Bacteria associated with ensiling fermentation and aerobic stability of total mixed ration silage

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Advantages of ensiling wet by-products as TMR silage

- Minimize the risk of effluent production
- Counterbalance the nutrients of by-products
- Improve odors and flavors during fermentation
- Stabilize microbial function and improve energy and protein utilization in the rumen
- Reduce the labors associated with mixing prior to feeding
Characteristics of TMR silage

- More than 10 ingredients including wet by-products and dry feeds
- High nutritive value targeted for dairy cows (CP >160 g/kg DM, TDN 720-760 g/kg DM)
- Low moisture (DM 500-600 g/kg)
- Short storage usually within one month
Resistance to aerobic deterioration

![Graphs showing temperature changes over time for different feed types.](image)
Prevention of intake depression in summer

Palatability Score

Non-ensiled TMR

TMR silage

(Yoshihara et al. 2006)
Association of *L. buchneri* in the ensiling process

**Plate-culture**

**Pre-ensiled TMR mixture**

- *Lactobacillus fermentum* 43%
- *Lactobacillus delbrueckii* 57%

**TMR silage**

**Day 14**

- *Lactobacillus plantarum* 67%
- *Lactobacillus brevis* 33%

**Day 56**

- *Lactobacillus buchneri* 44%
- *Pediococcus acidilactici* 30%
- *Lactobacillus plantarum* 20%
- *Lactobacillus brevis* 3%
- *Lactobacillus parvulus* 3%

**Culture-independent DGGE**

- *Lactobacillus delbrueckii*
- *Lactobacillus delbrueckii*
- *Lactobacillus brevis*
- *Lactobacillus fermentum*
- *Lactobacillus fermentum*
- *Lactobacillus buchneri*
Seasonal changes – a survey of commercial products –

-2 – 10°C | 5 – 25°C | 20 – 30°C | 5 – 22°C

Lactic acid (g/kgDM)

Acetic acid (g/kgDM)

Ethanol (g/kgDM)
Seasonal changes – a survey of commercial products –

-2 – 10°C

5 – 25°C

20 – 30°C

5 – 22°C

Weissella paramesenteroides

Weissella paramesenteroides

Lactobacillus plantarum

Lactobacillus fermentum

Lactobacillus brevis

Pediococcus pentosaceus

Lactobacillus panis

Lactobacillus pontis

Lactobacillus vaginalis

Lactobacillus frumenti

Jan–Feb

Apr–May

Jul–Aug

Oct–Nov

Jan-Feb Apr-May Jul-Aug Oct-Nov
Temperature effects – a laboratory-scale experiment –

Pre-ensiled TMR (commercial product)

Jan–Feb: -2 – 10°C
Apr–May: 5 – 25°C
Jul–Aug: 20 – 30°C
Oct–Nov: 5 – 22°C

Storage for 10, 30 & 90 days:
Warm temperature and long storage confirm stability

<table>
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<tr>
<th>Storage temp</th>
<th>Stability test</th>
<th>10 days</th>
<th>30 days</th>
<th>90 days</th>
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Temperature effects on acetic acid and ethanol contents

Days after ensiling

Lactic acid (g/kgDM)

Acetic acid (g/kgDM)

Ethanol (g/kgDM)

5°C  15°C  25°C  35°C
Temperature effects on bacterial community

Lactobacillus helveticus
Lactobacillus brevis
Lactobacillus plantarum
Acinetobacter baumannii
Lactobacillus sp.
Tetragenococcus halophilus
Lactobacillus buchneri
Lactobacillus panis
Lactobacillus sp.
Lactobacillus delbrueckii
Lactobacillus pontis
Temperature effects on bacterial community

- *Lactobacillus helveticus*
- *Lactobacillus brevis*
- *Lactobacillus plantarum*
- *Acinetobacter baumannii*
- *Lactobacillus sp.*
- *Tetragenococcus halophilus*
- *Lactobacillus buchneri*
- *Lactobacillus panis*
- *Lactobacillus delbrueckii*
- *Lactobacillus pontis*
Conclusions

- Product seasons (storage temperature) have effects on fermentation and bacterial community
  
  Ehanol may increase in winter and acetic acid will increase in summer.
  
  Long storage can confirm aerobic stability even at low temperature storage.

- A number of bacteria have potential to inhibit spoilage
  
  *L. buchneri* is not essential to support stability.

  Inoculant effects and functions of *L. panis* and *L. pontis* are worth examining.