Sensory Profiling of Commercial Sirloin Steaks

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Aims

• Customer Objectives:

• To externally benchmark their current sirloin steak products with three of their competitors.

• To internally benchmark three of their own suppliers.
Experimental

- Customer to supply sirloin steak from six sources. Three from within their supply chain (A, B, C) and one from each of three competitors (X, Y, Z).

- Sensory profiling panel to be conducted over three week period.

- Texture analysis for Warner Brazler Shear force.
Sensory Methodology

• Assessment was conducted by a trained profiling panel.

• The trained profiling panel generated a list of 31 sensory attributes over two training sessions. These encompassed aroma, appearance, texture, flavour and aftertaste.

• Panellists used a 0-100 line scale to score the increasing intensity of each attribute.
Instron analysis

• Two steaks from different packs from each source for each session were selected to measure the Warner Bratzler Shear Force.
• Steak samples were also measured for cooking loss on each panel day.
• WBSF was measured by analysing 10 replicate cores from each cooked steak.
## Instrumental Results

<table>
<thead>
<tr>
<th>Supplier</th>
<th>WBSF (kg Force)</th>
<th>Thickness (mm)</th>
<th>pHu</th>
<th>Cooking loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier A</td>
<td>4.00&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>19.3&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>5.62</td>
<td>26.6</td>
</tr>
<tr>
<td>Supplier B</td>
<td>4.20&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>16.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.47</td>
<td>28.2</td>
</tr>
<tr>
<td>Supplier C</td>
<td>4.39&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>16.5&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>5.52</td>
<td>27.8</td>
</tr>
<tr>
<td>Competitor X</td>
<td>4.29&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>18.0&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>5.54</td>
<td>26.0</td>
</tr>
<tr>
<td>Competitor Y</td>
<td>3.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.2&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>5.57</td>
<td>26.0</td>
</tr>
<tr>
<td>Competitor Z</td>
<td>4.88&lt;sup&gt;c&lt;/sup&gt;</td>
<td>21.8&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.58</td>
<td>24.6</td>
</tr>
</tbody>
</table>

Sig (source)#

| P<0.05 | P<0.05 | P<0.001 | ns |

<sup>ab</sup>  indicates mean values within a column that are significantly different from each other.

<sup>a</sup><sup>b</sup>  indicates mean values within a column that are significantly different from each other.

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Instrumental Conclusions

- Steaks from competitor Z were significantly “more tough”.
- There was variation in the thickness of the steaks.
- This was also recognised during the sensory training and suitable adjustments made to the cooking protocol.
Effect of source on possible “positive” attributes (*, *** = significant differences at $P<0.05$, $P<0.001$, respectively)
Effect of source on possible “negative” attributes
(*, *** = significant differences at $P<0.05$, $P<0.001$, respectively)
Principal Component Analysis (PC1v PC2)

△ = attribute

PC1 37.5%
PC2 19.3%
Principal Component Analysis (PC1 vs PC2)

- PC1: 37.5%
- PC2: 19.3%

\[ \begin{align*}
&-1 & -0.5 & 0 & 0.5 & 1 \\
&-1 & -0.5 & 0 & 0.5 & 1 \\
&\end{align*} \]

\[ \begin{align*}
&= \text{attribute} \\
&\end{align*} \]
Principal Component Analysis (PC1 vs PC2)

- PC1 37.5%
- PC2 19.3%

△ = attribute
△ = product
Principal Component Analysis (PC1 vs PC2)

- PC1: 37.5%
- PC2: 19.3%

Symbols represent attributes:
- SweetFL
- IntensityFL
- JuicyAP
- JuicyTX
- BeefyAR
- 0.5
- BeefyFL
- SteakAR
- SteakFL
- TenderTX
Principal Component Analysis (PC1 vs PC2)

- PC1 37.5%
- PC2 19.3%

= attribute

more positive attributes

- SteakAR
- BeefyAR
- JuicyAP
- IntensityFL
- SweetFL
- TenderTX
- JuicyTX
- BeefyFL
- SteakFL
Principal Component Analysis (PC1 v PC2)

- Attribute

PC1 37.5%
PC2 19.3%
Principal Component Analysis (PC1 vs PC2)

- PC1: 37.5%
- PC2: 19.3%

Directions:
- More negative attributes

Attributes:
- CompactAP
- CaramAP
- SourFL
- BitterFL
- LiverFL
- FarmydFL
- FarmydAR
- OilyFL
- CardbdFL

Symbols:
- ▲ = attribute
Principal Component Analysis (PC1 vs PC2)

- Attribute: more negative attributes
- Attribute: more positive attributes

PC2 19.3%

PC1 37.5%
Principal Component Analysis (PC1 vs PC2)

- ▲ = attribute
- △ = product

- PC1 37.5%
- PC2 19.3%

- more negative attributes
- more positive attributes

- Comp X1
- Comp X2
- Comp X3
- SteakAR
- BeefyAR
- FarmydAR CaramAP
- JuicyAP CompactAP

- SteakFL
- BeefyFL
- SourFL
- SweetFL
- BitterFL
- OilyFL
- CardbdFL
- LiverFL

- JuicyTX
- IntensityFL
- SweetFL
- BeefyAR
- SteakAR
- TenderTX

- More positive attributes
- More negative attributes

- PC1: 37.5%
- PC2: 19.3%

- Positive attributes:
  - Juicy
  - JuicyTX
  - Intensity
  - Sweet
  - Beefy
  - Steak
  - Tender

- Negative attributes:
  - Sour
  - Bitter
  - Oily
  - Cardbd
  - Liver
Principal Component Analysis (PC1 vs PC2)

- ▲ = attribute
- ▲ = product

- PC1 37.5%
- PC2 19.3%

- More negative attributes
- More positive attributes

- Attributes: SourFL, BitterFL, FarmydFL, CompX1
- Products: SteakAR, BeefyAR, JuicyAP, JuicyTX, IntensityFL, SweetFL, OilyFL, LiverFL, CardbdFL, TenderTX, SteakFL, BeefyFL
Principal Component Analysis \((PC1 v PC2)\)

- ▲ = attribute
- ▲ = product

PC1 37.5%

PC2 19.3%

more negative attributes

more positive attributes

- SteakAR
- BeefyAR
- FarmydAR CaramAP
- JuicyAP CompactAP
- IntensityFL SteakFL
- BeefyFL TenderTX
- SourFL SweetFL
- Bitte FL
- OilyFL
- CardbdFL LiverFL

= attribute
= product

Principal Component Analysis (PC1 vs PC2)
Principal Component Analysis (PC1 vs PC2)

- ▲ = attribute
- ▲ = product

Comp Y2
Comp Y3
CompactAP
SteakAR
BeefyAR
FarmydAR
CaramAP
JuicyAP
TenderTX
JuicyTX
SourFL
BitterFL
SweetFL
IntensityFL
OilyFL
LiverFL
CardbdFL
BeefyAR
SteakAR
TenderTX

PC1 37.5%
PC2 19.3%

= more negative attributes
= more positive attributes

.attributive
.product

Principal Component Analysis (PC1 vs PC2)
Principal Component Analysis (PC1 vs PC2)

- Attribute: Λ
- Product: ▲

- More negative attributes: SteakAR, BeefyAR, FarmydAR, CaramAP, JuicyAP, IntensityFL
- More positive attributes: SourFL, SweetFL, BitterFL, OilyFL, JuicyTX, TenderTX

Principal Component Analysis (PC1 vs PC2)

- PC1: 37.5%
- PC2: 19.3%

- Components: Comp Y1, Comp Y2, Comp Y3, CompactAP, FarmydFL, CardbdFL
Principle Component Analysis (PC1 vs PC2)

- ▲ = attribute
- ▼ = product

More negative attributes

More positive attributes

PC1 37.5%

PC2 19.3%

Principal Component Analysis (PC1 vs PC2)
Principal Component Analysis (PC1 vs PC2)

- = attribute
- = product

= more negative attributes

= more positive attributes

PC1 37.5%

PC2 19.3%
Principal Component Analysis (PC1 vs PC2)

- = attribute
- = product

PC2 19.3%

PC1 37.5%

more negative attributes

more positive attributes

Sup A1
Sup A2
Sup A3

PC1v PC2

Principal Component Analysis

attribute
product

= more positive attributes
= more negative attributes

-1 -0.5 0 0.5 1

-1 -0.5 0 0.5 1

PC1

PC2

-1 -0.5 0 0.5 1

-1 -0.5 0 0.5 1
Principal Component Analysis (PC1 vs PC2)

- ▲ = attribute
- △ = product

PC2 19.3%
PC1 37.5%

- SteakAR
- BeefyAR
- FarmydAR
- CaramAP
- IntensityFL
- SourFL
- BitterFL
- OilyFL
- LiverFL
- CardbdFL

More positive attributes:
- JuicyAR
- JuicyTX
- TenderTX
- BeefyFL
- SteakFL

More negative attributes:
- Sup A1
- Sup A2
- Sup A3

Principal Component Analysis (PC1 vs PC2)
Principal Component Analysis (PC1 v PC2)

More negative attributes

More positive attributes

Sup B1
Sup B2
Sup B3

PC2 19.3%
PC1 37.5%

Attribute
Product

= attribute
= product

PC1
PC2

-1 -0.5 0 0.5 1
-1 -0.5 0 0.5 1

-1 -0.5 0 0.5 1
-1 -0.5 0 0.5 1

Sup B1
Sup B2
Sup B3

-1 -0.5 0 0.5 1
-1 -0.5 0 0.5 1

PC1
PC2

sup B1
sup B2
sup B3

= attribute
= product

Principal Component Analysis (PC1 v PC2)
Principal Component Analysis (PC1 vs PC2)

= attribute
= product

PC1 37.5%
PC2 19.3%

more negative attributes
more positive attributes

Sup B1
Sup B2
Sup B3

BeefyFL
SteakFL
JuicyFL
IntensityFL
SweetFL
LiverFL
TenderTX
SteakAR
BeefyAR
OilyFL
CardbdFL
BitterFL
CaramAP
CompactAP
SourFL
FarmydAR
FarmydFL
Principal Component Analysis  (PC1v PC2 )

**Pie Chart:**

- **Sup B1**
- **Sup B2**
- **Sup B3**

**Axes:**
- PC1 37.5%
- PC2 19.3%

**Attributes:**
- BeefyAR 0.5
- JuicyTX
- SweetFL
- IntensityFL
- SourFL
- BitterFL
- CardbdFL
- OilyFL
- FarmydFL
- CaramAP
- CompactAP
- QilyFL

**Legend:**
- ▲ = attribute
- ➡️ = product

**Notes:**
- = more positive attributes
- = more negative attributes

**PC1 vs PC2:**
- More positive attributes to the right
- More negative attributes to the left
Principal Component Analysis (PC1 vs PC2)

- Attribute
- Product

PC1 37.5%
PC2 19.3%

= more negative attributes
= more positive attributes

Sup C1
Sup C2
Sup C3

More positive attributes include:
- JuicyAP
- JuicyTX
- BeefyAR
- BeefyFL
- SteakFL

More negative attributes include:
- SourFL
- BitterFL
- CardbdFL
- FarmydAR
- FarmydFL
- CompactAP
- CaramAP
- OilyFL
- LiverFL

PC1 vs PC2

Principal Component Analysis (PC1 vs PC2)
Principal Component Analysis (PC1 vs PC2)

- Sup C1
- Sup C2
- Sup C3

- more negative attributes
- more positive attributes

PC2 19.3%
PC1 37.5%

Attributes:
- CompactAP
- FarmydFL
- SourFL
- BitterFL
- FarmydAR
- LiverFL
- CaramAP
- OilyFL
- JuicyAP
- JuicyTX
- SweetFL
- IntensityFL
- BeefyAR
- BeefyFL
- SteakAR
- SteakFL
- TenderTX
- CardbdFL

Products:
- SteakAR
- BeefyAR
- FarmydAR
- CaramAP
- JuicyAP
- JuicyTX

Attributes:
- SourFL
- BitterFL
- FarmydFL
- OilyFL
- LiverFL
- SweetFL
- IntensityFL
- BeefyAR
- BeefyFL
- SteakAR
- SteakFL
- TenderTX
- CardbdFL
Principal Component Analysis (PC1 vs PC2)

- Attribute: ▲
- Product: ▲

PC2 19.3%
PC1 37.5%

More negative attributes
More positive attributes

Sup C1
Sup C2
Sup C3

- Principal Component Analysis (PC1 vs PC2)
- Attribute: CompactAP, CaramAP, JuicyAP, CompactAR, BeefyAR, FarmydAP
- Product: SourFL, SweetFL, BitterFL, LiverFL, Tendertx, JuicyTX, BeefyFL, SteakFL, CardbdFL

- PC1: 37.5%
- PC2: 19.3%

- More positive attributes: SteakFL, BeefyFL, Tendertx, JuicyTX, SweetFL, IntensityFL
- More negative attributes: SourFL, BitterFL, LiverFL, CardbdFL

- Attribute values: -1, -0.5, 0, 0.5, 1
Principal Component Analysis (PC1 vs PC2)

- Attribute triangle
- Product triangle

PC1 37.5%
PC2 19.3%

Sup C1
Sup C2
Sup C3

- more positive attributes
- more negative attributes

- SweetFL
- IntensityFL
- JuicyAP
- JuicyTX
- BeefyAR
- BeefyFL
- SteakAR
- SteakFL
- TenderTX
- SourFL
- BitterFL
- FarmydFL
- FarmydAR
- CompactAP
- CaramAP
- OilyFL
- LiverFL
- CardbdFL
- SteakAR
- BeefyAR
- SweetFL
- IntensityFL
- JuicyAP
- JuicyTX
- BeefyFL
- SteakFL
- TenderTX

PC1 vs PC2

-1 -0.5 0 0.5 1
-1 -0.5 0 0.5 1

PC1 37.5%
PC2 19.3%

= attribute
= product
Principal Component Analysis (PC1 vs PC2)

- **PC1 37.5%**
- **PC2 19.3%**

= attribute  
= product

 attribute  
product

more negative attributes

more positive attributes

- Sup A1
- Sup A2
- Sup B1
- Sup B2
- Sup C1
- Sup C2
- Sup C3

- SteakAR
- BeefyAR
- FarmydAR
- CaramAP
- JuicyAP
- IntensityFL
- SourFL
- OilyFL
- CardbdFL
- LiverFL

- 0
- -0.5
- -1
- 0.5
- 1

- more positive attributes
Conclusions:

- There were significant differences between the customer’s product and their competitors.
- There were significant differences within the customer’s own suppliers.
- The quality of the meat from one supplier varied significantly over a 3 week sampling period.
<table>
<thead>
<tr>
<th>Group</th>
<th>Attribute</th>
<th>Definition</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma</td>
<td>Intensity of aroma</td>
<td>Overall intensity of aroma</td>
<td>IntAR</td>
</tr>
<tr>
<td></td>
<td>Steak aroma</td>
<td>Aroma of grilled beef steak</td>
<td>SteakAR</td>
</tr>
<tr>
<td></td>
<td>Sweet aroma</td>
<td>Sweet aroma</td>
<td>SweetAR</td>
</tr>
<tr>
<td></td>
<td>Beefy aroma</td>
<td>Species aroma characteristic of beef as opposed to lamb or pork</td>
<td>BeefyAR</td>
</tr>
<tr>
<td></td>
<td>Liver aroma</td>
<td>Aroma reminiscent of cooked liver</td>
<td>LiverAR</td>
</tr>
<tr>
<td></td>
<td>Oily aroma</td>
<td>Aroma of new vegetable oil</td>
<td>OilyAR</td>
</tr>
<tr>
<td></td>
<td>Farmyard aroma</td>
<td>Aroma reminiscent of animal slurry</td>
<td>FmYdAR</td>
</tr>
<tr>
<td>Appearance - external</td>
<td>Caramelised appearance</td>
<td>Browned external appearance</td>
<td>CarAP</td>
</tr>
<tr>
<td>Appearance - internal</td>
<td>Juicy appearance</td>
<td>Visible juices inside the meat after cutting</td>
<td>JuicyAP</td>
</tr>
<tr>
<td></td>
<td>Pink appearance</td>
<td>Pink colour of undercooked meat</td>
<td>PinkAP</td>
</tr>
<tr>
<td></td>
<td>Compact appearance</td>
<td>Compact appearance of cut surface (not open)</td>
<td>CompAP</td>
</tr>
<tr>
<td>Flavour</td>
<td>Intensity of flavour</td>
<td>Overall intensity of flavour</td>
<td>IntFL</td>
</tr>
<tr>
<td></td>
<td>Steak flavour</td>
<td>Flavour of grilled beef steak</td>
<td>SteakFL</td>
</tr>
<tr>
<td></td>
<td>Beefy flavour</td>
<td>Species flavour characteristic of beef as opposed to lamb or pork</td>
<td>BeefyFL</td>
</tr>
<tr>
<td></td>
<td>Sour flavour</td>
<td>Taste elicited by acids</td>
<td>SourFL</td>
</tr>
<tr>
<td></td>
<td>Sweet flavour</td>
<td>Taste elicited by sugar</td>
<td>SweetFL</td>
</tr>
<tr>
<td></td>
<td>Bitter flavour</td>
<td>Taste elicited by caffeine</td>
<td>BitterFL</td>
</tr>
<tr>
<td></td>
<td>Oily flavour</td>
<td>Flavour of new vegetable oil</td>
<td>OilyFL</td>
</tr>
<tr>
<td></td>
<td>Cardboard flavour</td>
<td>Flavour reminiscent of cardboard</td>
<td>CardbFL</td>
</tr>
<tr>
<td></td>
<td>Bloody flavour</td>
<td>Flavour associated with undercooked meat</td>
<td>BloodFL</td>
</tr>
<tr>
<td></td>
<td>Liver flavour</td>
<td>Flavour of cooked liver</td>
<td>LiverFL</td>
</tr>
<tr>
<td></td>
<td>Farmyard flavour</td>
<td>Flavour reminiscent of animal slurry</td>
<td>FmYdFL</td>
</tr>
</tbody>
</table>
List of attributes generated by the trained assessors and agreed descriptions (contd)

<table>
<thead>
<tr>
<th>Group</th>
<th>Attribute</th>
<th>Definition</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texture</td>
<td>Tender texture</td>
<td>Soft and easy to chew before swallow</td>
<td>TenderTX</td>
</tr>
<tr>
<td></td>
<td>Juicy/succulent texture</td>
<td>Juice in mouth after first chew</td>
<td>JuiceTX</td>
</tr>
<tr>
<td></td>
<td>Cohesive texture</td>
<td>Forms a ball in the mouth after chewing</td>
<td>CohesTX</td>
</tr>
<tr>
<td></td>
<td>Crumbly texture</td>
<td>Sample separates into bits in the mouth after chewing</td>
<td>CrumbTX</td>
</tr>
<tr>
<td>Aftertaste</td>
<td>Dry texture</td>
<td>Dry sensation in the mouth during chewing</td>
<td>DryMoTX</td>
</tr>
<tr>
<td></td>
<td>Intensity of aftertaste</td>
<td>Overall intensity of aftertaste</td>
<td>IntAT</td>
</tr>
<tr>
<td></td>
<td>Dry aftertaste</td>
<td>Dry sensation in the mouth after swallowing</td>
<td>DryMoTX</td>
</tr>
<tr>
<td></td>
<td>Greasy aftertaste</td>
<td>Greasy sensation in the mouth</td>
<td>GreasAT</td>
</tr>
<tr>
<td></td>
<td>Metallic aftertaste</td>
<td>Aftertaste reminiscent of iron and metallic</td>
<td>MetAT</td>
</tr>
</tbody>
</table>
### Profiling results (ANOVA)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Attribute code</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Sig (source)#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steak aroma</td>
<td>SteakAR</td>
<td>26.8b</td>
<td>25.0ab</td>
<td>22.8ab</td>
<td>27.7b</td>
<td>21.7a</td>
<td>20.5a</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Beefy aroma</td>
<td>BeefyAR</td>
<td>18.4ab</td>
<td>14.9a</td>
<td>15.4a</td>
<td>20.5b</td>
<td>14.3a</td>
<td>14.1a</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Caramelised appearance</td>
<td>CaramAP</td>
<td>27.1b</td>
<td>23.5ab</td>
<td>19.3a</td>
<td>26.6b</td>
<td>28.1b</td>
<td>28.8b</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Juicy appearance</td>
<td>JuicyAP</td>
<td>46.4c</td>
<td>35.4ab</td>
<td>34.2ab</td>
<td>33.5a</td>
<td>41.9bc</td>
<td>31.6a</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Pink appearance</td>
<td>PinkAP</td>
<td>31.6c</td>
<td>26.6bc</td>
<td>21.2b</td>
<td>20.9b</td>
<td>7.6a</td>
<td>7.9a</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Steak flavour</td>
<td>SteakFL</td>
<td>37.5d</td>
<td>34.7cd</td>
<td>30.7bc</td>
<td>34.1cd</td>
<td>25.1ab</td>
<td>21.7a</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Beefy flavour</td>
<td>BeefyFL</td>
<td>26.0b</td>
<td>23.3ab</td>
<td>21.2ab</td>
<td>23.9b</td>
<td>18.0a</td>
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