การวิเคราะห์คุณภาพนมดิบและผลิตภัณฑ์นม
<table>
<thead>
<tr>
<th>Composition</th>
<th>Grade A</th>
<th>Requirement</th>
<th>Grade B</th>
<th>Requirement</th>
<th>Grade C</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat (g/100g)</td>
<td>Min 3.0</td>
<td>Min 3.0</td>
<td></td>
<td></td>
<td>Min 3.0</td>
<td>Min 3.0</td>
</tr>
<tr>
<td>Acidity (g of lactic acid/100ml)</td>
<td>0.14-0.18</td>
<td>0.14-0.18</td>
<td>0.14-0.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Density, 15/15°C, g/ml</td>
<td>1028-1034</td>
<td>1028-1034</td>
<td>1028-1034</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crioscopy (maximum)</td>
<td>-0.530°H</td>
<td>-0.530°H</td>
<td>-0.530°H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNF – Solids Non Fat (g/100g)</td>
<td>Min 8.4</td>
<td>Min 8.4</td>
<td></td>
<td></td>
<td>Min 8.4</td>
<td>Min 8.4</td>
</tr>
<tr>
<td>Total Protein (g/100g)</td>
<td>Min 2.9</td>
<td>Min 2.9</td>
<td></td>
<td></td>
<td>Min 2.9</td>
<td>Min 2.9</td>
</tr>
<tr>
<td>Redutase (Methylen Blue)</td>
<td>Min 5 h</td>
<td>Min 3:30 h</td>
<td></td>
<td>Min 1:30 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Plate Count (CFU/ml)</td>
<td>Max 10,000</td>
<td>Max 500,000</td>
<td>Not defined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somatic Cell Count (cel/ml)</td>
<td>Max 600,000</td>
<td>Max 600,000</td>
<td>Not defined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasteurized Milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcaline Phosphatase Test</td>
<td>Negative</td>
<td>Negative</td>
<td></td>
<td></td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Peroxidase Test</td>
<td>Positive</td>
<td>Positive</td>
<td></td>
<td></td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Standard Plate Count (CFU/ml)</td>
<td>Max 1,000</td>
<td>Max 80,000</td>
<td>Max 300,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, Brazil, Instrução Normativa 51, published in 09/20/02. In: Conselho Brasileiro de Qualidade do Leite (Brazilian Council of Milk Quality) website http://www.cbql.com.br
การวิเคราะห์คุณภาพน้ำนมดิบ

**Platform Tests**

- **Organoletic tests**
  - ดูสี ดมกลิ่น ชิมรส
  - Sediment test, Lactometer test

- **Alcohol test**
  - Alcohol test
  - Alizarin-alcohol test

- **Clot-on boiling test**
### Alizarin-alcohol test

โดยใช้ Alizarin solution 0.2% ใน 68% alcohol

<table>
<thead>
<tr>
<th>color</th>
<th>flake</th>
<th>% lactic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lilac</td>
<td>-</td>
<td>&lt; 0.14</td>
</tr>
<tr>
<td>Pale red</td>
<td>-</td>
<td>0.14-0.17</td>
</tr>
<tr>
<td>Reddish-brown</td>
<td>small</td>
<td>0.17-0.20</td>
</tr>
<tr>
<td>Brownish-yellow</td>
<td>large</td>
<td>&gt; 0.20</td>
</tr>
</tbody>
</table>
Dye Reduction Test

Methylene Blue Reduction Test

\[ \text{methylene blue (blue)} \rightarrow \text{methylene blue (colorless)} \]

Resazurin Reduction Test

\[ \text{resazurin (blue)} \rightarrow \text{resorufin (pink)} \leftrightarrow \text{hydroresorufin (colorless)} \]
## Methylene Blue Reduction Test

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 4½ hr.</td>
<td>1</td>
</tr>
<tr>
<td>2½ - 4½ hr.</td>
<td>2</td>
</tr>
<tr>
<td>1 - 2½ hr.</td>
<td>3</td>
</tr>
<tr>
<td>Under 1 hr.</td>
<td>4</td>
</tr>
<tr>
<td>Color</td>
<td>Class</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Over 2¼ hr.</td>
<td>1</td>
</tr>
<tr>
<td>1½ - 2¼hr.</td>
<td>2</td>
</tr>
<tr>
<td>¾ - 1½ hr.</td>
<td>3</td>
</tr>
<tr>
<td>Under ¾ hr.</td>
<td>4</td>
</tr>
</tbody>
</table>
### Resazurin Reduction Test
แบบ one hour

<table>
<thead>
<tr>
<th>Color</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple</td>
<td>1</td>
</tr>
<tr>
<td>Lavender</td>
<td>2</td>
</tr>
<tr>
<td>Pink</td>
<td>3</td>
</tr>
<tr>
<td>Decolorised</td>
<td>4</td>
</tr>
</tbody>
</table>
Laboratory control in milk products

Chemical analysis

Fat

- Gravimetric method
  - Rose-Gottlieb
    -เติม ethanol และ ammonia
    - ถักด้วย ether
  - Majonnier
    - ปรับปรุงจากวิธี Rose-Gottlieb
  - Schmid-Bondzynski-Ratzlaff (SBR)
    -เติม HCl และ ethanol
    - ถักด้วย ether
Laboratory control in milk products
Chemical analysis

- Volumetric method
  - Babcock method
    - H₂SO₄
  - Gerber method
    - H₂SO₄ และ amyl alcohol
Laboratory control in milk products

Chemical analysis

- Instrumental method
  - Light scatter photometry ใช้เครื่อง Milko- Tester

- Infrared absorption ใช้เครื่อง Milko-Scan
  - 5.723 μm (carbonyl group)
  - 3.48 μm (methylene group)

- Near infrared reflectance ใช้เครื่อง Infra Analyser
Milko Scan
Figure 6.7  Infrared measurement of fat. A, measuring carbonyl; B, measuring ester linkages.
Laboratory control in milk products

Chemical analysis

- **Protein**
  - **Kjeldahl**
    - total nitrogen
  - Dye binding method
    - Amido Black 10B
    - เครื่องมือที่ใช้คือ Foss Pro-Milk Analyser (วัดที่ 550-620 nm)
  - **Infrared absorption**
    - 6.456 μm (N-H bond  ใน peptide bond)
PROTEIN

\[
\begin{align*}
\text{HC} & \quad \text{N} \quad \text{CH} \quad \text{C} \quad \text{N} \quad \text{HC} \\
R^1 & \quad \quad H & \quad & \quad H & \quad \quad H \\
\text{R}^2 & \quad \quad \quad & \quad \quad \quad & \quad \quad \quad & \quad \quad \quad \\
\text{R}^3 & \quad \quad \quad & \quad \quad \quad & \quad \quad \quad & \quad \quad \quad \\
\end{align*}
\]

amino - amino - amino
acids      acids      acids

Figure 6.8  Infrared measurement of protein.
Laboratory control in milk products

Chemical analysis

- **Lactose**
  - Titrimetric method
    - Chloramine-T
  - Munson-Walker method
    - Fehlings solution
  - Polarimetric method
    - Optical rotation
  - Enzymic method
Enzymic method

วิธีที่ 1

\[
\text{lactose} \xrightarrow{\beta\text{-galactosidase, pH 6.6}} \text{glucose + } \beta\text{-galactose}
\]

\[
\beta\text{-galactose} + \text{NAD}^+ \xrightarrow{\beta\text{-galactosidase dehydrogenase, pH 8.6}} \text{galactonic acid} + \text{NADH} + \text{H}^+
\]
Enzymic method

β-galactosidase

\[ \text{lactose} \rightarrow \text{glucose} + \beta-\text{galactose} \]

hexokinase, ATP

\[ \text{glucose} \rightarrow \text{glucose-6-phosphate} \]

glucose-6-phosphate dehydrogenase

\[ \text{glucose-6-phosphate} + \text{NADP}^+ \rightarrow \text{6-phosphogluconate} + \text{NADPH} \]
Laboratory control in milk products

Chemical analysis

- Infrared absorption
  
  $9.610 \, \mu m \ (C-OH)$
LACTOSE

Figure 6.9  Infrared measurement of lactose.
Laboratory control in milk products

Chemical analysis

HPLC
Laboratory control in milk products

Chemical analysis

○ Total solids
  ● Drying method
    ○ Hot air oven
  ● Lactometer method
    ○ Quevenne lactometer

Total solids = 0.25 L + 1.2 F

เมื่อ L = lactometer reading
F = % fat in milk
Laboratory control in milk products

Functional and physical tests

- **Milk**
  - Homogenisation index
    - USPH index
    - Farrall index
    - Mean Volumetric Diameters (MVD)
Laboratory control in milk products

Functional and physical tests

- Ice cream
  - Homogenization index (ice cream mix)
    - Farrall index
  - Viscosity (ice cream mix)
    - Pipette method
    - Brookfield viscometer
  - Overrun
  - Weight per unit volume
  - Meltdown test
Laboratory control in milk products

Functional and physical tests

- **Milk powder**
  - Wettability
  - Dispersibility
  - Solubility
1. Chemical properties
   1) Degree of denaturation of whey protein
   2) Titratable acidity

2. Microbiology properties
   1) Absence of pathogenic organisms
   2) Minimum food spoilage organisms
   3) Minimum plant hygiene indicators
3. Physical properties

1) Free moisture content
2) Bulk density
3) Solubility
4) Scorched particles

Milk powder

Milk powder properties
4. Functional properties

1) Wettability
2) Sinkability
3) Dispersability
4) Rate of hydration
5) Flowability
6) Hygroscopicity
7) Free fat
Analyses for Milk Powder

- Moisture
- Bulk Density
- Particle Density/Occluded Air
- Interstitial Air
- Flowability
- **Solubility**
- Scorched Particles
- Total Fat
- Surface Free Fat
- **Wettability**
- **Dispersibility**
- Sludge
- Slowly Dispersible Particles (SDP)
- Hot Water Test
- Coffee Test
- Rate of Hydration
Wettability
Wettability

- Skim milk powder should be wetted within 15 sec. to be termed instant.
- For whole milk powder there is no requirement, but many producers of instant whole milk powder manufacture the powder to the same standard as valid for the skim milk powder.
- However, for the subsequent dispersing process, especially for whole milk powder, it is advantageous that the wettability is about 30-60 sec., as it eases the subsequent dispersion of the powder into the water.
Dispersibility
Dispersibility

- To obtain a good dispersibility of a powder it is necessary that the powder is wettable and that the agglomeration is optimal, i.e. no fine particles should be present.
- The analytical method is very difficult to define and perform and the reproducibility is very poor. There are numerous methods, and the results cannot be compared.
- Being aware of that, IDF has developed a new dispersibility test. This test is based on determining the capability of a powder (25 g of skim or 34 g of whole milk powder) being poured on a surface of water (250 g, 25°C) to disintegrate into particles capable of passing through a 150-micron sieve when applying the prescribed manual stirring for 20 sec. The amount of powder passing the sieve and being dissolved or dispersed is found by the determination of total solids of the filtrate and expressed in percentage as dispersibility.
Solubility
Solubility

- 10 g of skim milk powder, 13 g of whole milk powder or 6 g of whey powder (or equivalent amount of concentrate depending on solids content) is mixed with 100 ml of water at approx. 24ºC in a mixer at high speed for 90 sec. The milk is then left for 15 min. after which it is stirred with a spatula. 50 ml is filled into a graduated 50 ml centrifuge glass with conically graduated bottom. The glass is spun in a centrifuge for 5 min., the sediment-free liquid is sucked off, the glass is filled up again with water (to make the reading easier), and the content is stirred up. Then the glass is put into the centrifuge and spun for 5 min. after which the sediment is read.
Moisture
Bulk Density
Bulk Density

- Bulk density is defined as the weight of a given volume of powder and is expressed in g/ml, g/100 ml, or g/l.
- The reciprocal value is the bulk volume which is expressed in ml/100 g or ml/g. The bulk volume is usually used when a graduated cylinder glass is used for the determination. The volume of 100 g of powder is then measured in the cylinder.
- As to the other method giving the bulk density, the weight of the powder in a 100 ml cylinder is measured.
- Both results can naturally be converted to the other expression.
- The value may either be expressed as tapped 0 times (loose), tapped 10 times (poured), 100 times, or 1250 times.
- Various types of equipment can be used for the tapping. Also manual tapping is used. The intensity of the tapping is naturally influencing the value.
## Particle Density/Occluded Air

### Solids, air and moisture free:

<table>
<thead>
<tr>
<th>Component</th>
<th>Density, g/ml at 20ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk fat</td>
<td>0.94</td>
</tr>
<tr>
<td>Non-fat milk solids</td>
<td>1.52</td>
</tr>
<tr>
<td>Calcium caseinate phosphate complex</td>
<td>1.39</td>
</tr>
<tr>
<td>Amorphous lactose</td>
<td>1.52</td>
</tr>
<tr>
<td>Beta-lactose</td>
<td>1.59</td>
</tr>
<tr>
<td>Alpha-lactose monohydrate</td>
<td>1.545</td>
</tr>
</tbody>
</table>
Scorched Particles
Scorched Particles

- 25 g skim milk powder, 32.5 g whole milk powder or 15 g whey powder (or equivalent amount of concentrate depending on total solids), is mixed with 250 ml of water of 18-28ºC in 60 sec. in the same kind of mixer as used for insolubility index. The milk solution is filtered and the filter pad is compared with a standard for classification. The scorched particles are expressed as A, B, C, or D depending on the intensity and colour of the particles left on the filter.
Surface Free Fat

[Diagram of the process involving shaking, filtration, and evaporation with weighing of residual]
Surface Free Fat

- To determine the free fat in the powder, 50 ml of petroleum ether and 10 g of powder are mixed slowly for exactly 15 min. The mixture is filtrated and 25 ml of the filtrate is evaporated, the residue weighed and the free fat percentage is calculated either based on total fat or more commonly based on the powder
Laboratory control in milk products

Functional and physical tests

- Heat number
  - วัดส่วนตะกอน

- Whey protein nitrogen index (WPNI)
  - วัดส่วนใส
<table>
<thead>
<tr>
<th>Product</th>
<th>Powder type</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconstituted milk and milk drinks</td>
<td>Low/medium heat</td>
<td>High solubility, minimal cooked flavour</td>
</tr>
<tr>
<td>Recombined evaporated milk</td>
<td>High heat</td>
<td>Heat stability, high viscosity</td>
</tr>
<tr>
<td>Cheese</td>
<td>Low heat</td>
<td>Rennetability</td>
</tr>
<tr>
<td>Ice cream</td>
<td>Medium heat</td>
<td>Emulsification, foaming, water absorption</td>
</tr>
<tr>
<td>Confectionery</td>
<td>High heat</td>
<td>Texture modification, water absorption</td>
</tr>
<tr>
<td>Comminuted meat</td>
<td>High heat</td>
<td>Emulsification, gelation, water absorption</td>
</tr>
<tr>
<td>Baked goods</td>
<td>High heat</td>
<td>Water binding, texture modification</td>
</tr>
</tbody>
</table>
## WHEY PROTEIN NITROGEN INDEX

<table>
<thead>
<tr>
<th>Heat Level</th>
<th>WPNI (mg N / g powder)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low heat</strong></td>
<td>≥ 6</td>
</tr>
<tr>
<td><strong>Medium heat</strong></td>
<td>1.51 – 5.99</td>
</tr>
<tr>
<td><strong>High heat</strong></td>
<td>≤ 1.5</td>
</tr>
</tbody>
</table>
Laboratory control in milk products
Microbiological analysis

Microbiological analysis
- Pathogenic microorganisms absence
- Spoilage and indicator microorganisms