Effects of different feeding systems on milk composition and processability:
Outdoor grazing on pasture vs. indoors feeding on TMR

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Feeding Systems

Profiling milk from Grass: Comparative effects of different dairy cow feeding systems on milk composition, processability and product manufacture

Characteristics of Pasture based feeding systems

- Natural environment
- Cost competitive
- Lower enteric emissions
- Inclusion of white clover fixes atmospheric Nitrogen

Characteristics of Indoor feeding offered TMR

- Protection from heat/cold stress
- Consistent feed composition
- Higher milk yield

- 20 Holstein-Friesian cows allocated to each of the three herds: GRS, GRC and TMR
- Herds balanced: breed, lactation no., calving date, and pre-experimental milk yield and milk solids yield.
Teagasc study on Pasture vs. TMR feeding systems

GRS Milk  GRC Milk  TMR Milk

Compositional/sensory properties
- Composition
- Protein and element profiling
- Fatty acid profiles
- Volatile compounds
- Flavour

Processability characteristics
- Heat stability
- Rennet gelation

Product forming characteristics

Cheese
- Cheddar
- Maasdamer

Mozzarella

Powders
- SMP, WMP

Composition
- Biochemistry
- Yield/losses
- Texture
- Functionality
- Volatiles
- Sensory

Application
Results

- Milk composition / physico-chemical characteristics
- Rennet Gelation & Mozzarella cheesemaking characteristics
Effect of feeding system: Composition

- **GRS milk**:  
  - highest mean levels of total solids (TS), protein, casein ($P < 0.05$)

- **TMR milk**:  
  - Highest content of lactose ($P < 0.05$)

- **GRC milk**  
  - Intermediate of GRS and TMR for mean TS, protein, casein, lactose content. But had highest proportion of $\alpha_{s2}$-casein.

- **No difference** between GRS, GRC or TMR milk for:  
  - mean levels of whey protein, NPN or Urea  
  - mean level of serum casein as % of total casein ($3.7 – 6.25 \%$)  
  - mean proportions of $\alpha_{s1}$, $\beta$- or $\kappa$-caseins
Effect of feeding system: Milk Elements

- **GRS milk** had higher concentrations of Ca, P and Na than GRC or TMR milk ($P < 0.05$)

- **GRC milk** had lowest levels of Se, Cu and Zn

- **TMR milk** had highest level of Se, Cu and Zn
Results

- Milk composition / physico-chemical characteristics
- Rennet Gelation & Mozzarella cheesemaking characteristics
Effect of feeding system: rennet gelation and cheese manufacture

Rennet Gelation: Prerequisite in cheese making

Rennet addition

Gel strength at 40 min, $G'_40$ (Pa)

Days in lactation, DIL

Rennet gelation of **GRS** milk superior to that of **TMR** milk

- Higher gel-firming rate ($\delta G'/\delta t$) : $P < 0.05$
- higher gel firmness at 40 min, $G'_40$ : $P < 0.05$
**Effect of feeding system: cheese manufacture**

- **Cheese yield** from **GRS** milk or **GRC** milk was significantly higher than that of **TMR**

<table>
<thead>
<tr>
<th>Item</th>
<th>Mid Lactation</th>
<th>Late Lactation</th>
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<tbody>
<tr>
<td></td>
<td>GRS</td>
<td>GRC</td>
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<tr>
<td>Actual yield, Ya (kg/100 kg milk)</td>
<td>9.3b</td>
<td>9.7a</td>
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</tbody>
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- **No effect** on cheese composition or recoveries of fat and protein from milk to cheese, or characteristics over ripening, proteolysis, water binding capacity, firmness, cohesiveness, chewiness,…

- Cheese from **GRS** milk or **GRC** milk significantly ‘**yellower**’ than cheese from (GRS and GRC cheeses: higher $b^*$ colour coordinate).

- In mid-lactation, cheese from **GRS** milk had highest mean flow and loss tangent over storage time. This effect was not observed in late lactation.
Conclusion

- Milk from cows grazed outdoors on pasture differed from milk from cows offered TMR indoors in several respects
- Compared to TMR milk, pasture-based milk was characterized by
  - high concentrations of protein, casein, Ca, P
  - lower content of Se, Cu or Zn
  - stronger rennet gelation
  - higher Mozzarella cheese yield
  - ‘yellower’ cheese
- The type of pasture affected the extent of difference between pasture- and TMR-based feeding systems
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Thank You