'pear', 'pear drops' attributes and the D'anjou and Buerre Hardy pears scored highly for the 'watery', 'defrosted' attributes. For information, mean sensory scores for each attribute and each pear are shown in Appendix 3.

Consumer data

Two significant dimensions were identified from the consumer preference data. Figure 9 shows the position of the pears in relation to consumer preference. Dimension one explains 36.5% of the variance and, as with the sensory PCA, separates out the Italian Conference and Abate Fatel on the right from the Williams on the left. Dimension two explains 11.3% of the variance and the Dutch Conference at the top from the D'anjou and Packams at the bottom.

Figure 10 shows consumers loadings and can be superimposed onto Figure 9 to show where preference lies in relation to the pears. The majority of consumers are clustered to the right on dimension one, indicating a preference for the Italian Conference and Abate Fatel pears. Only a couple of consumers lie on the left of dimension one showing a preference for the Williams.

Figure 11 shows the position of the pears (in bold type), as in Figure 9, with the sensory attributes from the trained panel projected onto the map to show which attributes are important in consumer preference. As with the sensory PCA plot (Figure 7) dimension one comprises of a 'sweet', 'juiciness' attributes on the right to 'unripe', 'toughness', 'hardness' attributes on the left. Superimposing Figure 10 onto Figure 11 identifies the key attributes that drive consumer preference; these being 'sweet', 'juicy' and 'pear flavour'.

To propose a working sensory profile for breeders, buyers and researchers, we have investigated each attribute in terms of its relevance to the key preference dimensions and/or the ability of the panel to detect significant variation among the pears in the study. Although clearly the selection will be a function of the current samples, it does give a basis to produce some simpler bar charts to make direct comparisons between the various pear profiles.

Table 2 shows the attributes used by the trained panel, grouped into aroma, flavour, texture, first bite and external appearance. They are ranked in each group for ability to discriminate between the pears; the higher the number, the better that attribute was able to discriminate between the pears. For example, in the flavour group, pear is an attribute that easily discriminated between the pears, whereas floral was not. The next five columns of the table show whether the attributes were important attributes on the sensory PCA, and consumer preference map dimensions. Important attributes on the positive end of the dimension are marked with a '+' and those on the negative end with a '-'.

Figure 12 shows mean scores for the important attributes on the main preference dimension of the preference map. Attributes were included if they discriminated between the pears and were marked as important. For example, A_sweet was included as it discriminated between the pears and was important on consumer dimension one, whereas F_floral was not included as it did not discriminate between the pears.

Discussion of results, Implications and future work

Clear differences in preference between the pears was identified, with preference lying along one dimension. This dimension was a ripeness dimension; the more unripe pears (and least liked) at one end, with the attributes 'unripe', 'hard', 'tough', and the riper pears at the other end. The attributes that were controlling preference in this study were 'sweet', 'juicy' and 'pear' flavour. Consumers have a clear preference for pears that are ripe and are sweet, juicy and with a pear flavour. There was no segmentation of consumers.

From the sensory data three main dimensions were perceived. Dimension one is the same as the preference dimension, 'unripe', 'hard' to 'sweet', 'juicy'. Dimension two was 'green', 'shiny', 'defrosted' to 'brown specks', 'woody' and the third dimension was 'pear', 'pear drops' to 'watery', 'defrosted'.

The main difficulty with drawing clear and reproducible conclusions from this trial is that the ripeness of the pears varied between varieties and in some cases between pieces of fruit within a variety. This would not be a problem if the sensory panel or the consumers were unable to detect variation due to this variable. However, since this is the key preference and perceptual dimension, this variation will confound the results.

There are only two ways to deal with this problem. One way is to arrange the treatment of the fruit so that all variation in ripeness is removed. The second is to monitor indicators of ripeness, preferably in a non-destructive fashion so that individual pieces of fruit can be assessed and then used for the trial. Variation in ripeness can then be removed from the overall analysis by regression and the effects on the preference and perceptual maps examined. If different products arrive at the markets at different stages of ripeness then this can also be modelled if estimates of the typical ripeness parameters for each variety are available.

We recommend that this trial be repeated with these monitoring measures as soon as funds are available. The present study was carried out at the end of the northern

hemisphere pear season. If a second study is run, we recommend that it is in the middle of this season.

Results of this work will be presented to the Apples and Pears Research Council (APRC) in the form of a presentation to the research committee and also as an article in the APRC quarterly newsletter.

Figure 5

Principal Component Scores Plot of Sensory Data on Pears February 1999

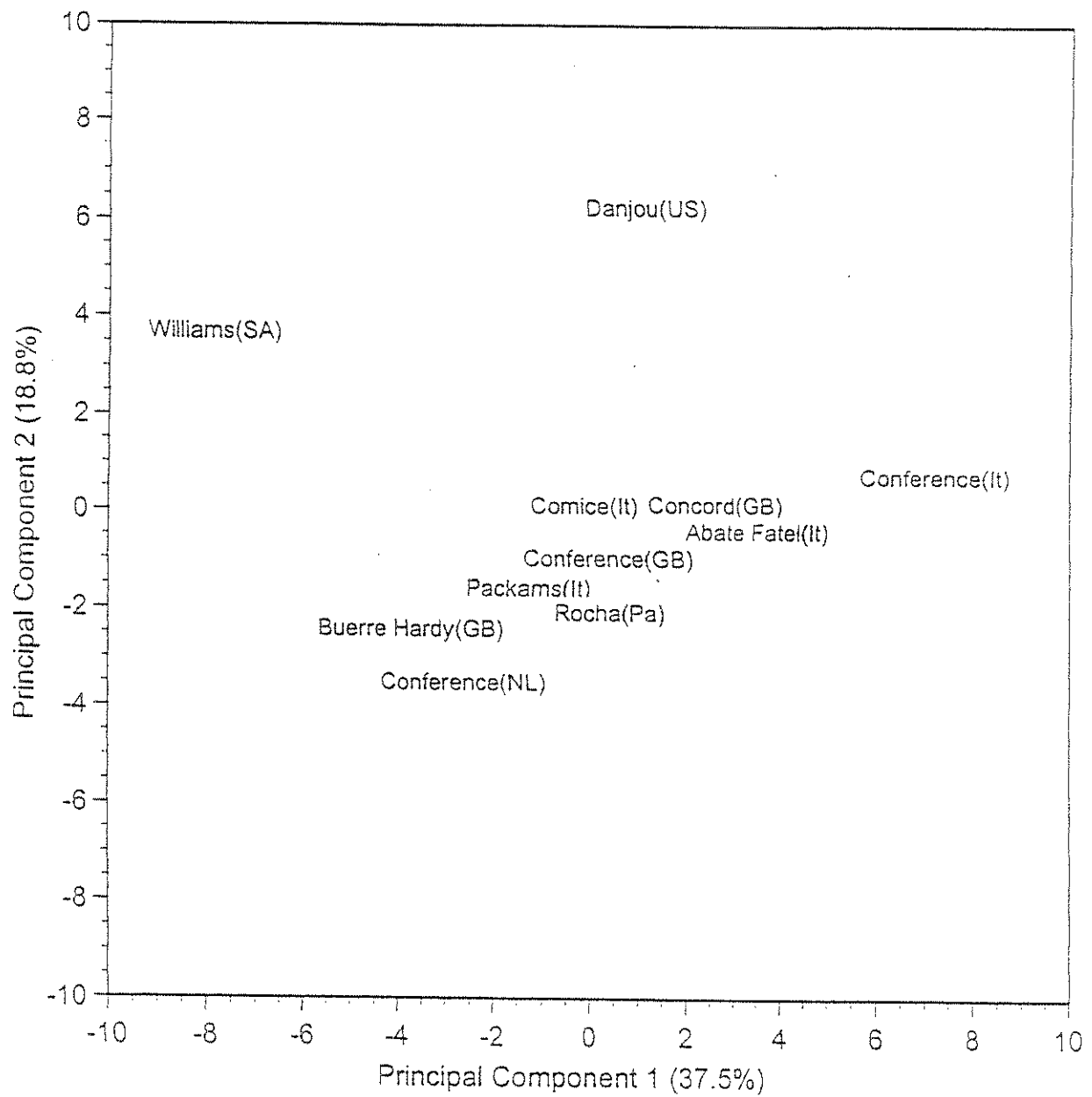


Figure 6

Principal Component Scores Plot of Sensory Data on Pears February 1999

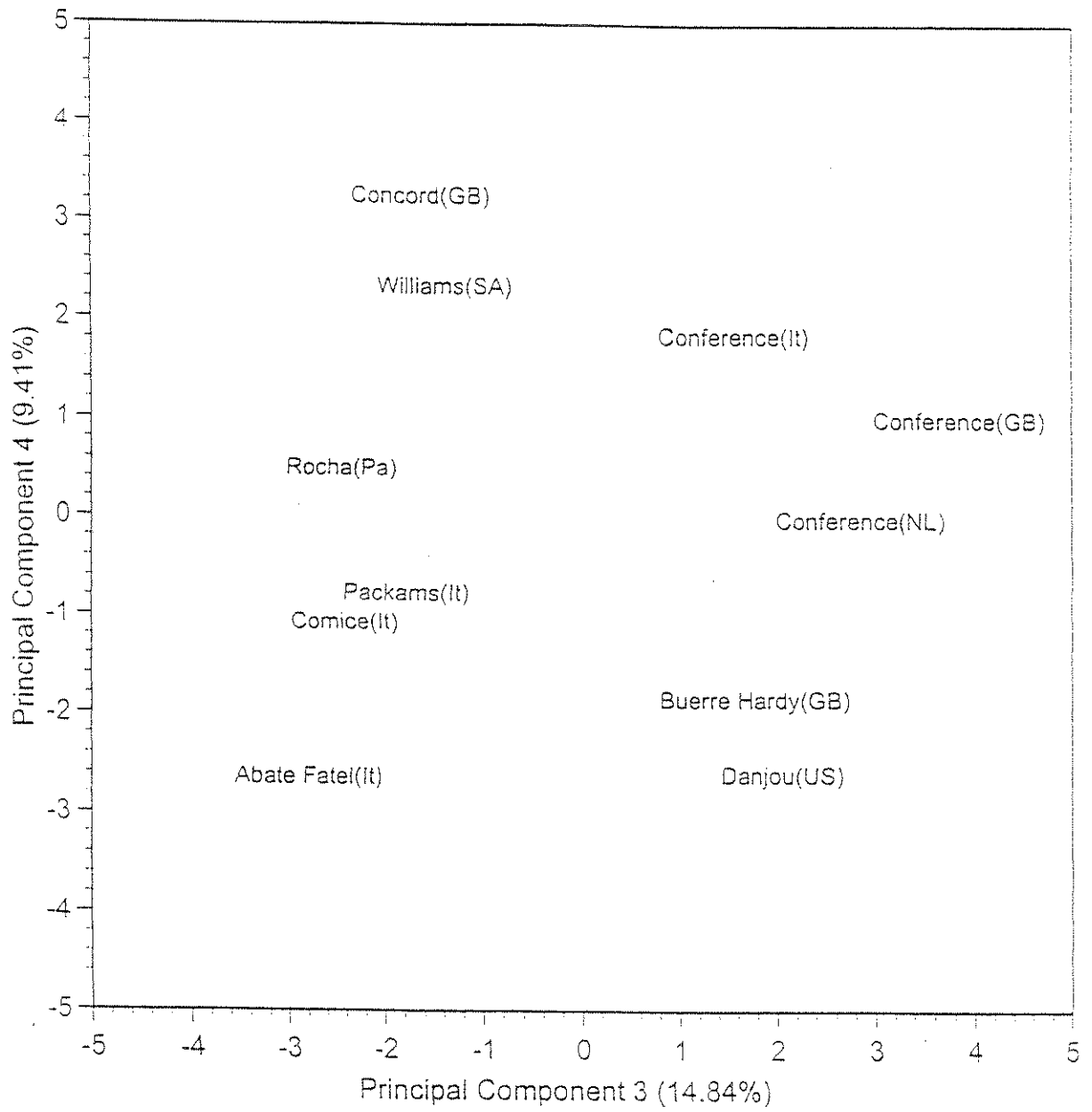


Figure 7

Principal Component Attribute Loadings Plot of Sensory Data on Pears February 1999

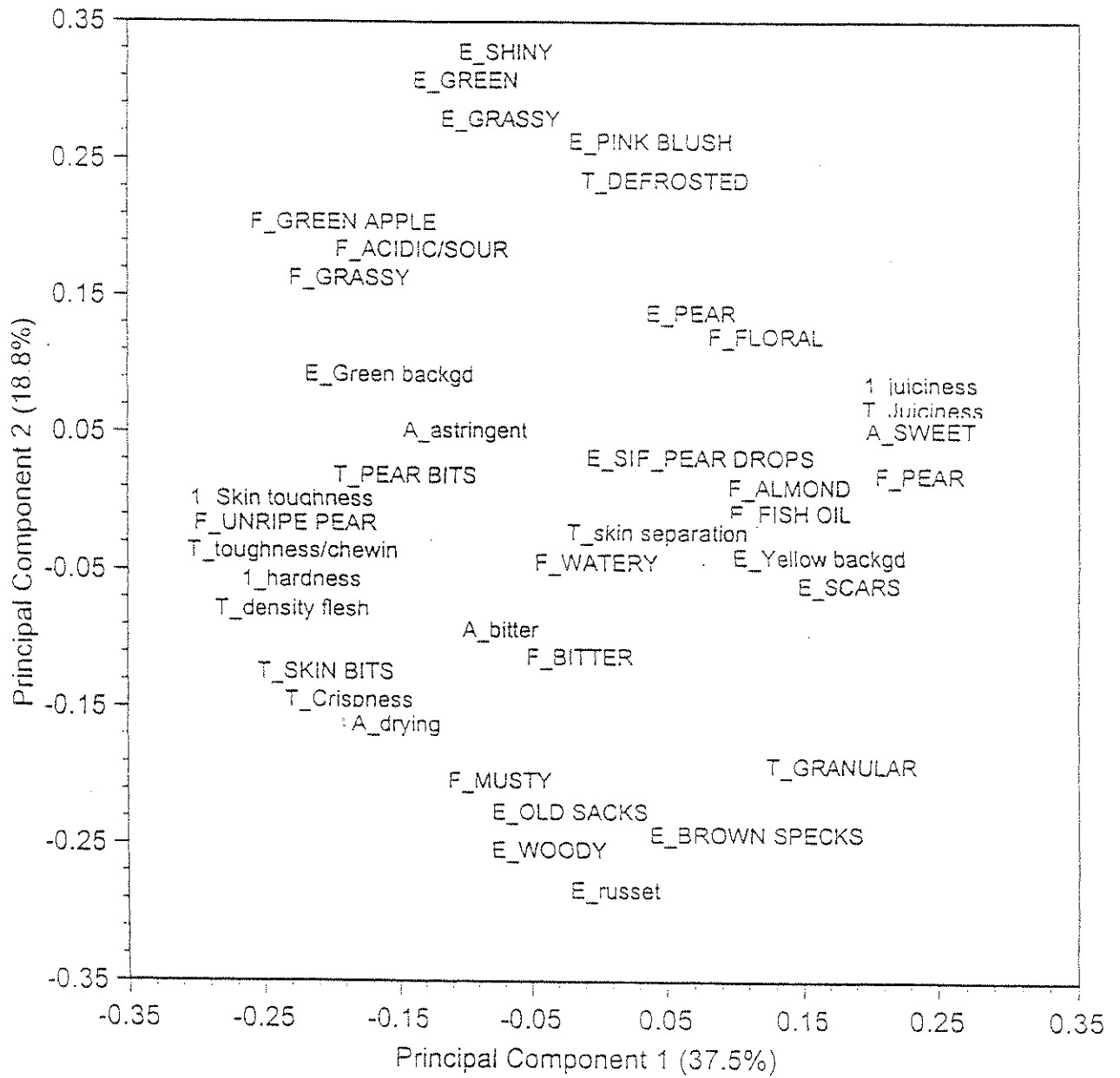


Figure 8

Principal Component Attribute Loadings Plot of Sensory Data on Pears February 1999

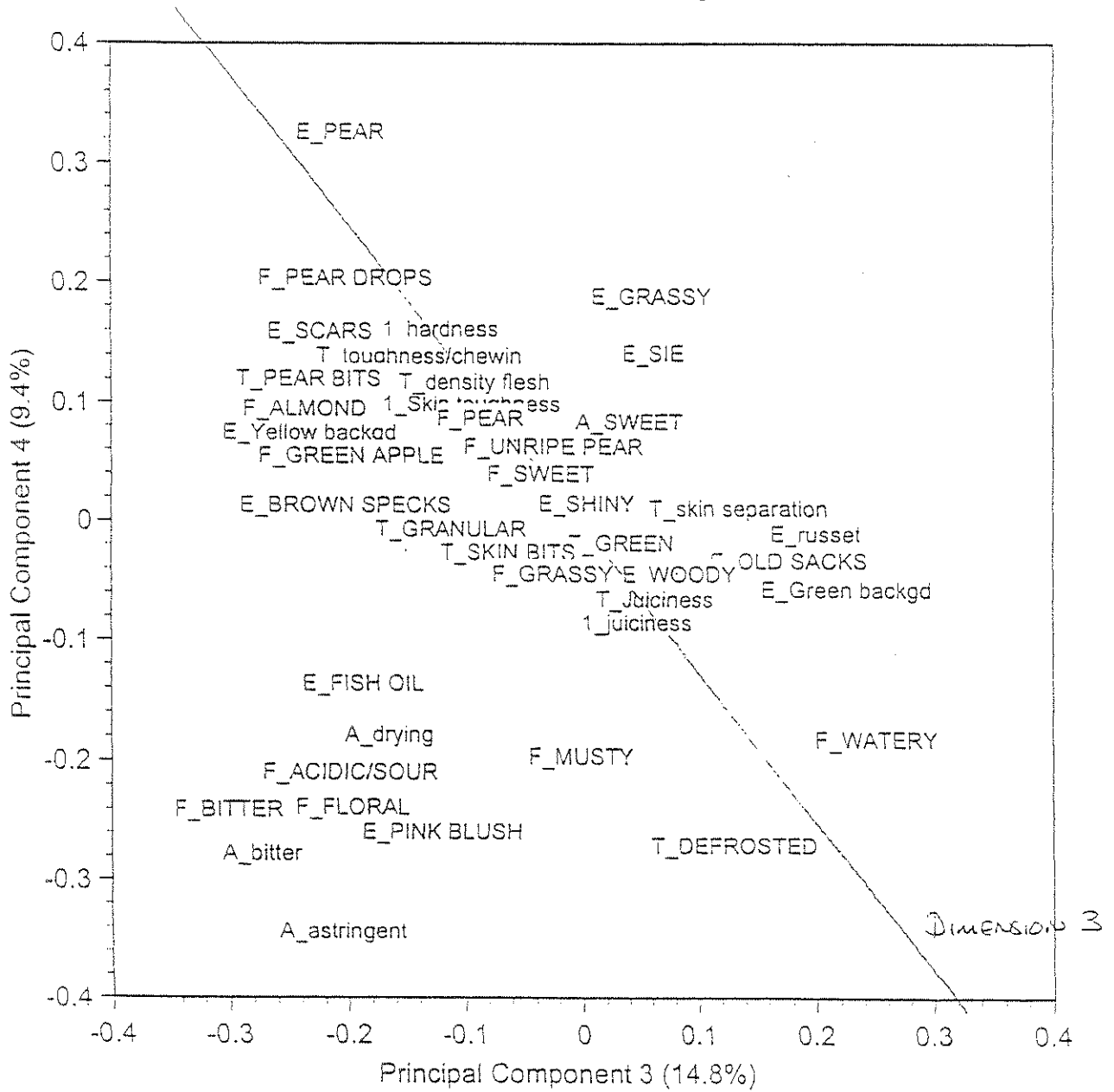


Figure 9

Internal Preference Mapping of Pears February 1999

Product Scores : Dimension 2 vs Dimension 1

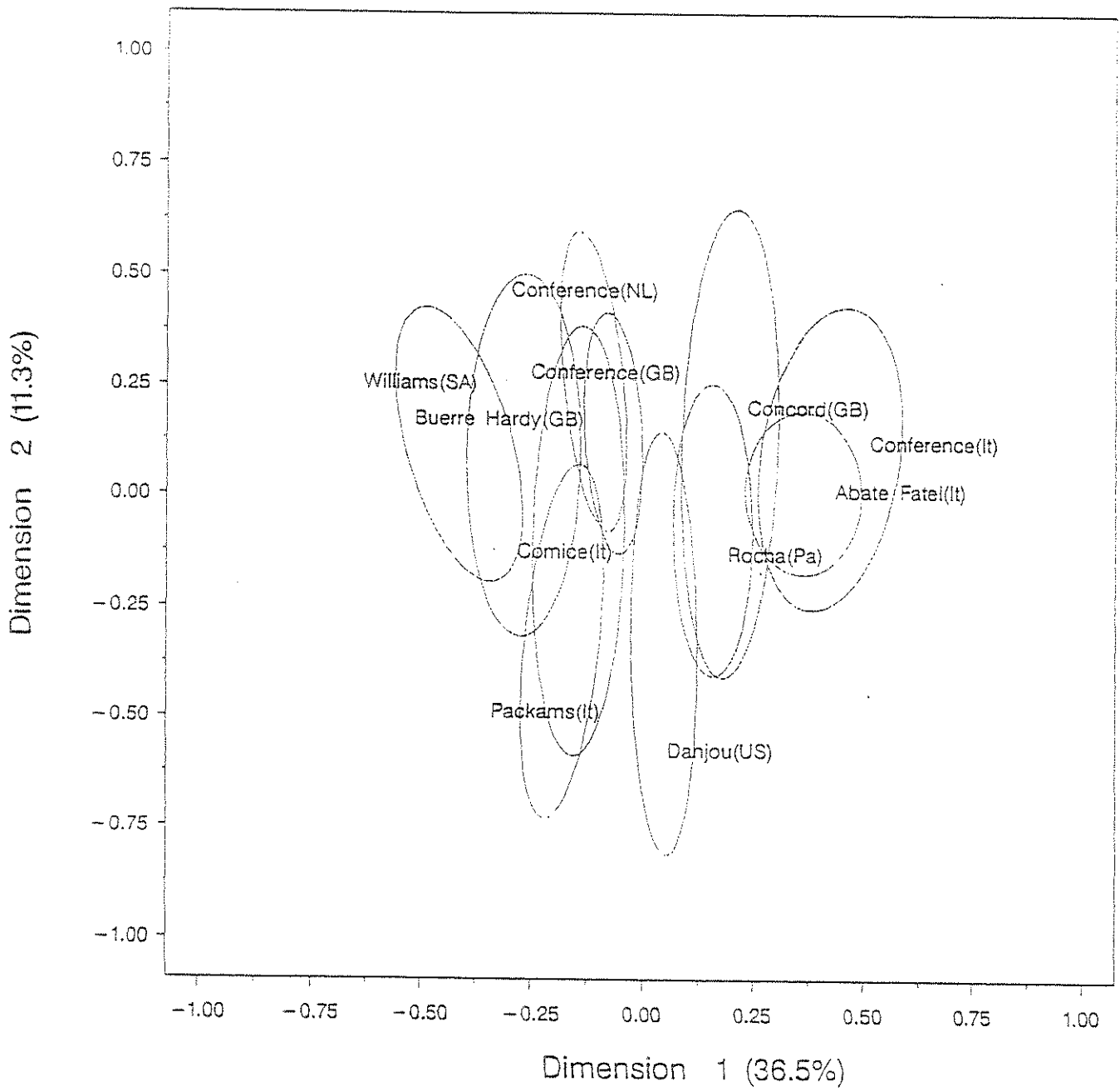


Figure 10

Internal Preference Mapping of Pears February 1999

Consumer Loadings : Dimension 2 vs Dimension 1

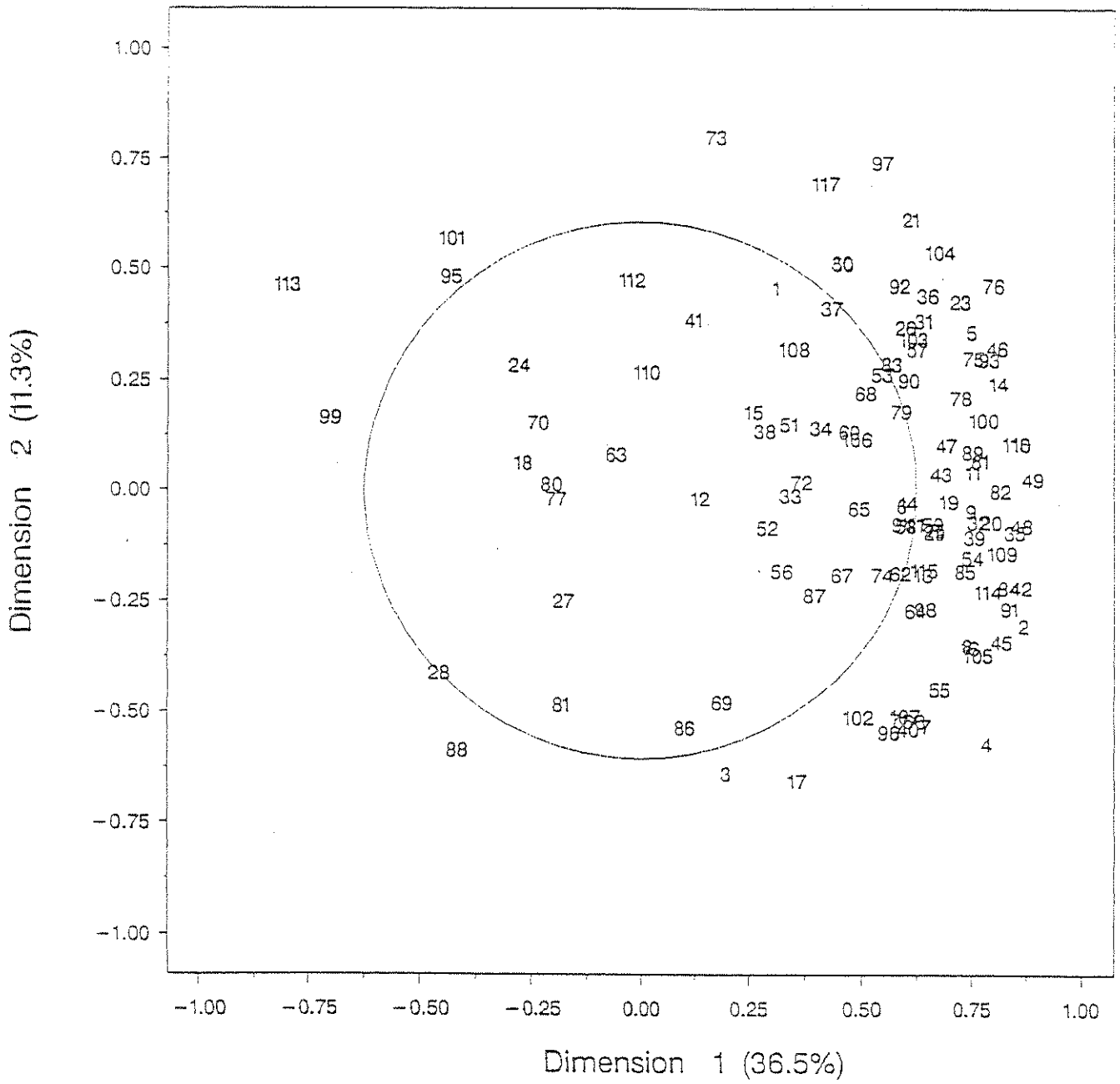


Figure 11
 Internal Preference Mapping of Pears
 February 1999
 showing projections of Sensory Panel Means

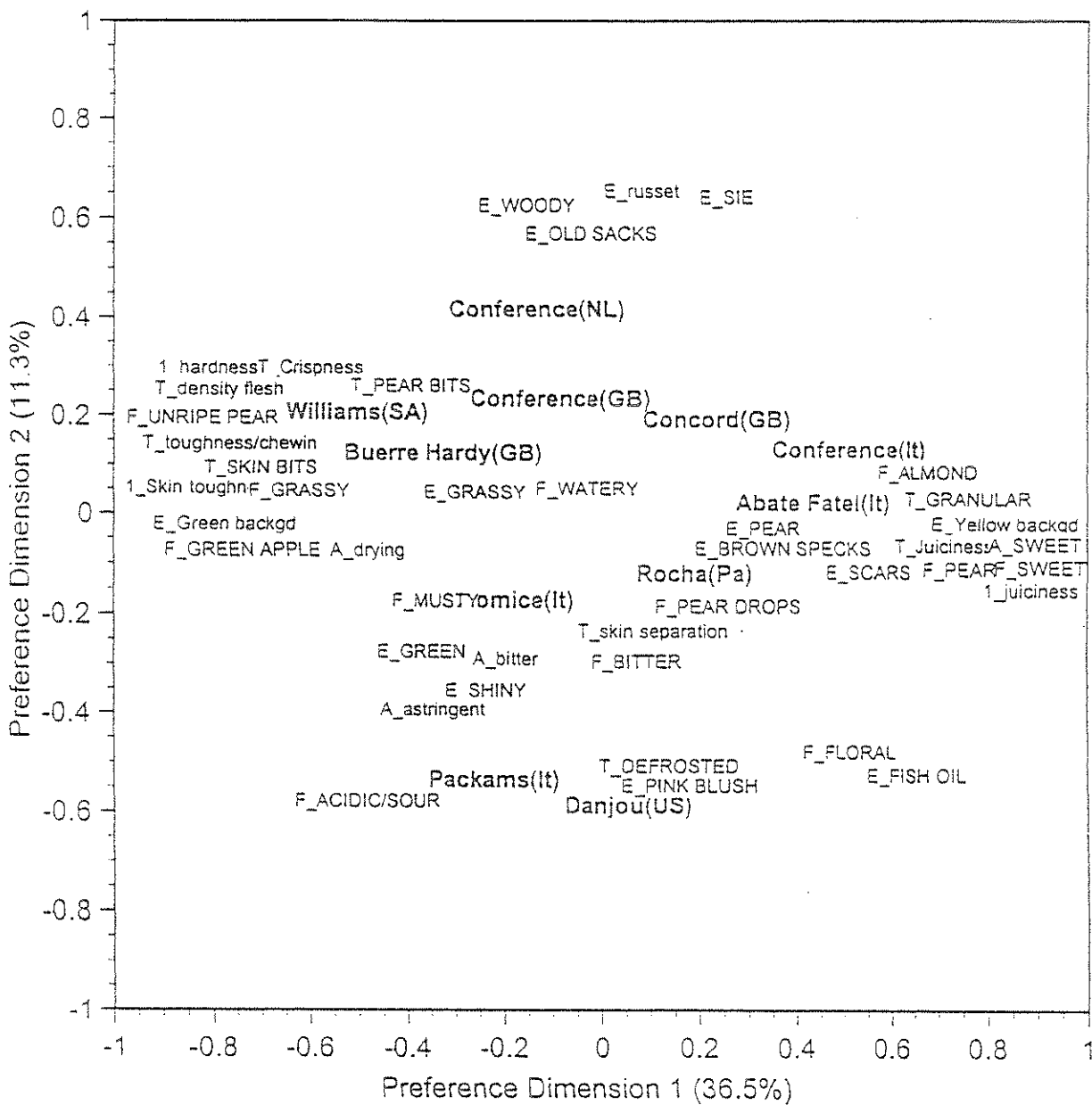


Table 2							
Attribute	Power of discrimination	Attribute type	Sensory dim.1	Sensory dim.2	Sensory dim.3	Consumer dim.1	Consumer dim.2
A_Sweet	21.9	Aroma	+			+	
A_Bitter	7.5	Aroma			.		
A_Astringent	3.8	Aroma					
A_Drying	2.2	Aroma					
F_Pear	20.4	Flavour	+			+	
F_Unripe Pear	19.4	Flavour	.			.	
F_Sweet	19.1	Flavour				+	
F_Green Apple	16.4	Flavour				.	
F_Watery	12.1	Flavour			+		
F_Acidic/Sour	11.5	Flavour					.
F_Bitter	8.1	Flavour			.		
F_Almond	7.8	Flavour			.		
F_Musty	4.3	Flavour		.			
F_Pear Drops	3.7	Flavour					
F_Grassy	3.5	Flavour					
F_Floral	1.9	Flavour					.
T_Density Flesh	58.5	Texture	-			-	
T_Toughness/Chew	55.2	Texture	-			-	
T_Juiciness	48.3	Texture	+				
T_Crispness	42.3	Texture					
T_Defrosted	6.9	Texture		+	.		.
T_Granular	5.3	Texture		.			
T_Skin Bits	4.2	Texture	-				
T_Pear Bits	4.1	Texture			.		
T_Skin Separation	1.6	Texture					
1_Hardness	64.0	1st Bite	-			-	
1_Juiciness	40.7	1st Bite	+			+	
1_Skin Toughness	16.6	1st Bite	-			-	
E_Green	114.6	Ext. App.		+			
E_Yellow Backgd	98.4	Ext. App.			.	+	
E_Green Backgd	54.7	Ext. App.			+	.	
E_Brown Specks	40.8	Ext. App.		.	.		
E_Shiny	38.4	Ext. App.		+			
E_Size	33.4	Ext. App.					+
E_Russet	33.1	Ext. App.		.	+		+
E_Fish Oil	20.0	Ext. App.					.
E_Scars	16.8	Ext. App.					
E_Grassy	10.5	Ext. App.		+			
E_Old Sacks	9.7	Ext. App.		.			+
E_Pink Blush	5.8	Ext. App.		+			.
E_Pear	3.7	Ext. App.					
E_Woody	3.5	Ext. App.		.			+

Appendices

Appendix one - Nine-point category scale used in consumer testing.

Appendix two - Sensory attributes used by the trained panel.

Appendix three - Mean sensory attribute scores for each pear.

Nine-point Category Scale used in Consumer Testing



Pear Study

ID:1

There are several different pears to taste. Please taste them as you would normally eat a pear - there is a knife available if you would normally use one.

You will receive the samples one at a time. Please check that the number on the plate matches the number on the score sheet.

Please answer all the questions by marking a 'X' in the relevant box.



Sample: 721

Please taste sample **721** and score it for how much you like it:

- Like extremely
- Like very much
- Like moderately
- Like slightly
- Neither like nor dislike
- Dislike slightly
- Dislike moderately
- Dislike very much
- Dislike extremely

When you have scored the sample, please pass it back through the hatch.

Then take a sip of water and eat a piece of cracker before tasting the next sample.



Sensory Attributes used by the Trained Panel

PANEL ATTRIBUTE TERMS FOR PEARS - WHOLE PEARS, UNPEELED

FEB 99 (All attributes scored from NIL to EXTREME unless indicated)

EXTERNAL APPEARANCE

- | | | |
|----|-------------------|--|
| 1 | Yellow background | Refers to the depth of yellow colour in the background |
| 2. | Green background | Refers to the depth of green colour in the background |
| 3. | Russet | Amount of brown colouration as on a russet apple |
| 4 | Shiny | Measure of how shiny the surface is. Scored from DULL to SHINY. |
| 5 | Brown specks | Amount of brown specks on the surface.(technical term: lenticels) |
| 6 | Green specks | Amount of green specs on the surface. |
| 7 | Pink blush | Amount of pink colouration - as found on pink lady apple |
| 8 | Size | Size of pear - an average sized pear as bought in shops would be about the middle of the scale |
| 9 | Scars | Black marks or indentations on skin |

EXTERNAL ODOUR

- | | | |
|----|-----------|---------------------------|
| 10 | Pear | Like pears |
| 11 | Old sacks | Like musty hessian sacks. |
| 12 | Woody | Like damp twigs |
| 13 | Grassy | Like freshly mown grass |
| 14 | Fish oil | Like cod liver oil |

FIRST BITE TEXTURE (Take one bite from the side with front teeth.)

- | | | |
|-----|----------------|---|
| 15. | Skin toughness | Measure of how tough the skin is. |
| 16. | Juiciness | Amount of juice from the first bite |
| 17 | Hardness | Resistance to bite. Scored from SOFT to HARD. |

TEXTURE(during chewing)

- | | | |
|-----|-----------------------|---|
| 18 | Crispness/crunchiness | How crisp the pears seems during chewing - brittle , makes a characteristic crunchy noise when chewing. Eg celery would be very crisp |
| 19 | Juiciness | Amount of juice produced during chewing |
| 20 | Skin separation | Extent to which skin separates from flesh |
| 21 | Toughness/chewiness | The amount of work required to break down the flesh (ignore skin) |
| 22 | Density of flesh | The degree of compactness of the cells. Scored from LOOSE CELLS to COMPACT |
| 23 | Granular | Sensation that there are small balls of pear flesh in the mouth |
| 24 | Defrosted | Like fruit that has been frozen and then defrosted. |
| 25 | Pear bits | Amount of bits (of pear flesh)left in mouth after chewing |
| 26. | Skin bits | Amount of tough skin bits in mouth |

FLAVOUR DURING CHEWING

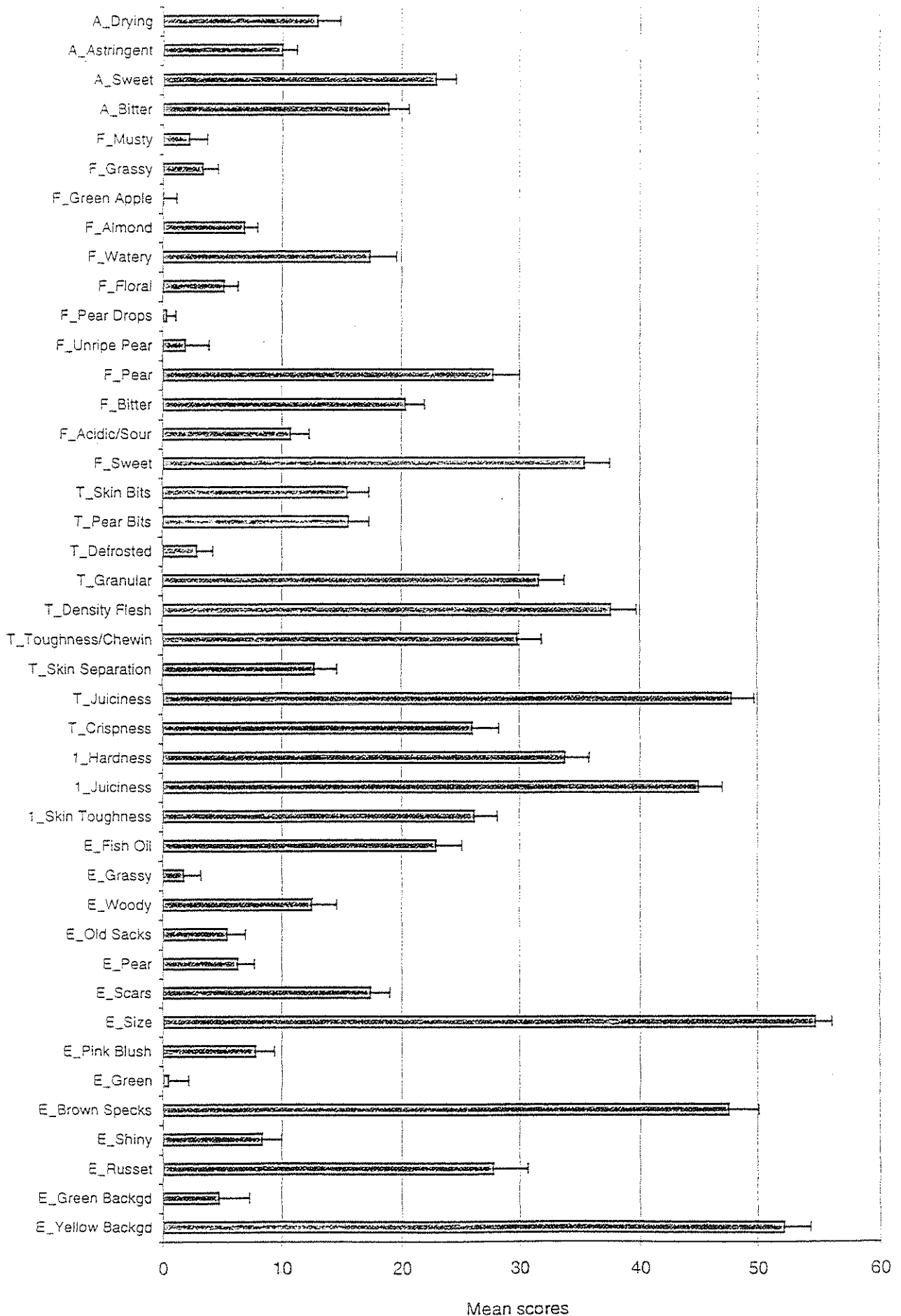
27	Sweet	One of basic tastes eg sucrose (table sugar)
28	Acidic/sour	One of basic tastes, eg. citric acid
29.	Bitter	One of basic tastes (eg quinine)
30.	Pear	Fully developed fresh pear flavour
31	Unripe pear	Associated with unripe pears, lacks maturity.
32	Pear drops	Flavour associated with pear drops sweets.
33	Floral	Like scented flowers - violets possibly
34	Watery	Tastes as if it is mainly water, lacking in flavour
35	Almond	Like almond essence
36	Green apple	Associated with green apples like Granny Smiths.
37	Grassy	Like freshly mown grass
38	Musty	Like musty barrels

AFTERSWALLOW (15 secs after swallowing)

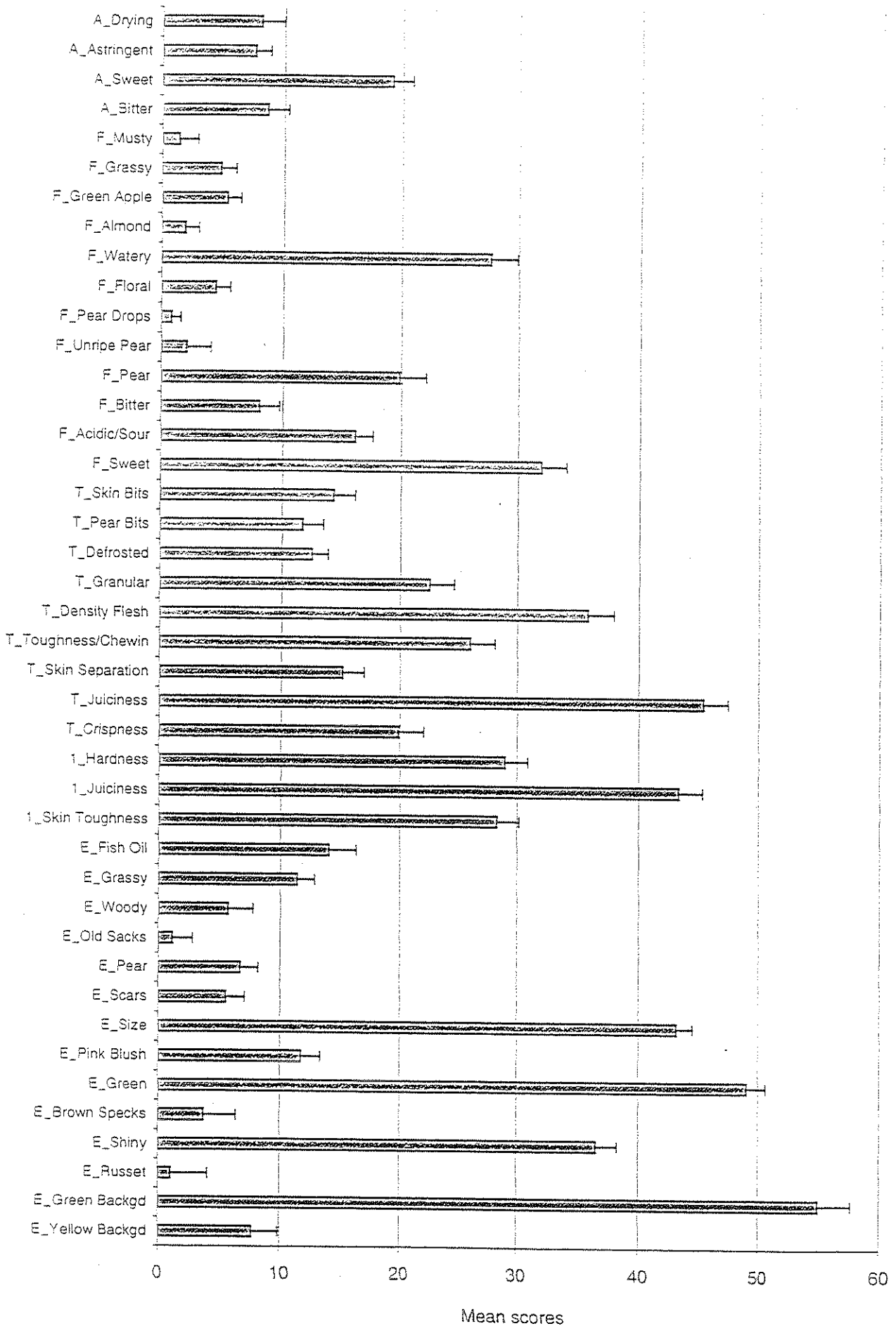
39	Bitter	
40	Sweet	
41	Astringent	Dries surface of the mouth (as tannic acid), mouthpuückering
42	Drying	Dry sensation in the mouth, lack of salivation

Mean Sensory Attribute Scores for each Pear

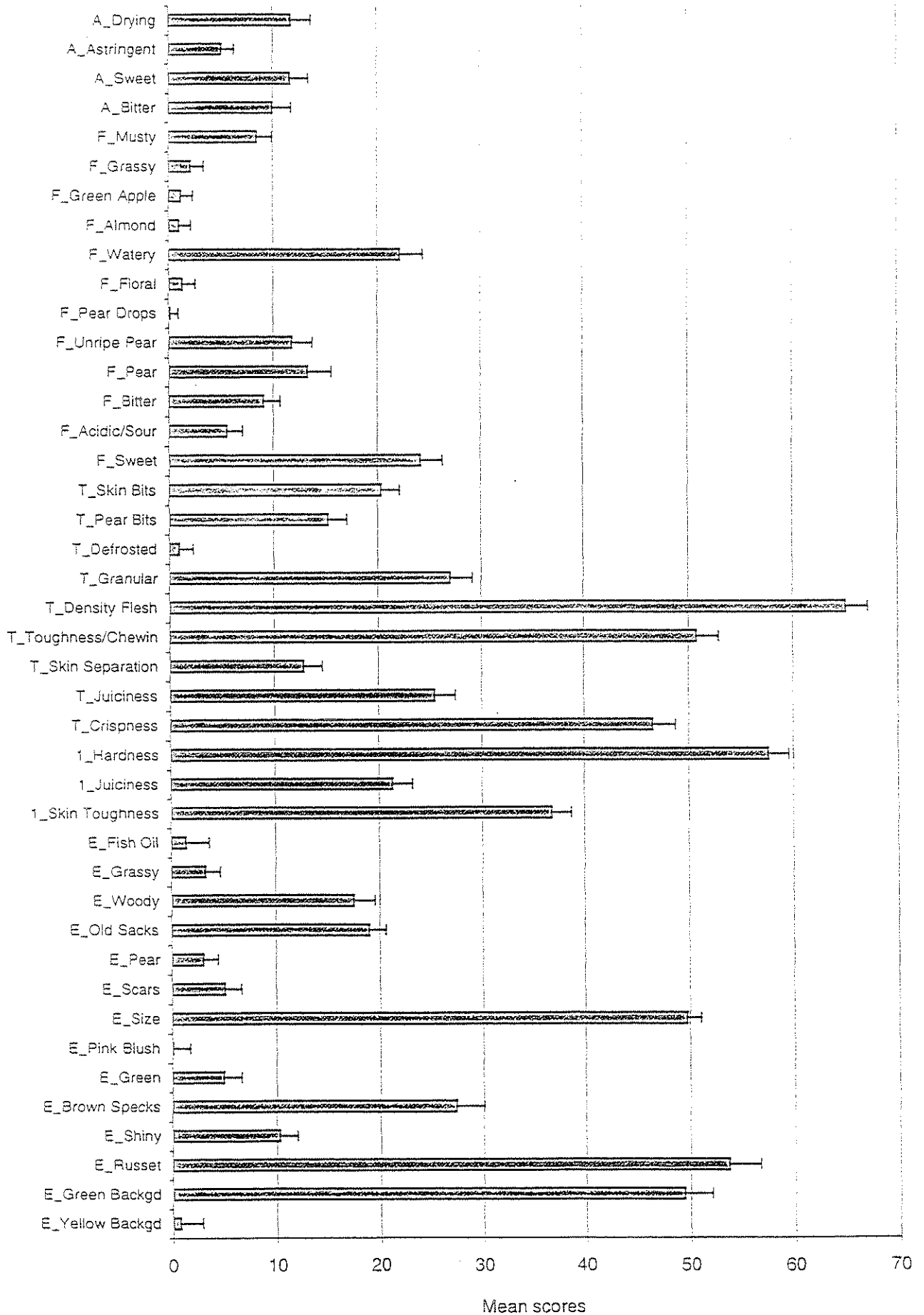
Abate Fateel (I) - mean scores for sensory attributes



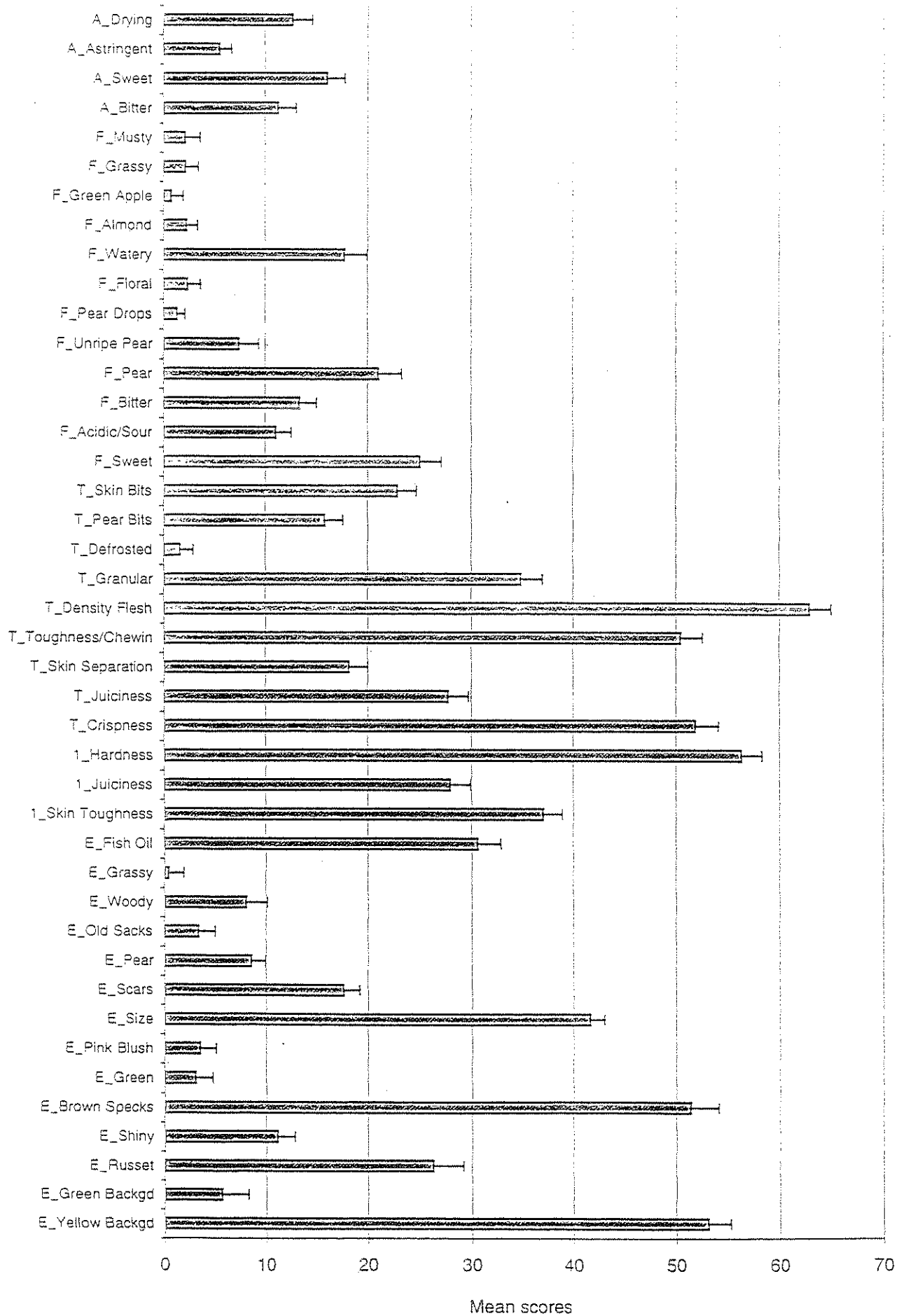
D'anjou (US) - mean scores for sensory attributes



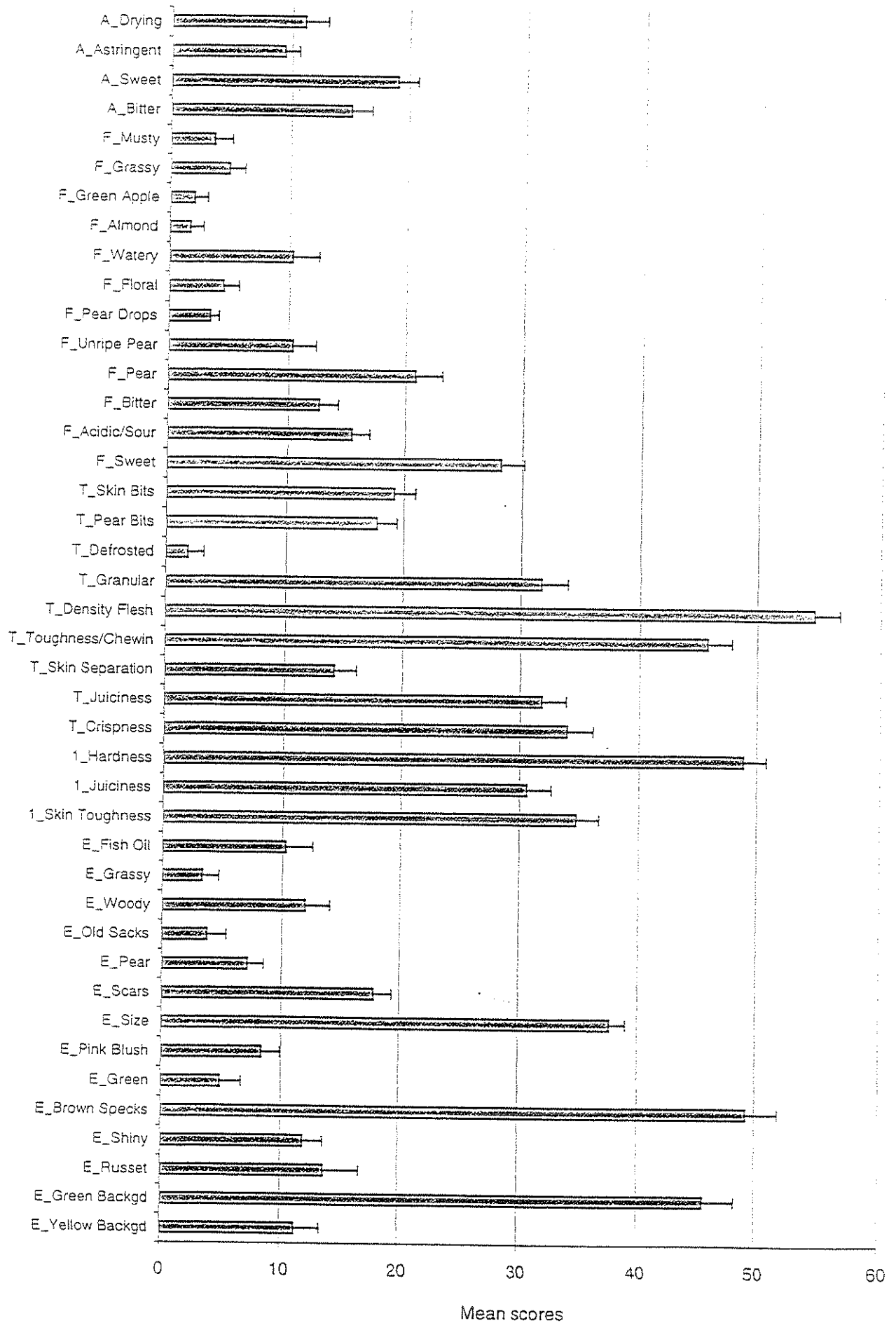
Conference (NL) - mean scores for sensory attributes



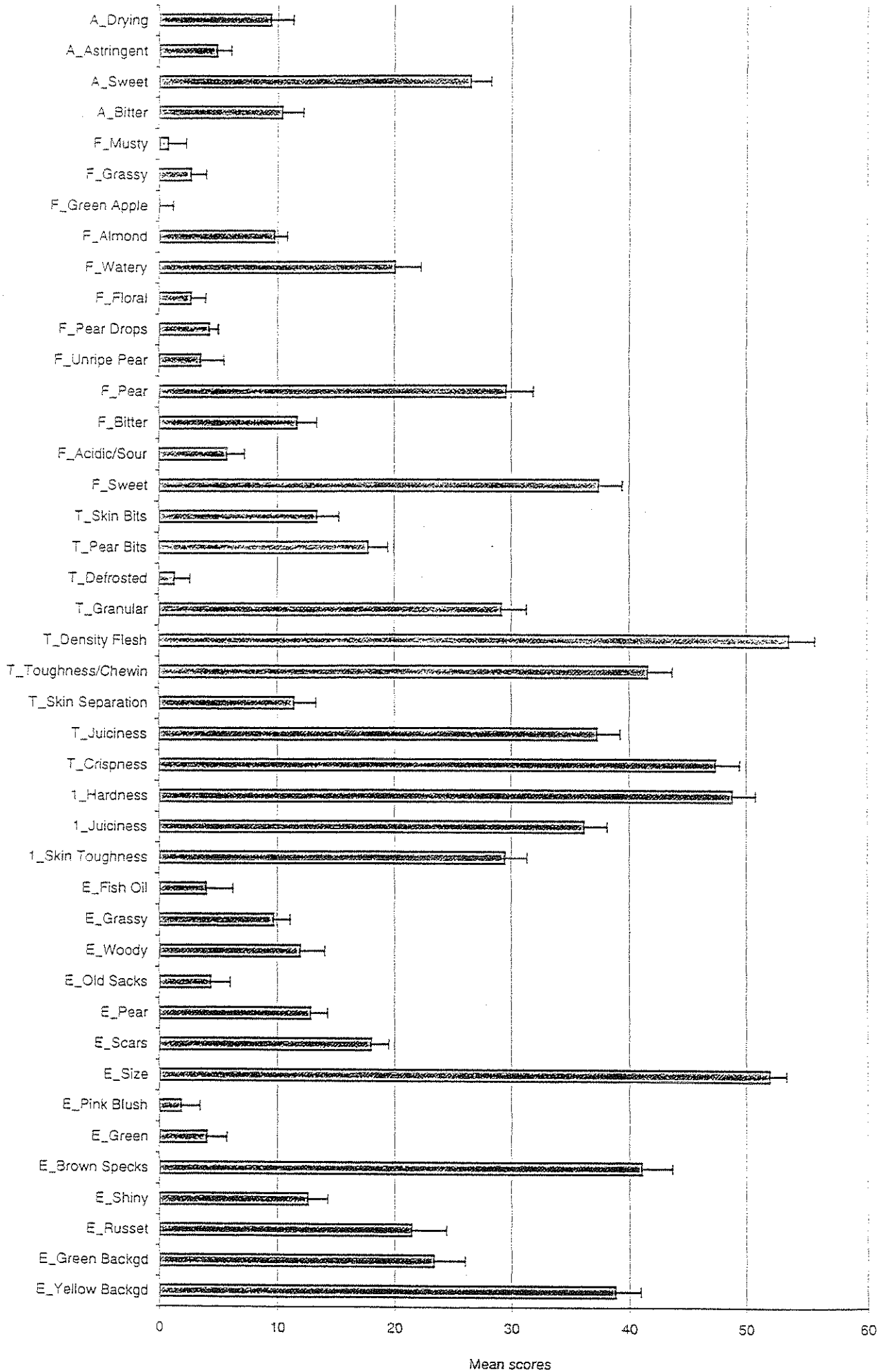
Rocha (P) - mean scores for sensory attributes



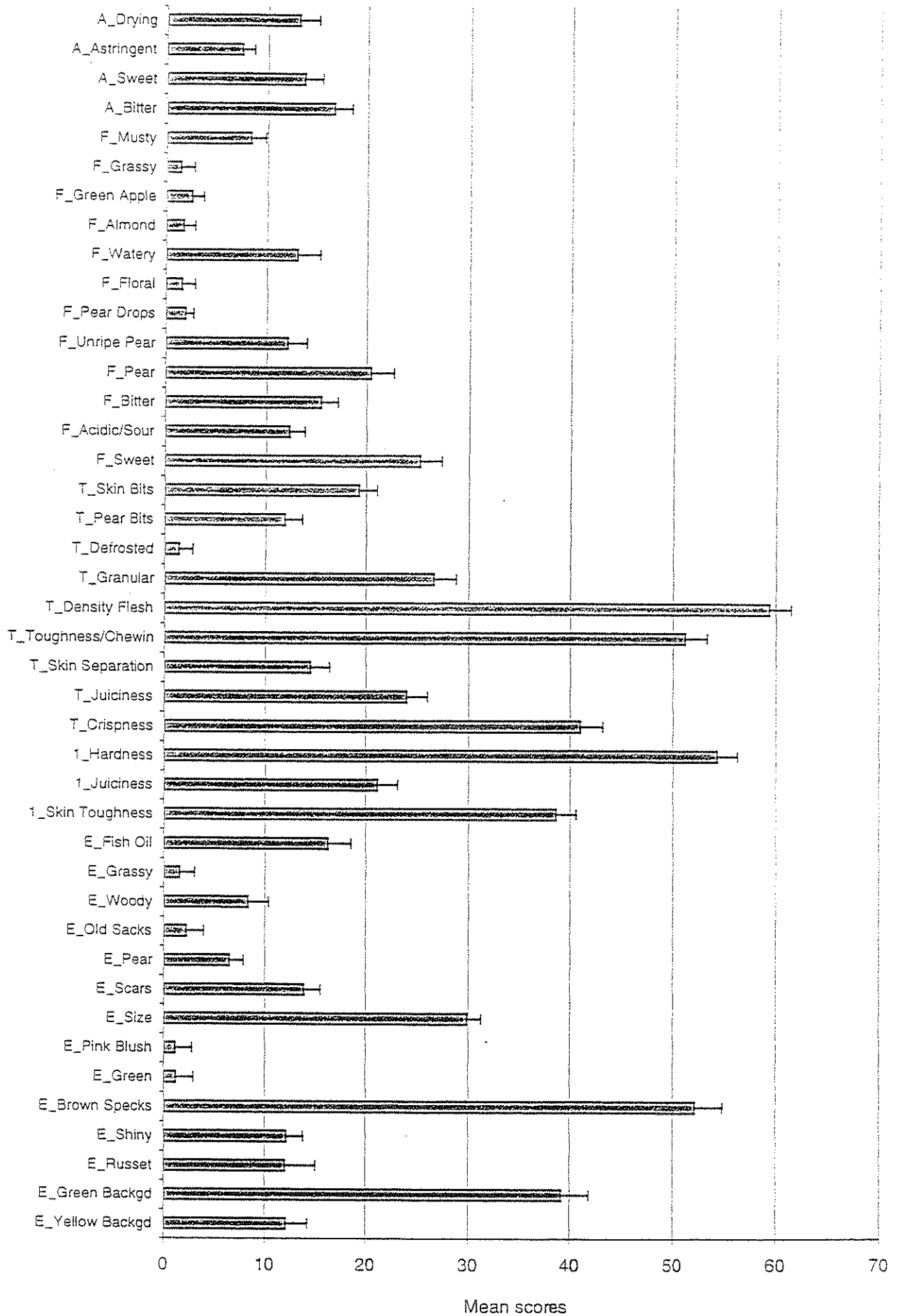
Comice (I) - mean scores for sensory attributes



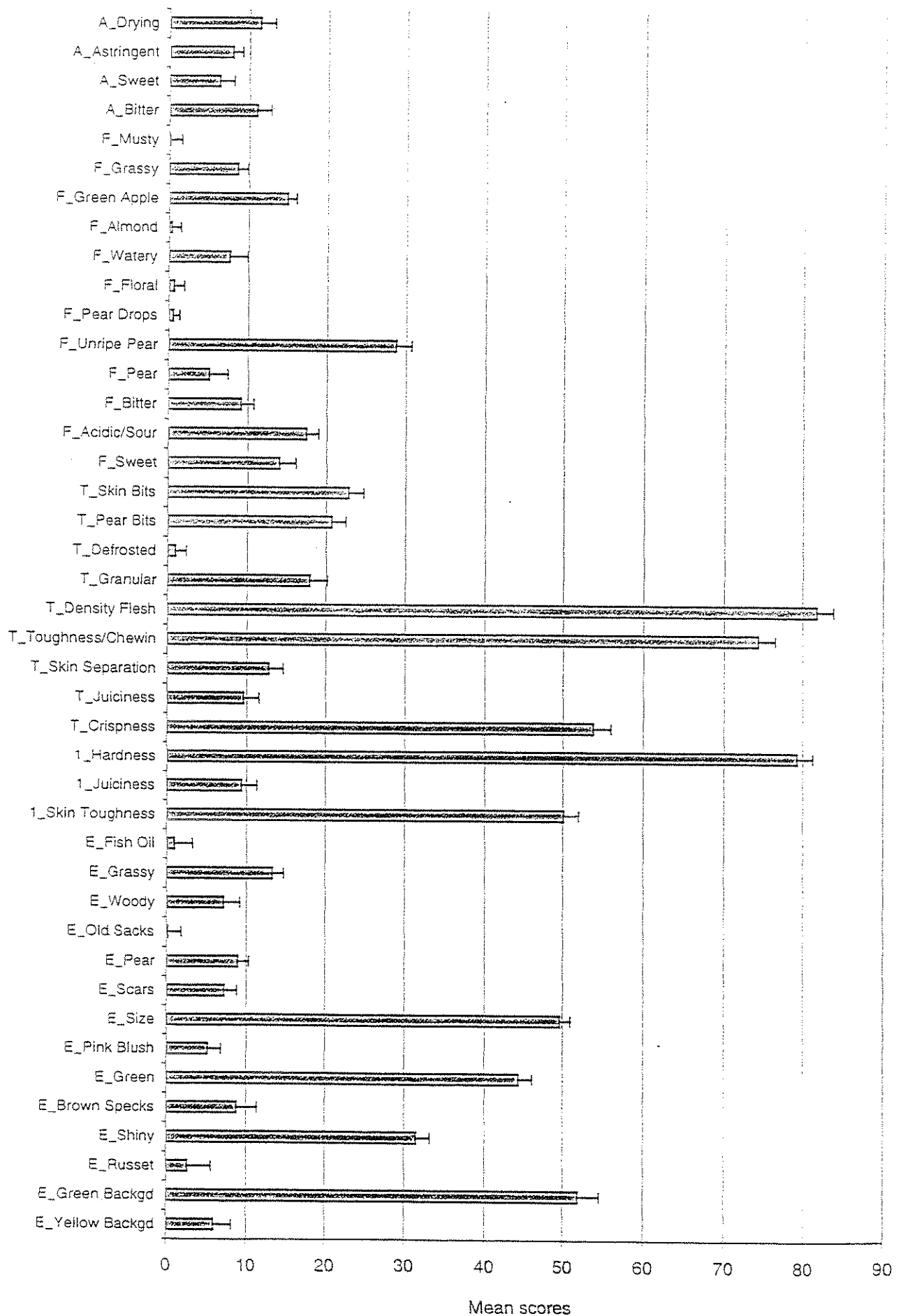
Concord(GB) - mean scores for sensory attributes



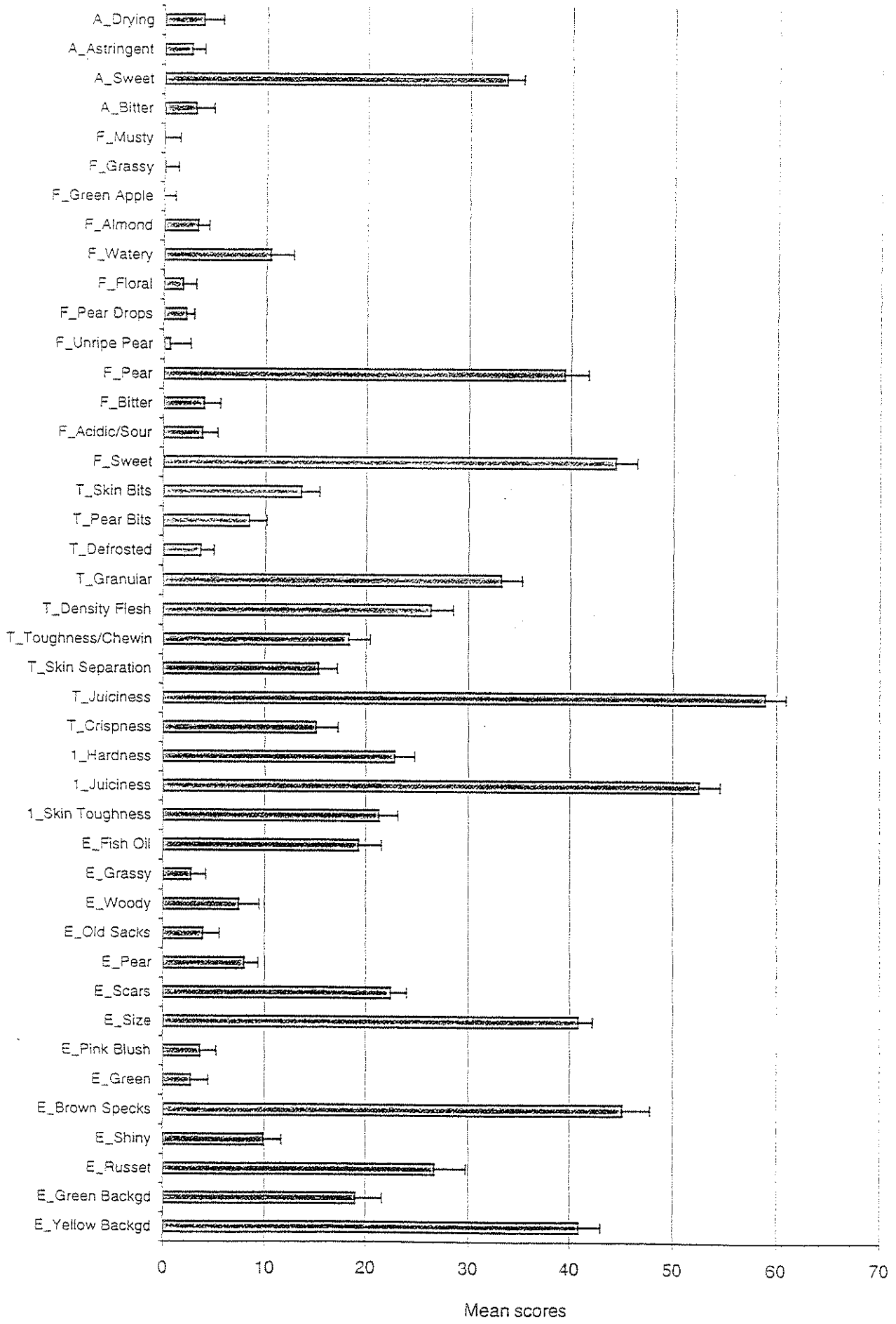
Packams (I) - mean scores for sensory attributes



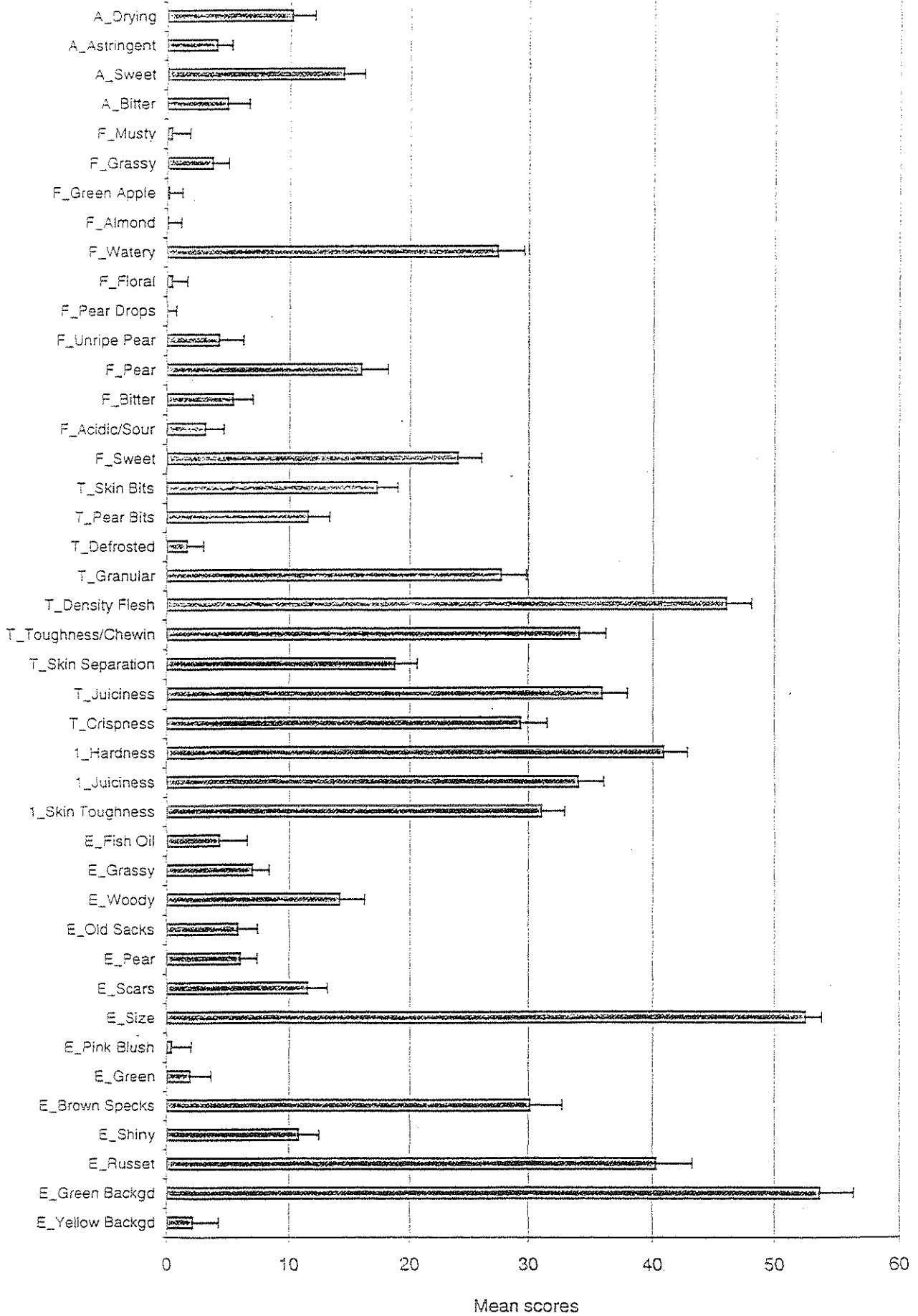
Williams (SA) - mean scores for sensory attributes



Conference (IT)- mean scores for sensory attributes



Conference (GB) - mean scores for sensory attributes



Buere Hardy (GB) - mean scores for sensory attributes

