Relationship between flavour volatiles and eating quality of lamb

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Relationship between flavour volatiles and eating quality of lamb

1. Background
2. Experimental design
3. Sensory profiling analysis
4. Analysis of odours
5. Conclusions
1. Background
What is the problem?

• Concern in Irish lamb meat industry about ram lambs vs castrated male lambs
• Perception that ram meat is of a lower quality
• Ram lambs favoured in production
• Medium length branched chain fatty acids (BCFAs), phenols or indoles may cause off-odour
AIM

To determine the cause of any off-flavours in ram meat & see how it is affected by diet
2. Experimental design
## Experimental design 1

<table>
<thead>
<tr>
<th>Farm</th>
<th>Diet</th>
<th>BSxSBx</th>
<th>Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ram</td>
<td>Cast</td>
</tr>
<tr>
<td>Outdoor</td>
<td>Fresh Grass</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Outdoor</td>
<td>Stubble Turnip</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Outdoor</td>
<td>Forage Rape</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Indoor</td>
<td>Conc</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Indoor</td>
<td>Clover silage</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Indoor</td>
<td>Grass silage</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>36</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

Total = 144 lambs
3. Sensory Profiling analysis
Sensory Profiling analysis

- 8 trained panellists tasted a 25mm slice of loin
- Grilled to internal temp of 75°C
- Every animal sampled
- Assessed sensory profiling attributes
- Data analysed using linear mixed model methodology using REML estimation
Sensory Profiling analysis - results for flavour related attributes

**Definitions:**
- **Crackling** = Crisp, Roasted fat
- **Meaty** = Beefy smell
- **Greasy** = Fatty, oily, chip shop
- **Fatty** = Greasy, fatty

**Significant breed effects for Aroma of Fat**

![Bar chart showing significant breed effects for Aroma of Fat](chart.png)

**Diet.Sex. Breed Interaction**

*
Sensory Profiling analysis - results

Definitions:

- **Juicy** = Juices on surface & on plate, moist
- **Tender** = Scale of tenderness
- **Cooked** = Scale of degree of cooked appearance

![Texture on cutting - Tender **](chart)

**Definitions:** **Juicy** = Juices on surface & on plate, moist; **Tender** = Scale of tenderness; **Cooked** = Scale of degree of cooked appearance.
Sensory Profiling analysis - results

Definitions:
- Tender = Scale of tenderness;
- Lumpy = Forms balls on chewing;
- Chewy = Requires a lot of chewing, hard to swallow.

**Significant diet effects for Texture of the Meat**

<table>
<thead>
<tr>
<th>Diet</th>
<th>Tender</th>
<th>Lumpy</th>
<th>Chewy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>***</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Rape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass silage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass silage</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Consumer score**

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*AFB Agri Food and Biosciences Institute* 10 Year Anniversary
4. Analysis of odours
GC-MS-O analysis

- Volatiles collected onto a Tenax trap
- 3 Assessors for each of 40 animals chosen

Grass Silage
Turnip
Concentrate
Grass

5 Rams + 5 Castrates from each
Results of GC-O

<table>
<thead>
<tr>
<th>Frequency of Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 5 10 15 20 25 30 35 40</td>
</tr>
</tbody>
</table>

- Rancid meat, Manure
- Sweet, Caramel
- Caramel
- Beefy
- Farmyard
- Rotten meat
- Beefy
- Dead animal
- Grass
- Sulphur
- Glue
- Thiols
- Grass 804
- Beefy, Meaty 818
- Smokey 867
- Chicken 871
- Medication 872
- Herbal, Green 903
- Citrus 906
- Potatoes 910
- Burning 915
- Burning, meat 922

Castrates
Rams
Main odours detected using GC-MS-O
Main odours detected using GC-MS-O

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet, caramel</td>
<td>2,3-Butanedione*</td>
</tr>
<tr>
<td>Caramel</td>
<td>3-Methyl butanal*</td>
</tr>
<tr>
<td>Glue</td>
<td>Toluene*</td>
</tr>
<tr>
<td>Grass</td>
<td>Hexanal*</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Methional</td>
</tr>
<tr>
<td>Mushrooms</td>
<td>1-Octen-3-ol</td>
</tr>
<tr>
<td>Mushrooms, metallic</td>
<td>1-Octen-3-one*</td>
</tr>
<tr>
<td>Citrus, Lemon</td>
<td>Octanal*</td>
</tr>
<tr>
<td>Flowers, Honey</td>
<td>Phenylacetaldehyde*</td>
</tr>
<tr>
<td>Earthy, stale</td>
<td>E-2-Octenal*</td>
</tr>
<tr>
<td>Cigarettes, burning</td>
<td>p-Cresol*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning</td>
<td>m-Cresol*</td>
</tr>
<tr>
<td>Burning rubber</td>
<td>Ethyl dimethyl pyrazine</td>
</tr>
<tr>
<td>Soap, floral</td>
<td>Nonanal*</td>
</tr>
<tr>
<td>Shortbread</td>
<td>2-Acetylthiazoline*</td>
</tr>
<tr>
<td>Lemon</td>
<td>Linalool*</td>
</tr>
<tr>
<td>Burning, popcorn</td>
<td>Furaneol</td>
</tr>
<tr>
<td>Melon, Grass</td>
<td>E-2-Nonenol*</td>
</tr>
<tr>
<td>Cucumber, watermelon</td>
<td>(E,Z)-2,6-Nonadienal</td>
</tr>
<tr>
<td>Tablets, ground</td>
<td>4-Ethyl phenol*</td>
</tr>
<tr>
<td>Meaty, onion</td>
<td>(E,E)-2,4-Heptadienal</td>
</tr>
</tbody>
</table>

* Tentative identification
Main odours detected using GC-MS-O
Odours from rams vs castrate lamb

Odours detected more in ram lamb

Frequency of detection

C G GS T
Dusty, wet ground

C G GS T
Mushrooms, metallic

C G GS T
Smokey

C G GS T
Lemon, citrus

C G GS T
Cucumber, watermelon

Odour (diet)
Odours from rams vs castrate lamb

![Graph showing frequency of detection of odours in rams and castrate lambs.](image)

- **Odours detected more in castrate lamb**:
  - Rotten meat
  - Beefy, Meaty
  - Popcorn
  - Wax, burning
  - Shortbread

**Odour (diet)**

- C
- G
- GS
- T

**Frequency of detection**

- C
- M

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**Legend**

- C: Castrate lamb
- M: Ram

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**Note**: The graph and table are used to compare the frequency of detection of various odours in castrate lambs versus rams.
Effect of diet

- **Medication 872**
- **Herbal, green 903**
- **Flowers, honey 1052**
- **Fresh, sweet 1159**
4. Conclusions
Conclusions

• There are sensory differences due to sex & diet
• Some odour differences detected by GC-O analysis
• Work in progress to confirm identities & quantify compounds
Compounds NOT detected using GC-MS-O...BUT detected by nose

- 4-Methyloctanoic Acid
- 4-Ethyloctanoic Acid
- 4-Methylnonanoic Acid
- Indole
- Skatole
- Etc...
<table>
<thead>
<tr>
<th>Compound</th>
<th>Literature Descriptors</th>
<th>GC-MS peak detected?</th>
<th>Assessor descriptors matching LRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-methyloctanoic acid</td>
<td>Goat, mutton, fatty, waxy</td>
<td>No</td>
<td>Burnt fat, hot oil, soap</td>
</tr>
<tr>
<td>4-methylnonanoic acid</td>
<td>Sweaty-sour, Sheepmeat, Waxy-sweet, soapy, fatty, wet wood</td>
<td>No</td>
<td>Wet ground, stale water, hot oil, soap</td>
</tr>
<tr>
<td>4-ethyloctanoic acid</td>
<td>Mutton, Fatty, Waxy, creamy, moldy, cheesy</td>
<td>No</td>
<td>Hot oil, vegetable oil, fat</td>
</tr>
<tr>
<td>Indole</td>
<td>Musty, Faecal, Mothball-like</td>
<td>No</td>
<td>Stale, Faeces</td>
</tr>
<tr>
<td>Skatole</td>
<td>Manure, Urine (Boar taint)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p-cresol</td>
<td>Animal, Barnyard-like, Leather, Faecal</td>
<td>Yes</td>
<td>Leather belt, Rubber, Wax</td>
</tr>
<tr>
<td>2-Isopropyl phenol</td>
<td>Ink-like &amp; Fruity</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3,4-dimethylphenol</td>
<td>Horse stable-like, fecal, ink-like</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thymol</td>
<td>Phenolic, Medicinal</td>
<td>No</td>
<td>Tablets</td>
</tr>
<tr>
<td>3-Isopropyl phenol</td>
<td>Ink-like &amp; leather-like</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dimethyl disulphide</td>
<td>Sweet, honey, acrid, cooked vegetables, sulphur</td>
<td>Yes</td>
<td>Bad eggs, rotten eggs, sulphur, toffee, boiled veg</td>
</tr>
<tr>
<td>3-methylbutanoic acid</td>
<td>Sweaty, Vomit, Parmesan cheese</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>