

25th International Symposium Animal Science Days

**Ph.D. ANIMAL
& FOOD
COURSE SCIENCE**
UNIVERSITY OF PADOVA

EFFECTS OF KETOSIS STATUS DEFINED BY FTIR SPECTROSCOPY ON MILK QUALITY TRAITS OF FIRST-LACTATION COWS

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Dipartimento di Agronomia Animali
Alimenti Risorse naturali e Ambiente

What is ketosis?

- A frequent metabolic disorder in dairy cattle;
- Occurring when cows are unable to manage the high energy request for milk production in early lactation;
- Abnormal concentration of circulating ketone bodies (hyperketonemia);

Herdt, 2000; Duffield et al., 2009; Berge and Vertenten, 2014

Negative effects on:

- Milk yield *Dohoo and Martin, 1984; Duffield et al., 2009*
- Milk chemical composition *Kayano and Kataoka, 2015; Santschi et al., 2016*
- Reproduction performance *Raboisson et al., 2014*



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Negative effects on:

- Milk yield
- Milk chemical composition
- Reproduction performance

Relevant economic loss for farmers

265€ per case

McArt et al., 2015



Ketosis can be ...

Clinical

- Decrease in milk yield
- Sweet-smelling breath
- Reduced feed intake and appetite
- Reduced activity and changes in behavior
- Excessive loss of body condition
- Constipation or hard/dry feces
- Nervous signs

Berge and Vertenten, 2014

Subclinical

- Hyperketonemia
- Absence of clinical signs
- More frequent than CK

*Andersson, 1988; Duffield et al., 2009;
Suthar et al., 2013*



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Prevalence in Italy
36.6%



Ketosis diagnosis

Through the measurement of β -hydroxybutyrate (BHB) concentration in body fluids of dairy cows

BLOOD BHB

- Reference method
- KET \geq 1.2 mmol/L

MILK BHB

- More practical tool
- KET \geq 0.15 - 0.20 mmol/L

BHB in milk can be routinely predicted by FTIR spectroscopy for screening hyperketonemia

Oetzel, 2004; van Knegsel et al., 2010; Denis-Robichaud et al., 2014



Aim

To investigate the effect of ketosis status on milk yield and quality traits of Holstein Friesian cows



Data

Sample collection

- From May 2015 to November 2016;
- 15,674 individual milk samples;
- 7,835 first-lactation Holstein Friesian cows: at least 2 tests in 5-60 DIM;
- 546 herds in Veneto region (northeast Italy);
- 2,618 herd-test-day (HTD): at least 3 cows;

Milk analysis

Milk samples were analysed using FTIR prediction models



Ketosis status

≥ 0.20 mmol/L

• KETOTIC

0.15 - 0.19
mmol/L

• SUSPECT

< 0.15 mmol/L

• NORMAL

Koeck et al., 2014; Santschi et al., 2016



Statistical analysis

$$Y_{ijklm} = \mu + \text{DIM}_i + K_j + (\text{DIM} \times K)_{ij} + \text{cow}_k + \text{HTD}_l + \varepsilon_{ijklm}$$

Y_{ijklm} = daily milk yield, fat, protein, casein, lactose, SCS*;

FIXED EFFECTS:

DIM_i = 1 – 8 classes, 5 – 30 DIM of 5 day, 31 – 60 of 10 day;

K_j = NORMAL, SUSPECT, KETOTIC classes;

RANDOM EFFECTS: cow_k HTD_l ε_{ijklm}

*SCS = $3 + \log_2(\text{SCC}/100,000)$



Results

Mean and standard deviation (SD), F-value and significance of fixed effects in the analysis of milk yield and quality traits.

Trait	Mean \pm SD	Effect		
		DIM	Ketosis status	DIM*Ketosis status
Milk (kg/d)	30.08 \pm 7.06	86.18***	36.13***	2.95***
Fat (%)	3.87 \pm 0.85	94.61***	193.29***	3.48***
Protein (%)	3.13 \pm 0.34	497.03***	10.36***	3.55***
Casein (%)	2.43 \pm 0.26	348.31***	26.83***	3.11***
Lactose (%)	4.93 \pm 0.21	233.48***	89.77***	1.91*
SCS	2.57 \pm 1.76	23.68***	8.03***	0.67

Statistical significance is given as: *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$.



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Results

Least squares means of milk yield and quality traits for ketosis status according to milk BHB concentration.

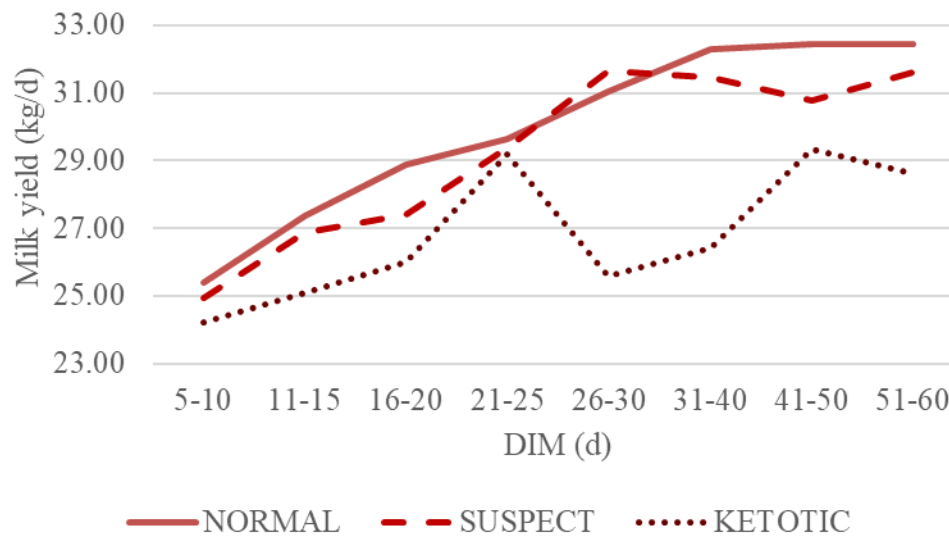
Trait	NORMAL	SUSPECT	KETOTIC
	(BHB <0.15 mmol/L)	(BHB 0.15-0.19 mmol/L)	(BHB ≥0.20 mmol/L)
Milk (kg/d)	29.94 ^a	29.26 ^b	26.81 ^c
Fat (%)	3.79 ^c	4.12 ^b	4.69 ^a
Protein (%)	3.12 ^a	3.08 ^b	3.06 ^b
Casein (%)	2.42 ^a	2.38 ^b	2.34 ^c
Lactose (%)	4.95 ^a	4.90 ^b	4.80 ^c
SCS	2.55 ^a	2.65 ^a	2.99 ^b

^{a-c} Least squares means with different letters across milk BHB concentrations are significantly different according to Bonferroni's test ($P < 0.05$).



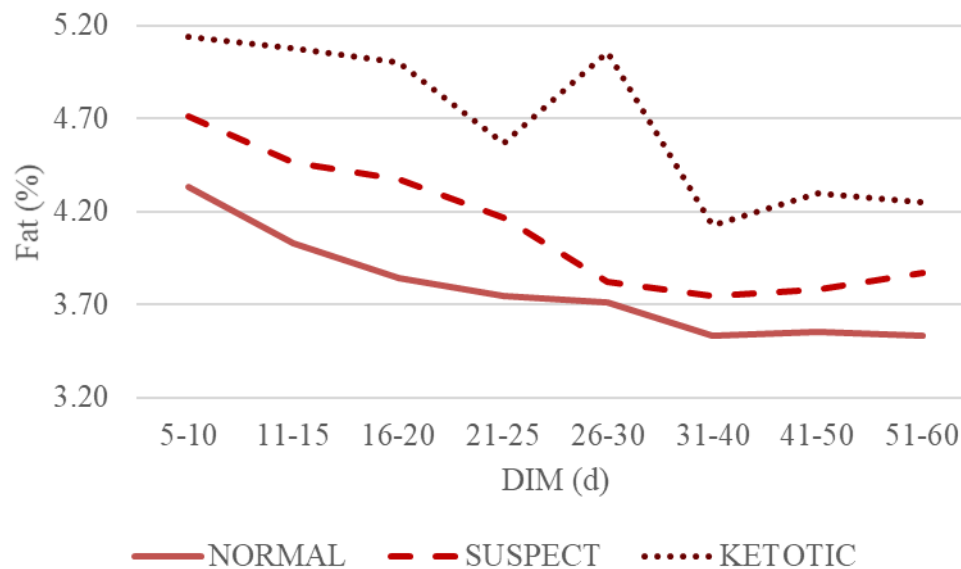
Least squares means of milk yield and quality traits for ketosis status according to milk BHB concentration and across days in milk (DIM).

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Conclusions

- I. Ketosis negatively affects milk yield and quality traits in early lactation;
- II. Cows exhibited significantly different performance across ketosis status classes;
- III. KETOTIC cows yielded less milk with greater fat and SCS contents than NORMAL cows (SUSPECT cows were intermediate);
- IV. Same trends of difference between classes were generally observed across 60 DIM;



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A.I.A.

THANK YOU!



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