Sensory Quality Aspects of Yoghurt

Ranjan Sharma PhD MBA

Dairy Australia/NCDEA
Webinar - 11 July 2013
Sensory quality of yogurt – background
Sensory quality of yogurt – background

• Combination of
  – Flavour
  – Colour & Appearance
  – Taste
  – Texture
  – (Feel/Touch)
  – (Sound)
Characterising sensory quality of yogurt - background

- **Flavour** - chemical compounds in milk and those produced during processing and fermentation of milk
  - Instrumental methods
- **Appearance** - the colour and visual separation of whey
  - Functionality methods
- **Texture** - strength of the gel network
  - Instrumental methods
- **Taste & flavour** - acidity, sweetness, bitterness etc
  - Trained & consumer sensory panels
Presentation Outlines

• Yogurt – definition, trends & products in Australia
• Factors affecting the quality of yogurt during manufacture
• Flavour compounds in yogurt
• Measuring physical properties
• Measuring consumer sensory properties
• Summary - quality defects in yogurt and possible causes for defects
**Fermented milk** means a milk product obtained by fermentation of milk and/or products derived from milk, where the fermentation involves the action of micro-organisms and results in coagulation and a reduction in pH.

**Yoghurt** means a fermented milk where the fermentation has been carried out with lactic acid producing micro-organisms.
FSANZ – Standard 2.5.3 – Fermented Milk Products

- Fermented milk may contain other foods.
- Micro-organisms used in the fermentation of fermented milk must remain viable in the product.
- Fermented milk and the fermented milk portion of a food containing fermented milk must contain each component shown below.

<table>
<thead>
<tr>
<th>Component or parameter</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (measured as crude protein)</td>
<td>Min 3.0% w/w</td>
</tr>
<tr>
<td>pH</td>
<td>Max 4.5</td>
</tr>
<tr>
<td>Microorganisms from added culture</td>
<td>Min $10^6$ cfu/g</td>
</tr>
</tbody>
</table>

Global yogurt market

Yogurt* represented $51bn in global spending in 2011

### Market value by category, 2011, global

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard yogurt</td>
<td>24.9%</td>
</tr>
<tr>
<td>Yogurt drinks</td>
<td>27.9%</td>
</tr>
</tbody>
</table>

### Fastest growing categories by value, 2011–15, global

<table>
<thead>
<tr>
<th>Category</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard yogurt</td>
<td>+4.43%</td>
</tr>
<tr>
<td>Yogurt drinks</td>
<td>+4.92%</td>
</tr>
</tbody>
</table>

### Top 10 markets by value ($m), 2011

<table>
<thead>
<tr>
<th>Country</th>
<th>Value ($m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>7491.5</td>
</tr>
<tr>
<td>US</td>
<td>6252.3</td>
</tr>
<tr>
<td>France</td>
<td>3131.4</td>
</tr>
<tr>
<td>Germany</td>
<td>3018.2</td>
</tr>
<tr>
<td>Japan</td>
<td>3014.5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2586.7</td>
</tr>
<tr>
<td>Italy</td>
<td>2268.6</td>
</tr>
<tr>
<td>UK</td>
<td>2019.0</td>
</tr>
<tr>
<td>Brazil</td>
<td>1282.3</td>
</tr>
<tr>
<td>Spain</td>
<td>1261.2</td>
</tr>
</tbody>
</table>

### Top 10 markets by per capita expenditure ($), 2011

<table>
<thead>
<tr>
<th>Country</th>
<th>Expenditure ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>153.5</td>
</tr>
<tr>
<td>Slovenia</td>
<td>89.6</td>
</tr>
<tr>
<td>Switzerland</td>
<td>86.4</td>
</tr>
<tr>
<td>Ireland</td>
<td>78.3</td>
</tr>
<tr>
<td>Finland</td>
<td>75.3</td>
</tr>
<tr>
<td>Norway</td>
<td>75.5</td>
</tr>
<tr>
<td>Denmark</td>
<td>60</td>
</tr>
<tr>
<td>Estonia</td>
<td>59.4</td>
</tr>
<tr>
<td>Portugal</td>
<td>57.6</td>
</tr>
<tr>
<td>Belgium</td>
<td>56.9</td>
</tr>
</tbody>
</table>

Datamonitor, 2012
Yogurt consumption

Per Capita yogurt consumption (Kg) - 2006

Source: Euromonitor
Market growth for yogurt

Projected growth for yogurt - Australia

Total market in 2009 ~ $0.9b

Total market in 2012 ~ $1.1b

Datamonitor, 2012
Yogurt types in Australia – August 2012

Woolworths - 205 SKUs

- Low fat: 89
- Greek: 28
- No fat: 21
- Full fat: 20
- Organic: 16
- Natural: 11
- Kids: 9
- Premium: 5
- Drinking: 3
Basic scheme for yogurt manufacture

- **Whole milk**
  - Separate
  - Yogurt mix
    - Heating & homogenisation
      - Cream
        - Whole milk
        - Skim milk
        - Whey
        - Non-dairy additives
      - Cultures
        - Incubation
          - Storage
            - Filling
              - Cooling
                - Chilled transport
                  - Warehouse chiller
                  - Supermarket chiller
                  - Household fridge
        - Fruit/Flavour prep
          - Filling
            - Cooling
              - Consumer

- **Flavour**
  - Filling
    - Incubation
      - Cooling
        - Storage
Basic factory layout for yogurt manufacture

Yogurt milk

PHE, heater

Triblender

PHE Chiller

Standardised Milk storage tank

Fermentation tank

Cooling yogurt

Yogurt base storage tanks

Fruits

Filler

Balance tank

Homogeniser

Pasteuriser

Holding tubes

Storage & distribution
Basic factory layout for yogurt manufacture
Factors affecting quality of yogurt

• Raw materials
  – Raw milk, skim milk, cream, sugar, cultures, milk concentrate, milk powders, fruit/fruit conserves, stabilisers, flavours and colours
  – All can contribute micro-organisms and chemicals that affect the quality
  – Changes in the source and supply will cause variation in factors that can influence shelf life
  – Partnerships with approved suppliers and agreed specifications are recommended
Factors affecting quality of yogurt

• Raw materials – Milk
  – Variability in protein, lactose, fat and microbial flora
  – Variability in breeds of cattle, season and region
  – Milking & storage conditions the farm

• Raw materials – cream
  – Depends on the quality of milk used for separation
  – Methods of handling before and after pasteurisation
  – Susceptibility to lipolysis due to high fat (potential for rancid taste)
Quality of milk is crucial for final yogurt flavour

- Milk is an extremely complicated entity which is comprised of lipids, proteins, carbohydrates, and minerals, and over 400 volatile compounds have been identified in milk products.

- The underlying flavor of yogurt arises principally from the native volatile constituents in cow's milk, influenced by pasteurization, fermentation, processing, and storage. A large number of the volatile organic compounds found in yogurt are not produced by the starter bacteria but originate from the milk.
Quality criteria for raw milk

• Low natural microflora
• Free from antibiotics, sanitising chemicals
• No contamination from mastitis milk and colostrums
• Free from rancidity
• Free from bacteriophages
• Free from hormones
• Stored below 5C
ABC flavour defects in raw and/or pasteurised milk

- **Absorbed/Transmitted**
- **Bacterial/Microbial**
- **Chemical/Enzymatic/Processing**
  - **A**
    - Feedy, barny, cowy, weedy, unclean, lacks freshness, stale, refrigerator/cooler odors
  - **B**
    - Acid, bitter, malty, lacks freshness, unclean, fruity/fermented, putrid and rancid
  - **C**
    - Cowy (ketosis), salty, rancid, bitter, oxidized, sunlight, foreign, astringent, medicinal, flat, cooked
Factors affecting quality of yogurt

• Raw materials – concentrates
  – Manufactured by either evaporation or membrane concentration
  – Quality of raw milk is important
  – Handling conditions before, during and after concentration
  – Heat stability of milk
  – Microbial flora should be low in thermodurics
  – Cooling rate and concentration factor can adversely affect the flavour and textural attributes
Factors affecting shelf life of yogurt

• Raw materials – fruits
  – Major areas of concern microbiological quality, fruit ripeness, freshness, presence of pesticides & other agrochemicals

• Raw materials – other ingredients
  – Source of ingredient, approval of supplier, identification of critical control points (CCPs), and hygiene standards are all important
## Effects of non-dairy raw materials on sensory of yogurt

<table>
<thead>
<tr>
<th>Additive</th>
<th>Yogurt description</th>
<th>Sensory effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inulin fibre (1%, 2%)</td>
<td>Low fat</td>
<td>No effect for 1, 7 and 14 days</td>
<td>Mazloomi et al. 2011</td>
</tr>
<tr>
<td>Strawberry vs apple</td>
<td>2.5% fat</td>
<td>Strawberry preferred over apple</td>
<td>Vahadi et al. 2008</td>
</tr>
<tr>
<td>Soluble (inulin) vs insoluble (grains) fibre</td>
<td>Regular and 30% reduced sugar</td>
<td>Soluble fibre preferred over insoluble in reduced sugar yogurt</td>
<td>Hoppert et al. 2013</td>
</tr>
<tr>
<td>Apple, bamboo and wheat fibre</td>
<td>Strained yogurt</td>
<td>Bamboo and wheat fibre preferred over apple fibre</td>
<td>Seckin &amp; Baladura, 2012</td>
</tr>
<tr>
<td>Chitosan (nano-powdered)</td>
<td>Normal fat</td>
<td>Low levels (0.3 and 0.5%) acceptable</td>
<td>Seo et al. 2009</td>
</tr>
<tr>
<td>Anti-oxidant (wine grape pomace)</td>
<td>Low fat yogurt</td>
<td>1% addition preferred over 2%</td>
<td>Tseng &amp; Zhao, 2013</td>
</tr>
</tbody>
</table>
Role of milk solids

- Skim milk powder, whey protein concentrates, Caseinates, etc
  - Improves the gel strength and consistency of yogurt
  - Helps in controlling the whey/serum separation
  - Criteria for selection depend on the cost, availability and desired functionality
Yogurt syneresis – effect of milk solids

2% fat, 5% protein fortification, Syneresis: 15 g sample, centrifugation 10°C, weighing supernatant

Guinee et al, 1994 2nd Food Ingredients Symposium
Heat treatment of yogurt milk

• Yogurt milk is heated at high temperature before starter inoculation
  – Destroys the potential competition for starter bacteria
  – Helps in enhancing the firmness of yogurt gel through denaturation of whey proteins and casein-whey protein interaction
  – Reduces the tendency for whey/serum separation by yogurt during storage
  – Conditions: 85°C/30 min, 90-95°C/5-10 min, 110-120/20-30 s
Major changes in proteins during heat treatment of milk

Casein micelles based on Walstra & Jenness, 1984

Unheated milk

Heating >85°C for >20 min

Heating at low pH (~pH 6.4-6.5)

Heating at high pH (~pH 7.0-7.1)

Submicelle

Protruding chain

Calcium phosphate

K-casein

Whey protein (native)

Submicelle

Protruding chain

Calcium phosphate

K-casein

Whey protein (native)

Whey protein (denatured)
Effect of WP denaturation

- Experim. points refer only to skim milk (SM)
  - WM = whole milk

- Denaturation degrees of β-Lg B [%]

- Resistance to penetration [N]

- Heat temp: 85 °C, 90 °C, 100 °C, 110 °C, 130 °C

- Denaturation degree of β-Lg B

- Depth of penetration
WP denaturation – effect on syneresis

Kessler (1998) IDF special issue 199802
Influence of homogenisation

- Mainly affects the fat globule size and the make up of the fat globule surface layers
- Helps in preventing cream separation during fermentation and cooling periods
- Improves the consistency and smoothness of yogurt
- Recommended for full-fat and low-fat yogurt
- Pressure: 20-25 MPa (200-250 bar) at 60-70°C
Yogurt networks

a) not heated, not homogenized

b) not heated, homogenized

c) heated, not homogenized

d) heated, homogenized

Kessler (1998) IDF special issue 199802
Effect of homogenisation on gel strength

10% fat, 4% protein, 95°C/10 min
Degree of denaturation - 90% Lg B

Kessler (1998) IDF special issue 199802
Yoghurt starter cultures

• Growth temperature
  – Thermophilic – *S. thermophilus, L. bulgaricus*
  – Mixed mesophilic/thermophilic

• State of delivery
  – Frozen
  – Freeze-dried (lyophilised)

• Probiotic
  – *L.casei, Bifidobacteria, L.acidophilus*

• Direct set

• Traditional cultures (undefined)
Delivery forms of starters

• Liquid, for propagation of mother culture (fairly rare)
• Deep-frozen, concentrated for propagation of bulk starter
• Deep-frozen, super-concentrated cultures in readily soluble form, for direct inoculation
• Freeze-dried, concentrated in powder form, for propagation of bulk starter or direct inoculation
Effect of incubation temperature on yogurt starter cultures

Yoghurt starter symbiosis

• *Streptococcus salivarius* subsp. *thermophilus* (ST)
  – Grows faster than LB
  – Produces acid plus carbon dioxide (help in the growth of LB)
  – Responsible for initial drop in pH (to ~5.0)

• *Lactobacillus delbrucii* subsp. *bulgaricus* (LB)
  – More proteolytic activity than ST - produce peptides and amino acids (stimulate the growth of ST)
  – Helps to drop pH below 5.0
Starter growth with pH change and flavour development (2.5% starter addition)

Role of starter in flavour development

<table>
<thead>
<tr>
<th>Organism</th>
<th>Acetaldehyde</th>
<th>Acetone</th>
<th>Acetoin</th>
<th>Diacetyl</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. thermophilus</em></td>
<td>1.0 to 13.5</td>
<td>0.2 to 5.2</td>
<td>1.5 to 7.0</td>
<td>0.1 to 13.0</td>
</tr>
<tr>
<td><em>Lb. delbruekii</em> subsp.</td>
<td>1.4 to 77.5</td>
<td>0.3 to 3.2</td>
<td>Trace to 2.0</td>
<td>0.5 to 13.0</td>
</tr>
<tr>
<td><em>bulgaricus</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed cultures</td>
<td>2.0 to 41.0</td>
<td>1.3 to 4.0</td>
<td>2.2 to 5.7</td>
<td>0.4 to 0.9</td>
</tr>
</tbody>
</table>

Changes during fermentation

- Partial conversion of lactose to lactic acid (lactose fermentation)
- Decrease in pH
- Release of volatiles
- Growth of starter bacteria
- Aggregation of proteins and formation of a gel network
Lactose fermentation

• 20-30% lactose fermented by lactic acid bacteria using different pathways
• LAB are homofermentative, i.e. producing one major end product (95% lactic acid)
• Lactic acid
  – Conc. 0.7-1.0%
  – ST produces L(+) isomer and LB produces D(−) isomer (yogurt contains ~ 50-70% L(+))
  – D(−) isomer is metabolised slower level than L(−) isomer by humans
• Bifidobacteria produces 3:2 acetic:lactic acid
Major changes in protein during fermentation (heated milk)

Repulsion

pH reduction

Attraction

Colloidal CaPO4

Network formation (e.g. yogurt)
Yogurt network formation
Yogurt microstructure

TEM

SEM

Skriver 1996 (KVL PhD Thesis)
Yogurt microstructure

TEM

SEM

Fat globules

Protein network

Lb bulgaricus

S. thermophilus

Skriver 1996 (KVL PhD Thesis)
Other changes during fermentation

• Slight proteolysis (1-2%) by starter bacteria is necessary for growth of the starter
  – *L. bulgaricus* more proteolytic than *S. thermophilus*

• Casein is the principal substrate but whey proteins may also be proteolysed
  – High levels of peptides and free amino acids (e.g. valine, proline, serine, histidine) in fermented milk

• Increased protein absorption
Cooling, fruit addition and packaging

• Rate of cooling
• Cooling temperature
• Aseptic fruit dosing and fruit quality
• Method of fruit addition
  – Mixed
  – Fruit on top
  – Fruit at the bottom
• Packaging material
Effect of fruit prep on syneresis and WHC

Table 4. Syneresis (%) and WHC (%) of control and different fruit yogurt in storage time.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Syneresis (%)</th>
<th></th>
<th></th>
<th>WHC (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First day</td>
<td>Sixth day</td>
<td>Tenth day</td>
<td>First day</td>
<td>Sixth day</td>
</tr>
<tr>
<td>Plane yogurt</td>
<td>27.32±0.12²</td>
<td>23.63±0.39²</td>
<td>24.91±0.12²</td>
<td></td>
<td>67.21±1.40¹</td>
<td>71.71±0.01²</td>
</tr>
<tr>
<td>Apple yogurt (7%)</td>
<td>22.61±0.36²</td>
<td>18.96±0.02²</td>
<td>20.65±0.14²</td>
<td></td>
<td>76.01±0.21²</td>
<td>80.01±0.36²</td>
</tr>
<tr>
<td>Apple yogurt (10%)</td>
<td>17.93±0.63³</td>
<td>15.74±0.26³</td>
<td>13.65±0.12⁴</td>
<td></td>
<td>80.31±0.89³</td>
<td>85.64±0.18³</td>
</tr>
<tr>
<td>Banana yogurt (7%)</td>
<td>20.31±1.6³</td>
<td>18.36±0.13³</td>
<td>16.32±0.67³</td>
<td></td>
<td>77.12±0.01³</td>
<td>87.09±0.12³</td>
</tr>
<tr>
<td>Banana yogurt (10%)</td>
<td>16.98±0.61³</td>
<td>14.20±1.3³</td>
<td>12.95±0.13³</td>
<td></td>
<td>83.65±0.14³</td>
<td>87.36±0.42³</td>
</tr>
<tr>
<td>Strawberry yogurt (7%)</td>
<td>24.33±0.96³</td>
<td>21.51±0.15³</td>
<td>23.69±0.23³</td>
<td></td>
<td>70.25±0.46³</td>
<td>72.65±0.13³</td>
</tr>
<tr>
<td>Strawberry yogurt (10%)</td>
<td>22.41±0.45³</td>
<td>20.65±0.65³</td>
<td>21.31±0.33³</td>
<td></td>
<td>72.36±0.03³</td>
<td>74.95±0.63³</td>
</tr>
</tbody>
</table>
Effect of fruit prep on sensory properties

<table>
<thead>
<tr>
<th>Sample</th>
<th>Appearance and color</th>
<th>Body and texture</th>
<th>Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First</td>
<td>Sixth</td>
<td>Tenth</td>
</tr>
<tr>
<td>Plane yogurt</td>
<td>4.31±0.14</td>
<td>4.40±0.12</td>
<td>4.21±0.14</td>
</tr>
<tr>
<td>Apple yogurt (7%)</td>
<td>4.70±0.21</td>
<td>4.81±0.14</td>
<td>4.60±1.5</td>
</tr>
<tr>
<td>Apple yogurt (10%)</td>
<td>4.21±0.45</td>
<td>4.32±02</td>
<td>3.81±0.17</td>
</tr>
<tr>
<td>Banana yogurt (7%)</td>
<td>4.61±0.12</td>
<td>4.43±0.15</td>
<td>4.82±0.14</td>
</tr>
<tr>
<td>Banana yogurt (10%)</td>
<td>4.10±0.26</td>
<td>3.91±0.12</td>
<td>4.20±0.31</td>
</tr>
<tr>
<td>Strawberry yogurt (7%)</td>
<td>4.81±0.12</td>
<td>4.80±0.09</td>
<td>4.41±0.2</td>
</tr>
<tr>
<td>Strawberry yogurt (10%)</td>
<td>4.72±0.11</td>
<td>4.71±0.87</td>
<td>4.60±0.5</td>
</tr>
</tbody>
</table>
Effect of fruit prep on overall acceptability

Table 6. Effect of fruit pulp concentrations on overall acceptable scores properties of yogurt

<table>
<thead>
<tr>
<th>Sample</th>
<th>overall acceptable scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First</td>
</tr>
<tr>
<td>Plane yogurt</td>
<td>4.31±0.14a</td>
</tr>
<tr>
<td>Apple yogurt (7%)</td>
<td>4.70±0.02a</td>
</tr>
<tr>
<td>Apple yogurt (10%)</td>
<td>4.01±0.05a</td>
</tr>
<tr>
<td>Banana yogurt (7%)</td>
<td>4.62±0.04a</td>
</tr>
<tr>
<td>Banana yogurt (10%)</td>
<td>4.12±0.06a</td>
</tr>
<tr>
<td>Strawberry yogurt (7%)</td>
<td>4.80±0.11a</td>
</tr>
<tr>
<td>Strawberry yogurt (10%)</td>
<td>4.61±0.11a</td>
</tr>
</tbody>
</table>

Yousef et al. 2013
Packaging, storage and distribution

Quality of product during manufacture

Temperature

Internal
(Composition + Micro-organisms)

O₂

Light

Packaging material

Mechanical
(Shaking, tension, pressure)
Consumer acceptability of yogurt during storage at 4°C

Based on Salvador and Fiszman, 2004
Syneresis in yogurt – effect of temperature during storage

Salvador and Fiszman, 2004
Measuring yogurt quality - consistency

Consistometer


http://foodqalab.byu.edu/testing_techniques/manual/bostwick.html
Measuring yogurt quality - viscosity

Brookfield viscometer
Helipath drive and “T” spindles
Measuring yogurt quality - rheology

- Tests are performed applying a small sinusoidal strain (or stress)
- Able to detect small changes in yogurt structure (useful for quality and consistency)
Measuring yogurt quality - syneresis

• Syneresis
  – Leave yogurt on a strainer at refrigeration temperature for a fixed time
  – Measure amount of free whey

Kessler (1998) IDF special issue 199802
Measuring yogurt quality – gel strength

- Penetrometer
  - Use fixed weight to penetrate into the gel network
  - Measure the resistance/depth
Flavour compounds and sensory aspects of yogurt
Flavour compounds in yogurt

• The flavour compounds of yogurt are determined by the
  – Relative balance of flavor compounds derived from fat, protein, or carbohydrate
  – The distinct flavor contributed by lactic acid and a complex mixture of aroma compounds, which include the volatiles already present in the milk and specific compounds produced from milk fermentation
Flavour compounds in yogurt

- Four main categories:
  - Volatile carbonyl compounds (e.g., acetaldehyde, acetone, acetoin, and diacetyl)
  - Volatile acids (e.g., acetic, propionic, and butyric)
  - Non-volatile acids (e.g., lactic, pyruvic, oxalic, and succinic)
  - Miscellaneous compounds (e.g., certain amino acids and/or constituents formed by thermal degradation of protein, fat, and lactose)
Volatile compounds in yogurt

• More than 90 volatiles identified
• Carbonyl compounds (30+) — e.g. acetaldehyde, diacetyl, propanal etc
• Alcohols (15+) — ethanol, propanol, butanol etc
• Acids (10+) — acetic acid, propionic acid butyric acid, etc
• Esters (5+) — methyl, ethyl, butyl acetates, etc
• Sulphur compounds (5+) — sulphides and disulphides, etc
• Hydrocarbons (4+) — heptane, nonane etc
• Aromatic compounds (10+) — benzene, toluene etc
• Heterocyclic compounds (10+) — furan, fufural, etc

Measuring volatiles in yogurt

- Complicated due to heterogeneous nature of matrix of fat, carbohydrate, proteins
  - Tendency to degrade or to form artifacts in the presence of heat and/or oxygen;
  - Potential formation of secondary volatiles via enzymatic reactions; and
  - Incomplete recovery of the polar/semi-volatile flavor constituents
- Involves pre-concentration before GC-MS
- May use electronic nose for qualitative mapping
Deterioration of flavour during storage

- Yogurt is prone to deterioration, especially at an ambient temperature, within a matter of days.
- Microbial, enzymatic, or chemical reactions occurring within yogurt during storage may alter its physical, chemical, and microbiological structure, causing deterioration or spoilage.
- Generation of volatile by-products leads to off-flavors and makes the product unsatisfactory for the tastes of consumers.
- The evolution of volatile compounds can often determine the storage and shelf life of yogurt.
Measuring sensory quality of yogurt

Aims:
- objective measurement of differences of tastes of similar product types
- verbal description of characteristics of products
- measurement of subjective impressions / hedonics / preference for products

Areas:
- Quality control
- Quality assurance
- Product development (R&D)
- Production
- Marketing
- Market research

Panels:
- trained food experts, trained tasters
- inhouse groups or external
- few people can set up reproducible results
- consumer groups
- representative random samples
Factors affecting sensory results

Factors that affect the results:

• Subjects - humans
• Type of test - appropriateness
• The way the test is carried out
• Testing facilities – lighting, odours, noise etc
Sensory analysis of yogurt – University of Queensland/Dairy innovation Australia

• Uses Quantitative Descriptive Analysis (QDA ®) as one of main descriptive analysis techniques developed by Tragon Corporation and Department of Food Science at the University of California, Davis
  – Recruitment of panelist
  – Selecting questionnaire
  – Screening sessions
  – Language development
  – Line scale training

• Compusense – data collection and analysis software
Sensory analysis of yogurt – language development

<table>
<thead>
<tr>
<th>Aroma</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rancid aroma</td>
<td>Oxidized fat (Spoilt yoghurt)</td>
<td>Feta cheese</td>
</tr>
<tr>
<td>Cheesy aroma</td>
<td>Aroma of cheese</td>
<td>Cheddar cheese</td>
</tr>
<tr>
<td>Acidic aroma</td>
<td>Aroma associated with Yoghurt</td>
<td>Yoplait and Select Greek style yoghurt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Taste</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweetness</td>
<td>Taste of sugars</td>
<td>Yoplait + Sugar</td>
</tr>
<tr>
<td>Sourness</td>
<td>Taste associated with acid like lactic acid</td>
<td>Yoplait + Citric acid</td>
</tr>
<tr>
<td>Bitterness</td>
<td>Taste associated with caffeine</td>
<td>Yoplait + Caffeine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flavour</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidic</td>
<td>Typical acidic flavor associated with yoghurt</td>
<td>Select Greek style yoghurt</td>
</tr>
<tr>
<td>Cheese</td>
<td>Aromatics/ flavour associated with cheese</td>
<td>Cheddar cheese</td>
</tr>
<tr>
<td>Rancid</td>
<td>Aromatics/flavor associated with oxidation of fat</td>
<td>Feta cheese</td>
</tr>
</tbody>
</table>
## Sensory analysis of yogurt – language development

<table>
<thead>
<tr>
<th>Texture</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Viscosity</strong></td>
<td>Resistance to flow in the mouth before saliva modifies the sample</td>
</tr>
<tr>
<td><strong>Fattiness</strong></td>
<td>Estimation of fat content in the mouth / Perceived amount of fat/grease in the mouth</td>
</tr>
<tr>
<td><strong>Firmness</strong></td>
<td>Solid compact sensation, holds its shape in the mouth</td>
</tr>
<tr>
<td><strong>Lumpiness</strong></td>
<td>Amount of lumps or graininess present in the sample (soft lumps)</td>
</tr>
<tr>
<td><strong>Stickiness</strong></td>
<td>Degree to which the sample sticks to the teeth and palate</td>
</tr>
<tr>
<td><strong>Astringency</strong></td>
<td>The shrinking or drying effect on the tongue surface, followed by increased saliva forming</td>
</tr>
</tbody>
</table>

### Mouthfeel

<table>
<thead>
<tr>
<th>Mouthcoating</th>
<th>Thin film or layer that lines the surface of the mouth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oiliness in the mouth</strong></td>
<td>Perception of oiliness in the mouth</td>
</tr>
</tbody>
</table>
Sensory analysis of yogurt – line scale development

- A line scale is 15 cm in length with sensory intensities word anchors located 1.25 cm from each end. The evaluation length is thus 12.5 cm. The scale direction goes from left to right with increasing intensities, e.g., weak to strong.
Sensory analysis of yogurt - results

### Yogurt with different fat levels

<table>
<thead>
<tr>
<th>Yoghurt Brand</th>
<th>Energy (kJ/100mL)</th>
<th>Protein (g/100mL)</th>
<th>Sugars (g/100mL)</th>
<th>Sodium (mg/100mL)</th>
<th>Calcium (mg/100mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2% Fat (Brand A)</td>
<td>300</td>
<td>5.7</td>
<td>9.0</td>
<td>60</td>
<td>200</td>
</tr>
<tr>
<td>2.0% Fat (Brand B)</td>
<td>306</td>
<td>5.4</td>
<td>8.3</td>
<td>78</td>
<td>198</td>
</tr>
<tr>
<td>4.8% Fat (Brand C)</td>
<td>360</td>
<td>5.8</td>
<td>6.6</td>
<td>83</td>
<td>196</td>
</tr>
<tr>
<td>9.7% Fat (Brand D)</td>
<td>520</td>
<td>5.7</td>
<td>8.6</td>
<td>69</td>
<td>175</td>
</tr>
<tr>
<td>11% Fat (Brand E)</td>
<td>614</td>
<td>4.9</td>
<td>5.8</td>
<td>51</td>
<td>173</td>
</tr>
</tbody>
</table>

### Greek yogurt with different fat levels

<table>
<thead>
<tr>
<th>Yoghurt Brand</th>
<th>Energy (kJ/100mL)</th>
<th>Protein (g/100mL)</th>
<th>Sugar (g/100mL)</th>
<th>Sodium (mg/100mL)</th>
<th>Calcium (mg/100mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1% Fat</td>
<td>282</td>
<td>3.2</td>
<td>5.9</td>
<td>99</td>
<td>130</td>
</tr>
<tr>
<td>2.1% Fat</td>
<td>412</td>
<td>7.5</td>
<td>8.3</td>
<td>110</td>
<td>160</td>
</tr>
<tr>
<td>4.8% Fat</td>
<td>425</td>
<td>5.6</td>
<td>9.0</td>
<td>80</td>
<td>206</td>
</tr>
<tr>
<td>9.1% Fat</td>
<td>561</td>
<td>4.7</td>
<td>7.2</td>
<td>65</td>
<td>168</td>
</tr>
<tr>
<td>10.7% Fat</td>
<td>601</td>
<td>5.7</td>
<td>7.9</td>
<td>77</td>
<td>202</td>
</tr>
</tbody>
</table>
Sensory properties of yogurt – effect of fat levels

UQ/DIAL 2013
Sensory properties of Greek yogurt – effect of fat content
Sensory and viscosity relationship

Panel viscosity vs rheometer viscosity

- Average Panel scores
- Rheometric Viscosity (Pa-s)

Yoghurt with different fat %

- Average panel score
- Rheometric viscosity [Pa-s]

Greek style yoghurt with different fat %

- Average panel score
- Rheometric viscosity [Pa-s]
Sensory-rheology relationship

Firmness vs elastic modulus

UQ/DIAL 2013
Sensory-texture relationship – effect of fat

Firmness vs Sensory Hardness

Adhesiveness vs Sensory stickiness

UQ/DIAL 2013
Sensory-texture relationship – Greek yogurt

Firmness vs Sensory Hardness

Adhesiveness vs Sensory stickiness

Greek style yoghurt with different fat%
Dairy Innovation Australia Sensory Analysis Lab

- Specially designed
- 6 booths
- Controlled environment
- Controlled lighting
- Noise-free area
- Discussion room
- Dedicated kitchen
Dairy Innovation Australia Sensory Analysis Lab
Dairy Innovation Australia Sensory Analysis Lab
Dairy Innovation Australia Sensory Analysis Lab
## Summary
### Quality defects – appearance/texture

<table>
<thead>
<tr>
<th>Defect</th>
<th>Cause of defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syneresis/whey separation</td>
<td>Low total solids, Over acidification, mechanical shaking of gel network, insufficient denaturation of whey proteins, incompatibility of dairy and non-dairy ingredients (inappropriate amount and/or type of stabiliser), too high incubation temperature, too low acidification (pH&gt;4.6)</td>
</tr>
<tr>
<td>Low viscosity/runny</td>
<td>Low total solids, insufficient heat treatment/homogenisation of milk, poor selection of stabiliser, too low incubation temperature, too low inoculation rate</td>
</tr>
<tr>
<td>Film or colony growth on surface of consumer packs</td>
<td>Growth of yeasts and moulds (poor pasteurisation and/or post processing contamination), unhygienic processing conditions in the factory</td>
</tr>
<tr>
<td>Long/roapy texture</td>
<td>Slime producing contaminants, too low temperature of incubation</td>
</tr>
</tbody>
</table>
## Summary

### Quality defects – appearance/texture

<table>
<thead>
<tr>
<th>Defect</th>
<th>Cause of defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grainy texture</td>
<td>Improper mixing or homogenisation of dry milk ingredients; too high incubation temperature, too low inoculation rate</td>
</tr>
<tr>
<td>Mealy gluey texture</td>
<td>Excessive addition of milk powder</td>
</tr>
<tr>
<td>Gas or air bubbles in coagulum</td>
<td>Contamination with yeasts or coli forms; aeration during pumping, air leaks in pipelines</td>
</tr>
<tr>
<td>Nodulation/curdy flecks</td>
<td>Improper mixing of starter culture, localised fermentation, too rapid acidification</td>
</tr>
</tbody>
</table>
# Summary

## Quality defects – flavour/taste

<table>
<thead>
<tr>
<th>Defect</th>
<th>Cause of defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclean/low-acidic</td>
<td>Poor activity of starter culture</td>
</tr>
<tr>
<td>Fermented</td>
<td>Contamination by yeasts and coli forms</td>
</tr>
<tr>
<td>High acid flavour</td>
<td>Too rapid fermentation by starter culture due to high temperature or too high starter conc level</td>
</tr>
<tr>
<td>Grassy/feed flavour</td>
<td>Grassy/feed flavour from raw milk</td>
</tr>
<tr>
<td>Bitter taste</td>
<td>High proteolytic activity, too high starter inoculation</td>
</tr>
<tr>
<td>Rancid flavour</td>
<td>Fat degradation due to lipolytic enzymes (insufficient heat treatment)</td>
</tr>
<tr>
<td>Oxidised</td>
<td>Light, metal catalyst</td>
</tr>
</tbody>
</table>