



**SENSORY COMPARISON OF FROZEN FOOD AND
FRESH FOOD**

OCTOBER 2009

**A BFFF PROJECT IN CONJUNCTION WITH THE
MANCHESTER FOOD RESEARCH CENTRE**



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1. EXECUTIVE SUMMARY

BFFF launched a foodservice campaign in March 2009 which aims to highlight a business case for using frozen food. As part of this, the BFFF instructed the Manchester Food Research Centre to conduct a 'Sensory Comparison' study to compare the taste and texture of frozen versus 'fresh' foodstuffs.

The research results highlighted that there was no statistically significant differences in overall ratings for the frozen or 'fresh' food sample in the case of seven of the foodstuffs, the exception being the blueberries¹.

Generally the quality of all products was acceptable; sometimes the frozen product achieved a higher overall rating and sometimes the 'fresh' product. This indicates that, although individual attributes may vary, there is little difference between the two forms of the products.

The 'Sensory Comparison' study tested a range of foods to give them an overall rating on a range of characteristics using sensory analysis. Using a panel of 32 chefs, eight foods were tested - each in frozen and fresh form. Foodstuffs commonly used within UK pubs, restaurants and hotels, they comprised of a wholemeal bloomer, puff pastry, blueberries, potato mash, spinach, duck breasts, pork and leek sausage and tuna steaks.

¹ Researchers considered the variant and grade of fresh and frozen fruit supplied was dissimilar



2. METHODOLOGY OF THE PROJECT

The study and following analysis was conducted within the specially designed test facilities at the Manchester Food Research Centre, situated within The School of Food, Consumer, Tourism and Hospitality Management of the Manchester Metropolitan University.

Eight foodstuffs were tested within the study. They are 'food components' commonly served within UK pubs, restaurants and hotels. They comprised of:

- A wholemeal bloomer;
- Puff pastry;
- Blueberries;
- Potato mash;
- Spinach;
- Duck breasts;
- Pork and leek sausage; and,
- Tuna steaks.

The BFFF, via a leading national wholesaler, supplied MFRC with each of the above food components in its frozen format, plus select foods in a 'fresh' format. Where 'fresh' versions were not available, MFRC sourced the foodstuff from a local retailer. All frozen and 'fresh' foodstuffs were supplied to the same specifications², to exactly the same weight and serving size. All foodstuffs were prepared and cooked in accordance with the supplier's recommendation.

² Researchers considered the variant and grade of fresh and frozen fruit supplied was dissimilar

The samples were assessed by 32 chefs currently working in the North West of England. The chefs were selected from a wide range of foodservice sectors including city centre, suburban and country pubs, bars, restaurants and hotels.

Four sessions were held in turn with eight participating chefs. During each session the chefs tasted each of the eight foodstuff samples in turn. Samples were presented on disposable plates in individual tasting booths. Samples were randomised and allocated individual random numbers. Water was served throughout the tasting sessions, with participants encouraged to rinse their mouths between tastings. Portion sizes were small and uniform. Participants were asked to mark their response to sensory attributes on continuous lines on separate forms, with space also provided for comments. Samples were presented in the following order: wholemeal bloomer, puff pastry, blueberries, potato mash, spinach, duck breast, pork and leek sausage and tuna steak.

The sensory tests were designed in accordance with best practice using the guidance given in BS7183 (ISO8589). Data were collected using Fizz-software (Biosystems, v2.00k, 2003). For data analysis, the software package Fizz calculations (Biosystems, v2.10a, 2003) was used.

The differences between the samples were analysed statistically (using the Mann Whitney Test). We can identify statistically significant differences using a scale from 1 to 0. If the samples score identically then the significance will be 1. The closer to 0, the greater the probability of a noticeable difference between the samples. Statistically significance is generally accepted at levels below 0.05 (5%). Significant differences are indicated in the report at 0.05 (5%, represented by one *), 0.01 (0.1%, represented by **) and at 0.001 confidence (0.01%, represented by ***). Non-significant scores are represented by NS.

The samples were presented to the tasters in random order and coded sets. Presentation was conducted using best practice techniques in accordance with BS5929 (ISO 6658). Panellists were asked to give their opinion of the characteristics by marking a 10cm scale. They were requested to cleanse their palate between each sample. Results were collected and analysed. Summary scores are presented in the Appendix.



3. SENSORY DESCRIPTORS

The sensory descriptors used within the study were designed specifically for each foodstuff tested.

Bloomer

Appearance	Dense	-----	Light
Crust Colour	Light	-----	Dark
Mouthfeel	Hard	-----	Soft
Consistency	Stale	-----	Fresh
Texture	Dry	-----	Moist
Saltiness	Low	-----	High
Nuttiness	Low	-----	High
Overall Rating	Dislike	-----	Like

Puff Pastry

Appearance	Dense	-----	Light
Colour	Light	-----	Dark
Mouthfeel	Hard	-----	Soft
Density	Dense	-----	Light
Consistency	Stale	-----	Fresh
Texture	Dry	-----	Moist
Saltiness	Low	-----	High
Overall Rating	Dislike	-----	Like

Blueberries

Appearance	Withered	-----	Plump
Colour	Light	-----	Dark
Berries	Split	-----	Entire
Consistency	Mushy	-----	Firm
Texture	Dry	-----	Juicy
Acidity	Low	-----	High
Sweetness	Low	-----	High
Overall Rating	Dislike	-----	Like

Potato Mash

Appearance	Watery	-----	Firm
Colour	White	-----	Yellow
Mouthfeel	Lumpy	-----	Smooth
Density	Dense	-----	Light
Consistency	Watery	-----	Creamy

Taste	Bland	-----	Tasty
Saltiness	Low	-----	High
Overall Rating	Dislike	-----	Like

Spinach

Appearance	Sloppy	-----	Firm
Colour	Light	-----	Dark
Mouthfeel	Soft	-----	Firm
Consistency	Watery	-----	Firm
Flavour	Weak	-----	Strong
Sweetness	None	-----	Sweet
Overall Rating	Dislike	-----	Like

Duck breast

Appearance	Fatty	-----	Lean
Colour	Pink	-----	Dark
Mouthfeel	Tough	-----	Tender
Consistency	Soft	-----	Chewy
Texture	Dry	-----	Moist
Meatiness	Weak	-----	Strong
Greasiness	Low	-----	High
Overall Rating	Dislike	-----	Like

Pork & leek sausage

Appearance	Light	-----	Dark
Colour	Dark	-----	Golden
Appeal	Dry	-----	Succulent
Mouthfeel	Tough	-----	Tender
Consistency	Smooth	-----	Lumpy
Texture	Dry	-----	Moist
Meatiness	Weak	-----	Strong
Fattiness	Low	-----	High
Herbiness	Low	-----	High
Saltiness	Low	-----	High
Leek Flavour	Low	-----	High
Overall Rating	Dislike	-----	Like

Tuna steak

Appearance	Flaky	-----	Dense
Colour	Grey	-----	Pink
Texture	Soft	-----	Firm
Chewiness	Not	-----	Very
Mouthfeel	Dry	-----	Moist
Flavour	Weak	-----	Strong
Saltiness	Low	-----	High
Overall Rating	Dislike	-----	Like



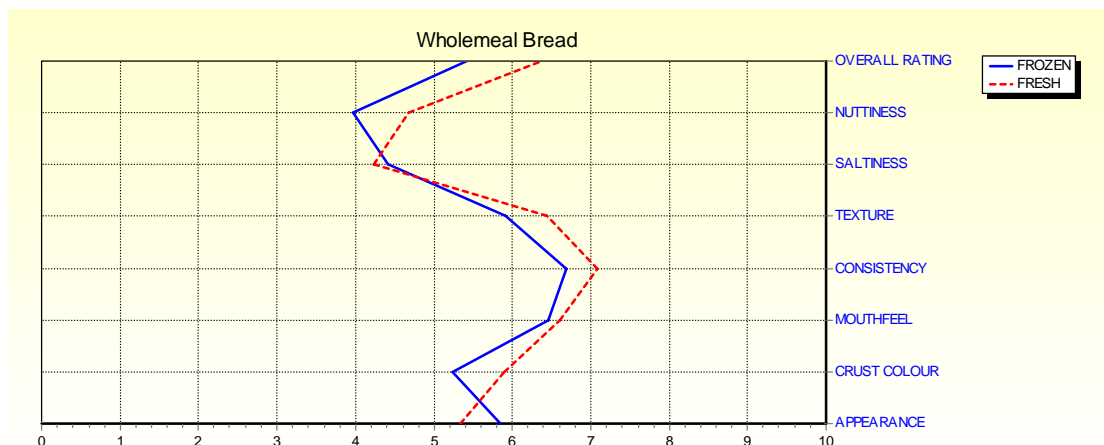
4. RESULTS

The following section highlights the sensory analysis results for each of the foodstuffs tested. Scores above “5” indicate a ‘positive’ detection for a particular attribute.

Wholemeal Bloomer

Whilst the fresh sample scored highest overall there were no significant differences for any of the product attributes tested.

Both samples were well received.

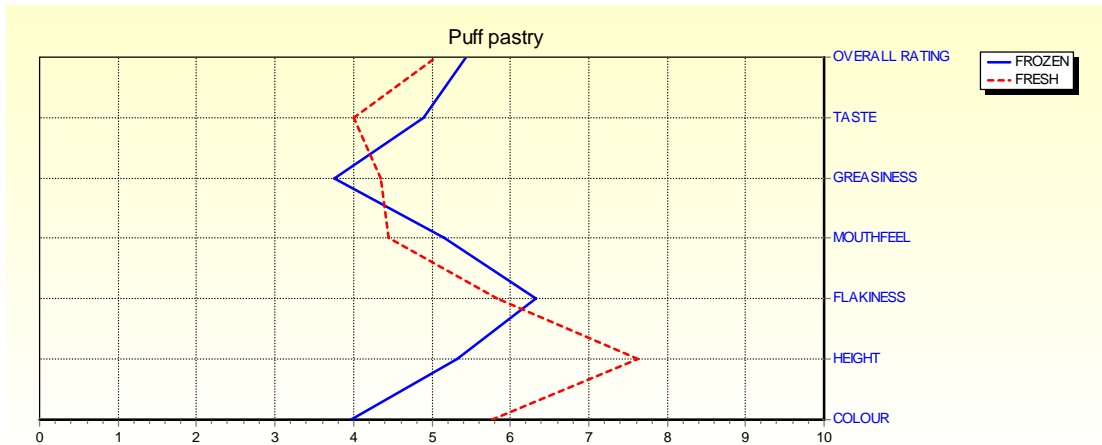


Puff Pastry

The frozen sample scored highest overall with a positive score for taste, mouthfeel, flakiness - and identified as less greasy.

There were statistically significant differences for colour and height but these did not influence the overall rating.

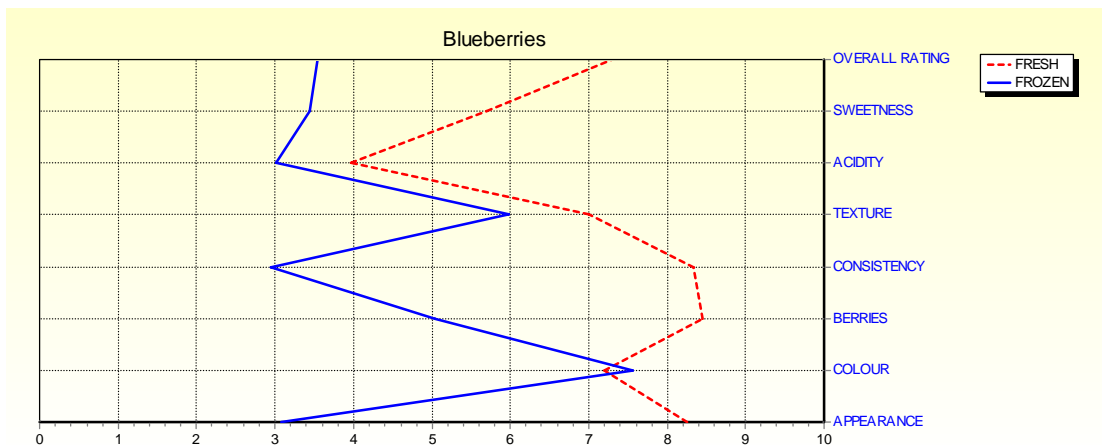
There was no discernible trend in the comments but one respondent stated that the frozen sample was “the best of the two”.



Blueberries

Results showed a preference for the ‘fresh’ over the frozen sample³. The statistically significant gap in the overall rating of the products, is largely influenced by texture and appearance – although the colour of the frozen sample was preferred.

Five of the panellists suggested that the fresh blueberries were “good” and one respondent stated that the sample was “definitely fresh”.



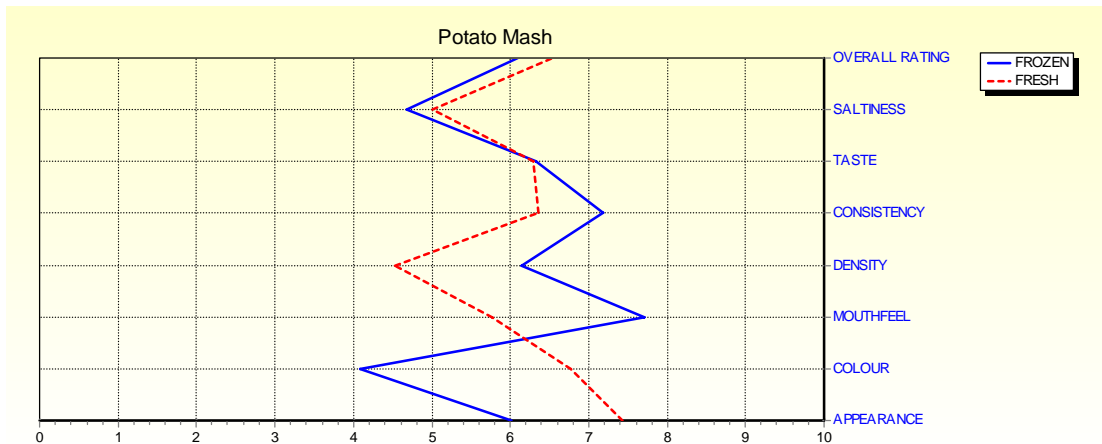
Potato Mash

Both products were well liked and there is no overall significant preference for either sample.

³ Researchers considered the variant and grade of fresh and frozen fruit supplied was dissimilar

The 'frozen' sample scored higher on density (significant preference), mouthfeel (significant preference) and consistency – and was like-for-like with 'fresh' on taste.

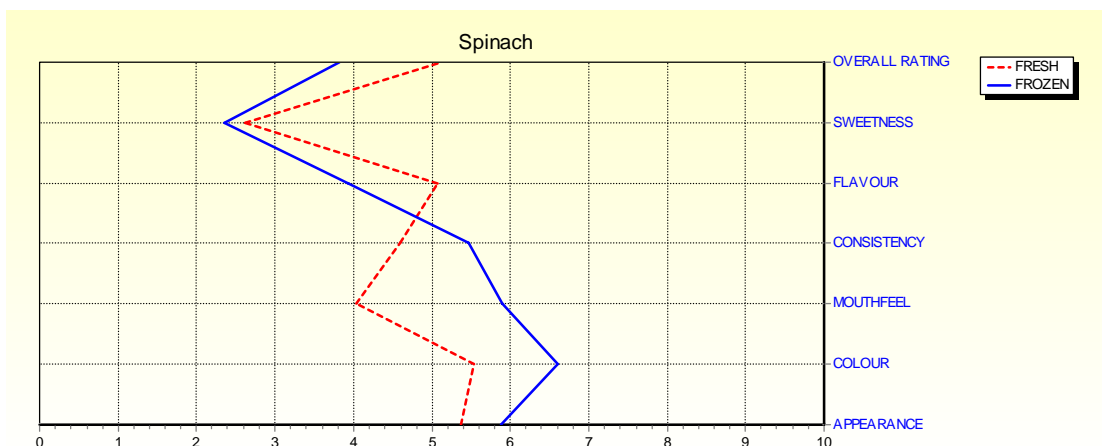
The fresh sample was described as “peppery” by nine members.



Spinach

The 'fresh' spinach was preferred but the preference is not statistically significant.

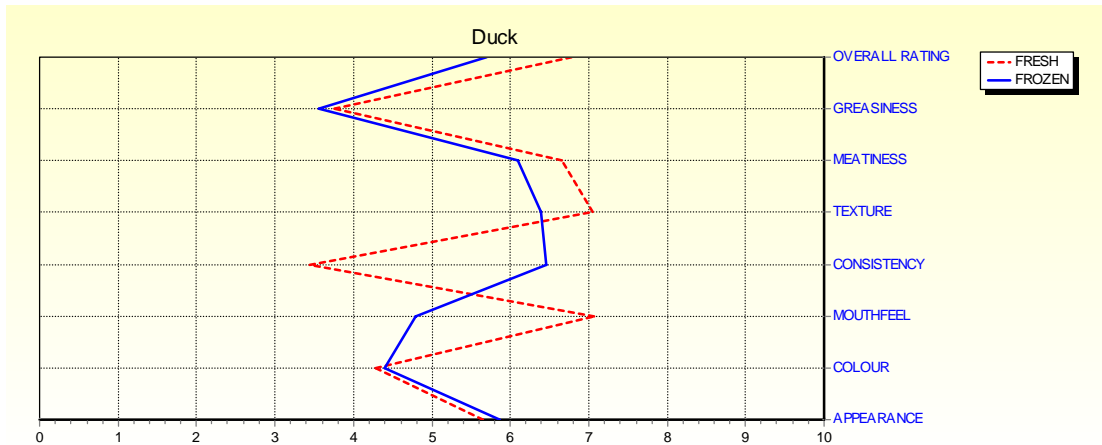
The frozen spinach was identified as statistically preferred in mouthfeel (firmness) and colour (darkness) than the 'fresh' sample which scored higher on flavour. The samples were comparable on appearance and sweetness.



Duck breast

There was no significant difference in the overall rating between frozen and 'fresh'.

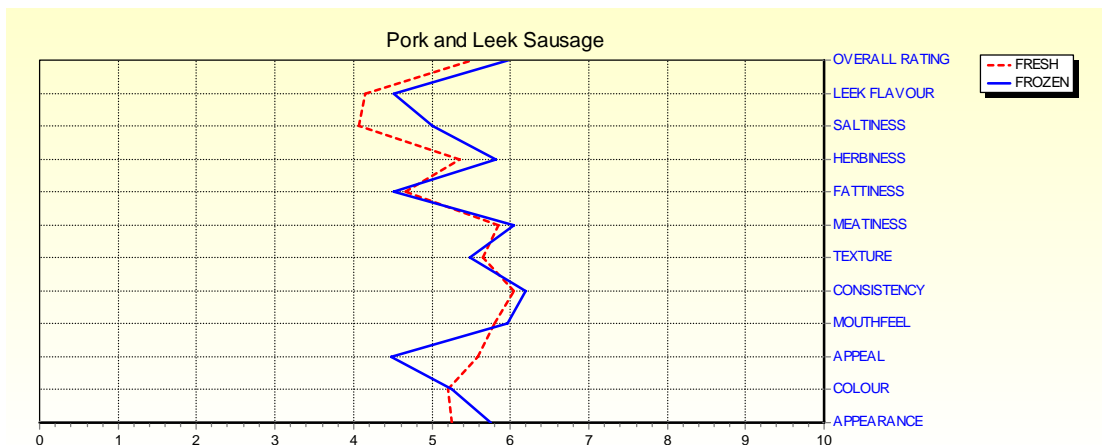
The frozen sample was significantly superior in consistency, whilst the 'fresh' sample was identified as statistically softer and more tender. Both samples were similar in greasiness, meatiness, texture, colour and appearance.



Pork and leek sausage

The frozen sample scored highest overall but there were no significant differences between the two samples.

Both the frozen and 'fresh' products were well received.

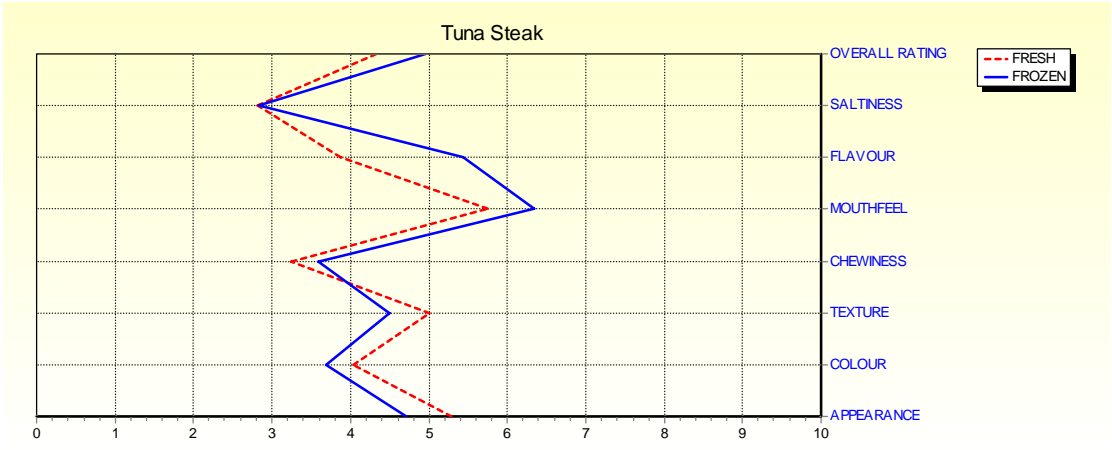


Tuna steak

The frozen sample scored highest overall but this was not statistically significant.

The frozen tuna was identified as statistically better in flavour and scored higher in mouthfeel, chewiness.

Frozen tuna generated a range of comment, but there is no discernable trend. The 'fresh' tuna was described as bland or lacking in flavour by 9 of the participants.





5. CONCLUSIONS

Results highlighted that there was no statistically significant differences in overall ratings for the frozen or 'fresh' food sample in the case of seven of the foodstuffs, the exception being the blueberries. This indicates that, although individual attributes may vary, there is little difference between the two forms of the products.

The study indicated the important attributes determining a high overall rating for each foodstuff. Generally the quality of all products was acceptable; sometimes the frozen product achieved a higher overall rating and sometimes the 'fresh' product.

Summary of results:

- *Wholemeal bloomer*
 - There was no significant difference for any of the product attributes tested. Both samples were well received.
- *Puff pastry*
 - There was no significant preference for either sample. However, overall the frozen sample scored higher than fresh.
- *Blueberries*
 - There was a significant difference. The 'fresh' sample was preferred over the frozen.⁴
- *Potato mash*
 - Both products were well liked and there was no overall significant preference for either sample.
- *Spinach*
 - There was no significant preference for either sample.
- *Duck breast*
 - There was no significant difference in the overall rating between frozen and 'fresh'.

⁴ Researchers considered the variant and grade of fresh and frozen fruit supplied was dissimilar

- *Pork & leek sausages*
 - The frozen sample scored highest overall but there were no significant differences between the two samples.
- *Tuna steak*
 - The frozen sample scored highest overall but this was not statistically significant.



APPENDIX 1

STATISTICAL DATA

WHOLEMEAL BLOOMER

File: G:\Frozen foods\Wholemeal bloomer.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FROZEN	FRESH
APPEARANCE	5.85	5.33
CRUST COLOUR	5.25	5.89
MOUTHFEEL	6.46	6.6
CONSISTENCY	6.69	7.09
TEXTURE	5.91	6.44
SALTINESS	4.41	4.24
NUTTINESS	3.97	4.69
OVERALL RATING	5.41	6.38

File: G:\Frozen foods\Wholemeal Bloomer.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FROZEN	32
Answers FRESH	32
Number of ties	8
Sum of ranks FROZEN	1123.5
Sum of ranks FRESH	956.5
Computed U1	428.5
Computed U2	595.5
Significance	NS
NS: not significant at 5 % ,*: 5 % , **: 1 % , ***: 0,1 %	

Attribute CRUST COLOUR	
Answers FROZEN	32
Answers FRESH	32
Number of ties	5
Sum of ranks FROZEN	942
Sum of ranks FRESH	1138
Computed U1	610
Computed U2	414
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute MOUTHFEEL	
Answers FROZEN	32
Answers FRESH	32
Number of ties	2
Sum of ranks FROZEN	992
Sum of ranks FRESH	1088
Computed U1	560
Computed U2	464
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute CONSISTENCY	
Answers FROZEN	32
Answers FRESH	32
Number of ties	5
Sum of ranks FROZEN	969
Sum of ranks FRESH	1111
Computed U1	583
Computed U2	441
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute TEXTURE	
Answers FROZEN	32
Answers FRESH	31
Number of ties	0
Sum of ranks FROZEN	940
Sum of ranks FRESH	1076
Computed U1	580
Computed U2	412
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute SALTINESS	
Answers FROZEN	32
Answers FRESH	32
Number of ties	6
Sum of ranks FROZEN	1079
Sum of ranks FRESH	1001
Computed U1	473
Computed U2	551
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute NUTTINESS	

Answers FROZEN	32
Answers FRESH	32
Number of ties	6
Sum of ranks FROZEN	928
Sum of ranks FRESH	1152
Computed U1	624
Computed U2	400
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute OVERALL RATING	
Answers FROZEN	32
Answers FRESH	32
Number of ties	4
Sum of ranks FROZEN	925
Sum of ranks FRESH	1155
Computed U1	627
Computed U2	397
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

PUFF PASTRY

File: G:\Frozen foods\Puff pastry.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FROZEN	FRESH
COLOUR	3.96	5.76
HEIGHT	5.33	7.63
FLAKINESS	6.33	5.83
MOUTHFEEL	5.16	4.45
GREASINESS	3.76	4.34
TASTE	4.89	4
OVERALL RATING	5.43	5.05

File: G:\Frozen foods\Puff pastry.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute COLOUR	
Answers FROZEN	32
Answers FRESH	31
Number of ties	10
Sum of ranks FROZEN	663
Sum of ranks FRESH	1353
Computed U1	857
Computed U2	135
Significance	***
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute HEIGHT	
Answers FROZEN	32
Answers FRESH	32
Number of ties	6
Sum of ranks FROZEN	724

Sum of ranks FRESH	1356
Computed U1	828
Computed U2	196
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute FLAKINESS	
Answers FROZEN	32
Answers FRESH	30
Number of ties	4
Sum of ranks FROZEN	1066
Sum of ranks FRESH	887
Computed U1	422
Computed U2	538
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute MOUTHFEEL	
Answers FROZEN	32
Answers FRESH	32
Number of ties	16
Sum of ranks FROZEN	1148
Sum of ranks FRESH	932
Computed U1	404
Computed U2	620
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute GREASINESS	
Answers FROZEN	31
Answers FRESH	32
Number of ties	6
Sum of ranks FROZEN	907
Sum of ranks FRESH	1109
Computed U1	581
Computed U2	411
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute TASTE	
Answers FROZEN	32
Answers FRESH	32
Number of ties	2
Sum of ranks FROZEN	1184
Sum of ranks FRESH	896
Computed U1	368
Computed U2	656
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute OVERALL RATING	
Answers FROZEN	32
Answers FRESH	32
Number of ties	8
Sum of ranks FROZEN	1121
Sum of ranks FRESH	959
Computed U1	431

Computed U2	593
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

BLUEBERRIES⁵

File: G:\Frozen foods\Blueberries.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FRESH	FROZEN
APPEARANCE	8.25	3.09
COLOUR	7.2	7.56
BERRIES	8.46	5.04
CONSISTENCY	8.34	2.95
TEXTURE	6.99	5.97
ACIDITY	3.98	3.02
SWEETNESS	5.7	3.44
OVERALL RATING	7.31	3.55

File: G:\Frozen foods\Blueberries.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	4
Sum of ranks FRESH	1535
Sum of ranks FROZEN	545
Computed U1	17
Computed U2	1007
Significance	***
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute COLOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	929
Sum of ranks FROZEN	1151
Computed U1	623
Computed U2	401
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

⁵ Researchers considered the variant and grade of fresh and frozen fruit supplied was dissimilar

Attribute BERRIES	
Answers FRESH	32
Answers FROZEN	32
Number of ties	11
Sum of ranks FRESH	1429
Sum of ranks FROZEN	651
Computed U1	123
Computed U2	901
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute CONSISTENCY	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	1536
Sum of ranks FROZEN	544
Computed U1	16
Computed U2	1008
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute TEXTURE	
Answers FRESH	31
Answers FROZEN	31
Number of ties	4
Sum of ranks FRESH	1087.5
Sum of ranks FROZEN	865.5
Computed U1	369.5
Computed U2	591.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute ACIDITY	
Answers FRESH	32
Answers FROZEN	32
Number of ties	8
Sum of ranks FRESH	1150
Sum of ranks FROZEN	930
Computed U1	402
Computed U2	622
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute SWEETNESS	
Answers FRESH	32
Answers FROZEN	32
Number of ties	4
Sum of ranks FRESH	1326
Sum of ranks FROZEN	754
Computed U1	226
Computed U2	798
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute OVERALL RATING	

Answers FRESH	31
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	1402
Sum of ranks FROZEN	614
Computed U1	86
Computed U2	906
Significance	***
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

POTATO MASH

File: G:\Frozen foods\Potato Mash.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FROZEN	FRESH
APPEARANCE	6.02	7.42
COLOUR	4.09	6.78
MOUTHFEEL	7.71	5.76
DENSITY	6.14	4.52
CONSISTENCY	7.19	6.35
TASTE	6.33	6.3
SALTINESS	4.68	5.01
OVERALL RATING	6.1	6.54

File: G:\Frozen foods\Potato Mash.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FROZEN	32
Answers FRESH	32
Number of ties	11
Sum of ranks FROZEN	774
Sum of ranks FRESH	1306
Computed U1	778
Computed U2	246
Significance	***
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute COLOUR	
Answers FROZEN	32
Answers FRESH	32
Number of ties	10
Sum of ranks FROZEN	641
Sum of ranks FRESH	1439
Computed U1	911
Computed U2	113
Significance	***
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute MOUTHFEEL	
Answers FROZEN	32
Answers FRESH	32
Number of ties	9

Sum of ranks FROZEN	1325.5
Sum of ranks FRESH	754.5
Computed U1	226.5
Computed U2	797.5
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute DENSITY	
Answers FROZEN	31
Answers FRESH	32
Number of ties	2
Sum of ranks FROZEN	1242.5
Sum of ranks FRESH	773.5
Computed U1	245.5
Computed U2	746.5
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute CONSISTENCY	
Answers FROZEN	32
Answers FRESH	32
Number of ties	10
Sum of ranks FROZEN	1234
Sum of ranks FRESH	846
Computed U1	318
Computed U2	706
Significance	**
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute TASTE	
Answers FROZEN	32
Answers FRESH	32
Number of ties	5
Sum of ranks FROZEN	1044
Sum of ranks FRESH	1036
Computed U1	508
Computed U2	516
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute SALTINESS	
Answers FROZEN	32
Answers FRESH	32
Number of ties	10
Sum of ranks FROZEN	1014.5
Sum of ranks FRESH	1065.5
Computed U1	537.5
Computed U2	486.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	

Attribute OVERALL RATING	
Answers FROZEN	31
Answers FRESH	31
Number of ties	6
Sum of ranks FROZEN	926.5
Sum of ranks FRESH	1026.5
Computed U1	530.5
Computed U2	430.5
Significance	NS
NS: not significant at 5 % , *: 5 %, **: 1 %, ***: 0,1 %	

SPINACH

File: G:\Frozen foods\Spinach.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FRESH	FROZEN
APPEARANCE	5.37	5.89
COLOUR	5.53	6.61
MOUTHFEEL	4.04	5.89
CONSISTENCY	4.6	5.48
FLAVOUR	5.08	3.93
SWEETNESS	2.61	2.35
OVERALL RATING	5.13	3.82

File: G:\Frozen foods\Spinach.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	977
Sum of ranks FROZEN	1103
Computed U1	575
Computed U2	449
Significance	NS
NS: not significant at 5 % , *: 5 %, **: 1 %, ***: 0,1 %	
Attribute COLOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	856.5
Sum of ranks FROZEN	1223.5
Computed U1	695.5
Computed U2	328.5
Significance	*
NS: not significant at 5 % , *: 5 %, **: 1 %, ***: 0,1 %	

Attribute MOUTHFEEL	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	822.5
Sum of ranks FROZEN	1257.5
Computed U1	729.5
Computed U2	294.5
Significance	**
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute CONSISTENCY	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	919.5
Sum of ranks FROZEN	1160.5
Computed U1	632.5
Computed U2	391.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute FLAVOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	8
Sum of ranks FRESH	1179
Sum of ranks FROZEN	901
Computed U1	373
Computed U2	651
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute SWEETNESS	
Answers FRESH	32
Answers FROZEN	32
Number of ties	12
Sum of ranks FRESH	1083.5
Sum of ranks FROZEN	996.5
Computed U1	468.5
Computed U2	555.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute OVERALL RATING	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	1183.5
Sum of ranks FROZEN	896.5
Computed U1	368.5
Computed U2	655.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	

File: G:\Frozen foods\Duck breast.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FRESH	FROZEN
APPEARANCE	5.65	5.87
COLOUR	4.29	4.39
MOUTHFEEL	7.07	4.79
CONSISTENCY	3.45	6.45
TEXTURE	7.05	6.4
MEATINESS	6.65	6.1
GREASINESS	3.75	3.55
OVERALL RATING	6.78	5.7

File: G:\Frozen foods\Duck breast.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	4
Sum of ranks FRESH	1001
Sum of ranks FROZEN	1079
Computed U1	551
Computed U2	473
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute COLOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	1035.5
Sum of ranks FROZEN	1044.5
Computed U1	516.5
Computed U2	507.5
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute MOUTHFEEL	
Answers FRESH	32
Answers FROZEN	31
Number of ties	6
Sum of ranks FRESH	1288
Sum of ranks FROZEN	728
Computed U1	232
Computed U2	760
Significance	***
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

Attribute CONSISTENCY	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	683.5
Sum of ranks FROZEN	1396.5
Computed U1	868.5
Computed U2	155.5
Significance	***
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute TEXTURE	
Answers FRESH	31
Answers FROZEN	32
Number of ties	10
Sum of ranks FRESH	1057
Sum of ranks FROZEN	959
Computed U1	431
Computed U2	561
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute MEATINESS	
Answers FRESH	31
Answers FROZEN	32
Number of ties	4
Sum of ranks FRESH	1071
Sum of ranks FROZEN	945
Computed U1	417
Computed U2	575
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute GREASINESS	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	1068.5
Sum of ranks FROZEN	1011.5
Computed U1	483.5
Computed U2	540.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute OVERALL RATING	
Answers FRESH	32
Answers FROZEN	31
Number of ties	6
Sum of ranks FRESH	1164
Sum of ranks FROZEN	852
Computed U1	356
Computed U2	636
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	

PORK AND LEEK SAUSAGE

File: G:\Frozen foods\Pork & leek sausage.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FRESH	FROZEN
APPEARANCE	5.25	5.76
COLOUR	5.21	5.25
APPEAL	5.59	4.47
MOUTHFEEL	5.8	5.96
CONSISTENCY	6.04	6.2
TEXTURE	5.65	5.48
MEATINESS	5.85	6.05
FATTINESS	4.65	4.51
HERBINESS	5.35	5.82
SALTINESS	4.07	5.01
LEEK FLAVOUR	4.16	4.51
OVERALL RATING	5.51	5.98

File: G:\Frozen foods\Pork & leek sausage.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	958.5
Sum of ranks FROZEN	1121.5
Computed U1	593.5
Computed U2	430.5
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute COLOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	1051
Sum of ranks FROZEN	1029
Computed U1	501
Computed U2	523
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute APPEAL	
Answers FRESH	31
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	1129
Sum of ranks FROZEN	887
Computed U1	359
Computed U2	633
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

Attribute MOUTHFEEL	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	1009
Sum of ranks FROZEN	1071
Computed U1	543
Computed U2	481
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute CONSISTENCY	
Answers FRESH	32
Answers FROZEN	32
Number of ties	8
Sum of ranks FRESH	1075.5
Sum of ranks FROZEN	1004.5
Computed U1	476.5
Computed U2	547.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute TEXTURE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	1050
Sum of ranks FROZEN	1030
Computed U1	502
Computed U2	522
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute MEATINESS	
Answers FRESH	32
Answers FROZEN	32
Number of ties	10
Sum of ranks FRESH	992
Sum of ranks FROZEN	1088
Computed U1	560
Computed U2	464
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute FATTINESS	
Answers FRESH	32
Answers FROZEN	31
Number of ties	6
Sum of ranks FRESH	1036.5
Sum of ranks FROZEN	979.5
Computed U1	483.5
Computed U2	508.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	

TUNA STEAK

File: G:\Frozen foods\Tuna steak.frp		
Option: Descriptive statistics		
Comparison table of means		
Attribute	FRESH	FROZEN
APPEARANCE	5.28	4.71
COLOUR	4.04	3.69
TEXTURE	5.01	4.5
CHEWINESS	3.25	3.59
MOUTHFEEL	5.74	6.34
FLAVOUR	3.88	5.43
SALTINESS	2.82	2.84
OVERALL RATING	4.34	4.96

File: G:\Frozen foods\Tuna steak.frp	
Profile 1	
Option: Mann Whitney test	
Raw data	
Two-tailed test	
Attribute APPEARANCE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	4
Sum of ranks FRESH	1137.5
Sum of ranks FROZEN	942.5
Computed U1	414.5
Computed U2	609.5
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute COLOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	8
Sum of ranks FRESH	1049
Sum of ranks FROZEN	1031
Computed U1	503
Computed U2	521
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	
Attribute TEXTURE	
Answers FRESH	32
Answers FROZEN	32
Number of ties	5
Sum of ranks FRESH	1101
Sum of ranks FROZEN	979
Computed U1	451
Computed U2	573
Significance	NS
NS: not significant at 5 % , *: 5 % , **: 1 % , ***: 0,1 %	

Attribute CHEWINESS	
Answers FRESH	32
Answers FROZEN	32
Number of ties	4
Sum of ranks FRESH	984
Sum of ranks FROZEN	1096
Computed U1	568
Computed U2	456
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute MOUTHFEEL	
Answers FRESH	32
Answers FROZEN	32
Number of ties	2
Sum of ranks FRESH	976.5
Sum of ranks FROZEN	1103.5
Computed U1	575.5
Computed U2	448.5
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute FLAVOUR	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	850
Sum of ranks FROZEN	1230
Computed U1	702
Computed U2	322
Significance	*
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute SALTINESS	
Answers FRESH	32
Answers FROZEN	32
Number of ties	6
Sum of ranks FRESH	1019
Sum of ranks FROZEN	1061
Computed U1	533
Computed U2	491
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	
Attribute OVERALL RATING	
Answers FRESH	31
Answers FROZEN	32
Number of ties	0
Sum of ranks FRESH	920
Sum of ranks FROZEN	1096
Computed U1	568
Computed U2	424
Significance	NS
NS: not significant at 5 % ,*: 5 %, **: 1 %, ***: 0,1 %	



APPENDIX 2

CHEFS NAMES AND ORGANISATIONS

NAME	POSITION	ESTABLISHMENT	SIZE
Alan Edge	Chef	Player's	80 covers
Andrew Bebbington	Chef	Quilty Hotel	200 covers
Andrew Rainford	Chef	Hilton Hotel	150 covers
Brian Yates	Chef	Hopwood Hall	120 covers
C. Wilson	Chef	The Gardens Rest	45 covers
David Strothard Shar	Chef	Buxton Masonic Hall	100 covers
Dean Sharp	Chef	Avenance Catering	200 covers
Dermot Stutz	Chef	High Peak Golf Club	180 covers
Elaine Pickett	Chef	Freelance	various
Gary Waterhouse	Chef	Royal Oak Hotel	50 covers
Herbie Davies	Chef	Ravenstone Catering Services	70 covers
Jean Henderson	Chef	View Rest	45 covers
Jefferson Green	Chef	Greens restaurant	80 covers
John Daley	Chef	Toasts Event Catering	various
John Raffo	Chef	Giovanni Mobile Pizzeria	various
Karen Wright	Chef	The View	45 covers
Katherine Browbridge	Chef	The Lead Station	60 covers
Marie Hatton	Chef	Bredbury Hall Hotel	150 covers
Mark Gibson	Chef	Press House Wine Bars	200 covers
Matthew Burne	Chef	Chancellor's Hotel	120 covers
Naged Omari	Chef	Hilton Hotel	150 covers
Paul Linever	Chef	Chancellor's Hotel	120 covers
Paul McNair	Chef	Hilton Hotel	150 covers
Paul Watson	Chef	Fat Loaf	150 covers
Paul Yau	Chef	Tameside College	100 covers
Richard Bell	Chef	Jem 81	80 covers
Robert Edwards	Chef	Bredbury Hall Hotel	150 covers
S. Brown	Chef	Bredbury Hall Hotel	150 covers
Steve Vardy	Chef	Event caterer	various
Steven Green	Chef	Fat Loaf	150 covers
Stuart Walker	Chef	The Hanging Gate	130 covers
Trevor Jones	Chef	Beetons Restaurant & Catering	various