Capitalizing on European collaboration for large-scale screening for ketosis in dairy cows

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Milk production losses

Prevalence:
4% for clininal ketosis
22% for subclinical ketosis

Increased risk for other diseases and reproductive problems

Ketosis

Metabolic disease no. 1 in early lactation
with consequences often underestimated

Early detection is a key point!

Cost:
117 US$
(289 US$ when accouting for subsequent diseases)

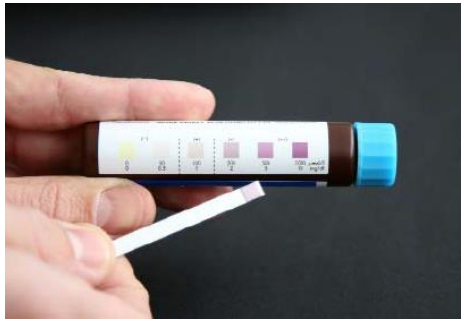
Suthar et al., 2013, J. Dairy Sci.
McAart et al., 2015, J. Dairy Sci.

Ketosis

Early detection is a key point!

Detection = measuring ketone bodies

- **In blood with an analyser**
  - (+) reliable (~ gold standard)
  - (-) 'costly', invasive, time-consuming

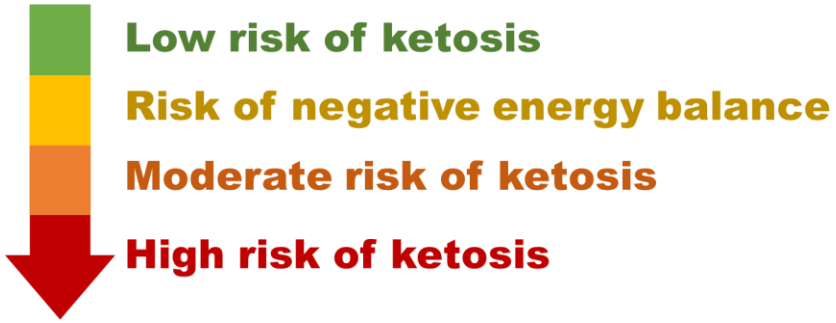


- **With cow side test strips in milk or urine**
  - (+) cheaper, easier
  - (-) less reliable

- **By mid-infrared analysis of milk recording samples**
  - (+) no extra costs, no extra sampling on cow, all cows tested at each test-day
  - (-) less reliable

Detection of ketosis in milk recording samples: 2 examples

- "CÉTOLAIT score"



- Obtained by a decision tree which uses 4 milk traits predicted by MIR: fat/protein, BHB, acetone, C18:1 *cis*-9
- Specificity = 72% & Sensitivity = 71%

- "KetoMIR score"

Class 1 Healthy	Class 2 In Danger	Class 3 Severely in danger

- Predictive model using:
  - fixed effects + milk yield + MIR predicted traits (KetoMIR1, used in routine)
  - fixed effects + MIR spectra corrected for DIM (KetoMIR2, in test)
- Specificity = 84% & Sensitivity = 72%

Going further in the screening for ketosis through milk recording samples?

1. Predict directly **NEFA and BHB blood concentrations** from milk mid-infrared spectral data

2. Take **advantage of these new traits to:**
   - ✓ reinforce CÉTOLAIT score
   - ✓ promote KetoMIR2 score

Developing calibration equations to predict NEFA and BHB blood concentrations from milk MIR spectral data

Capitalizing on European collaboration

Equations were developed in the framework of European Milk Recording EEIG

Advantages:

- Collation of large, diverse and variable datasets
- Use of standardized spectral data
  (→ avoid bias among apparatus and time periods)
- Take advantage of expertise of each members/associated partners

MIR prediction of blood NEFA & BHB
Data set

- Blood BHB and NEFAs associated with MIR standardized spectral data
- Compilation of data from 2 projects
  - "OptiMIR" project: 4 research farms in Germany and France
  - "Acetone" project: 6 commercial farms in Switzerland
- Breeds: Holstein, Brown Swiss, Simmental, Montbeliard
- Final dataset (after editing)

Trait	N	Mean ± Std	Range
Blood NEFA (mmol/L)	1516	0.338 ± 0.373	0.010 – 2.160
Blood BHB (mmol/L)	735	0.770 ± 0.439	0.250 – 3.200

MIR prediction of blood NEFA & BHB
Methodology

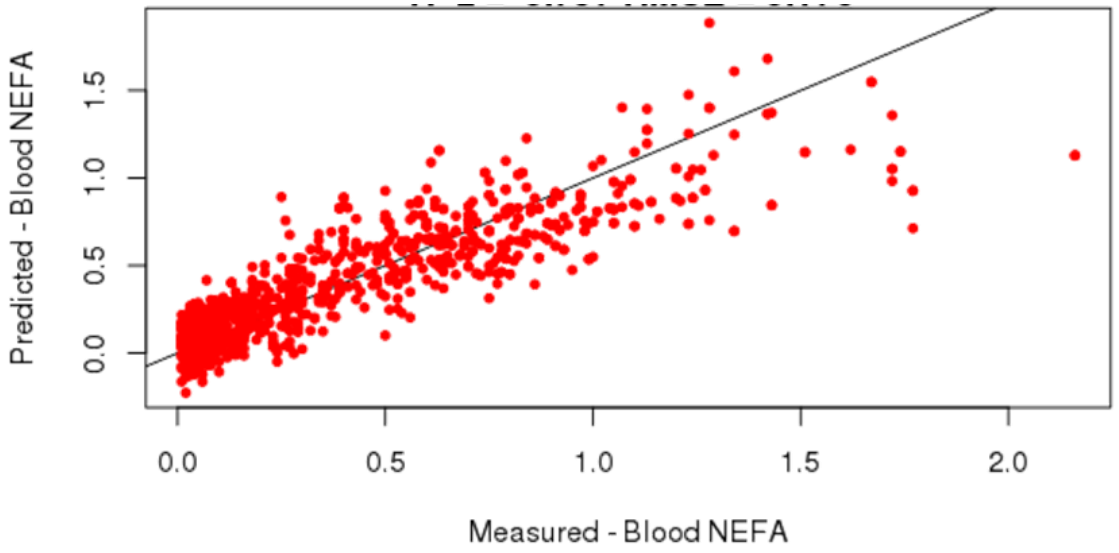
- Pre-processing:
  - Savitsky-Golay first derivative
  - selection of 212 informative wavenumbers
- Log10 transformation for blood BHB values
- Canonical powered PLS method

MIR prediction of blood NEFA & BHB

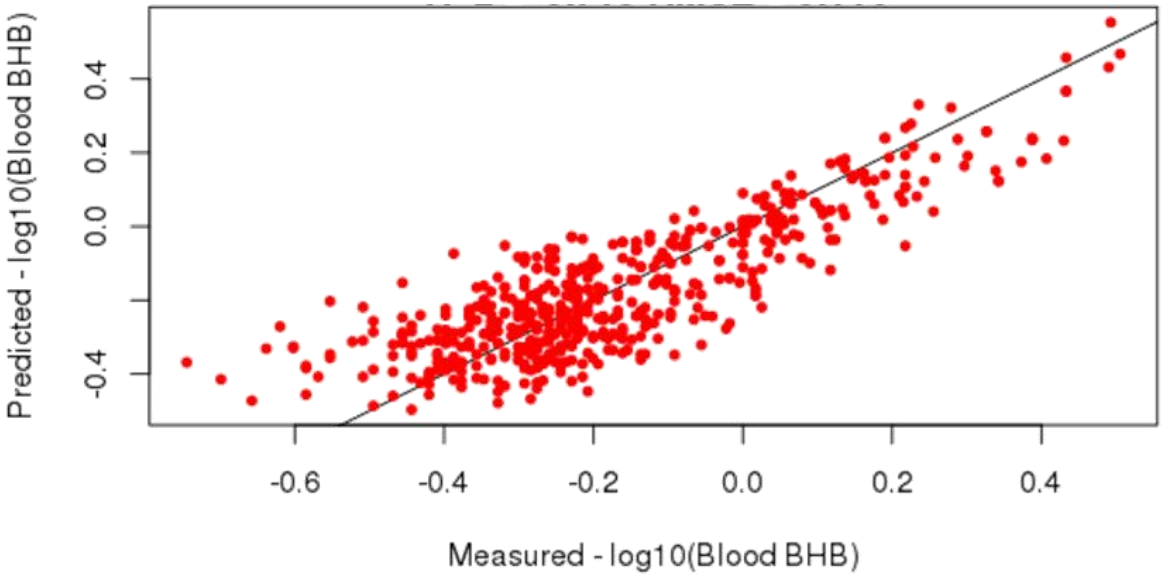
Calibration results

Trait	N	Mean ± Std	Range
Blood NEFA (mmol/L)	1516	0.338 ± 0.373	0.010 – 2.160
Blood BHB (mmol/L)	735	0.770 ± 0.439	0.250 – 3.200

Blood NEFA



Blood BHB



MIR prediction of blood NEFA & BHB

Calibration & cross-validation results

Trait	N	Mean ± Std	Range	No. terms	Standard Error of Calibration	R^2 calibration
Blood NEFA (mmol/L)	1516	0.338 ± 0.373	0.010 – 2.160	15	0.171	0.79
Blood BHB (mmol/L)	735	0.770 ± 0.439	0.250 – 3.200	20	0.106	0.73

Cross-validation results

With 4 datasets

Trait	Standard error of cross-validation	R^2 cross-validation	RPD (Std/Secv)
Blood NEFA (mmol/L)	0.181	0.77	2.06
Blood BHB (mmol/L)	0.116	0.68	1.76

Allow to discriminate groups of cows, identify high from low values

Promote MIR predictions of blood NEFA and BHB through their practical use

Using blood BHB & NEFA MIR predictions to verify 'KetoMIR2' score

Class 1 Healthy	Class 2 In Danger	Class 3 Severely in danger

- "KetoMIR score" assesses the risk of ketosis through milk recording samples

- "KetoMIR2" score vs. MIR predictions

Trait	r with 'KetoMIR2' score
Blood NEFA (mmol/L)	0.78
Blood BHB (mmol/L)	0.59

→ KetoMIR2 indicator is consistent in addressing the risk of ketosis

Using blood BHB & NEFA MIR predictions to enhance CÉTOLAIT score

- "CÉTOLAITscore" assesses the risk of ketosis through milk recording samples

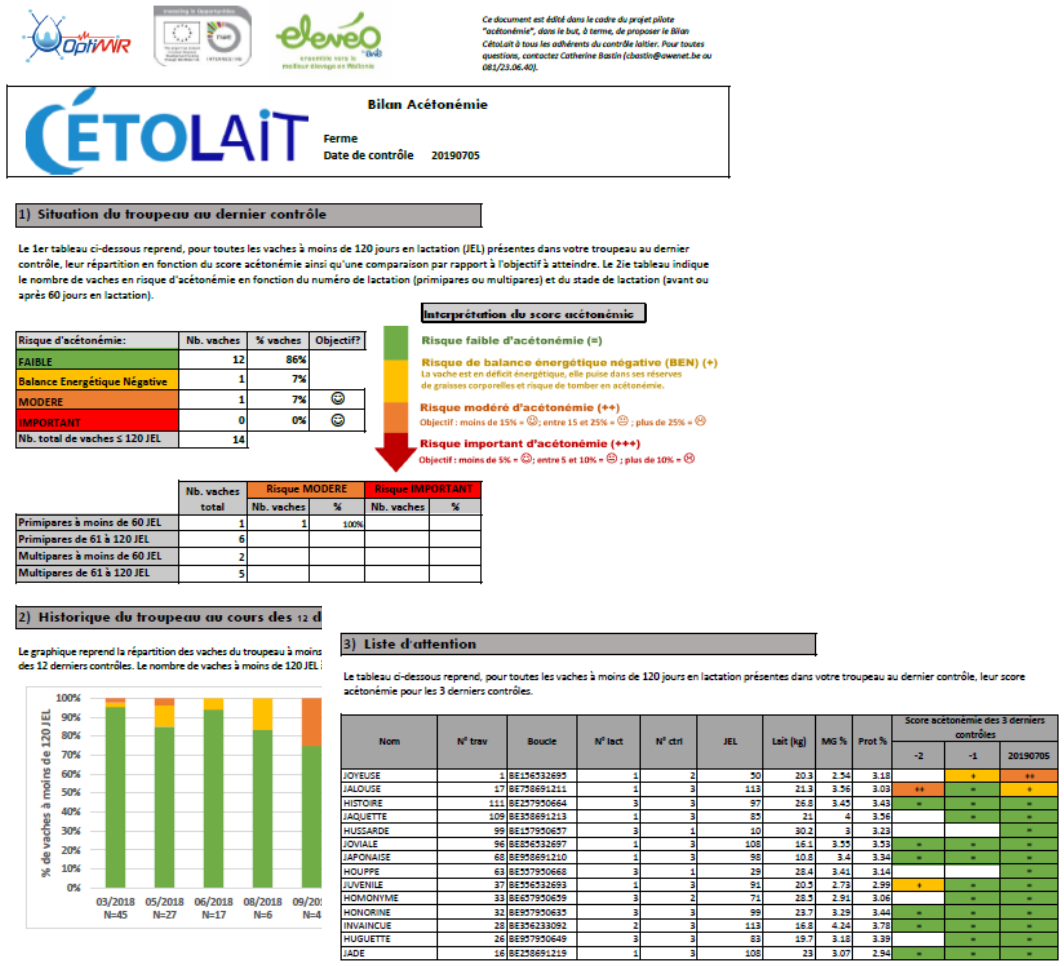
Low risk of ketosis

Risk of negative energy balance

Moderate risk of ketosis

High risk of ketosis

- Report sent to farmers after each test-day
- Pilot project – 120 farms



Ce document est édité dans le cadre du projet pilote "acétonémie", dans le but, à terme, de proposer le Bilan CétoLait à tous les adhérents du contrôle laitier. Pour toutes questions, contactez Catherine Bastin (cbastin@uwenet.be ou 081/23.06.40).

CÉTOLAIT

Bilan Acétonémie

Ferme

Date de contrôle 20190705

1) Situation du troupeau au dernier contrôle

Le 1er tableau ci-dessous reprend, pour toutes les vaches à moins de 120 jours en lactation (JEL) présentes dans votre troupeau au dernier contrôle, leur répartition en fonction du score acétonémie ainsi qu'une comparaison par rapport à l'objectif à atteindre. Le 2ie tableau indique le nombre de vaches en risque d'acétonémie en fonction du numéro de lactation (primipares ou multipares) et du stade de lactation (avant ou après 60 jours en lactation).

Risque d'acétonémie:	Nb. vaches	% vaches	Objectif?
FAIBLE	12	86%	
Balance Energétique Négative	1	7%	
MODERE	1	7%	☺
IMPORTANT	0	0%	☺
Nb. total de vaches ≤ 120 JEL	14		

Interprétation du score acétonémie

Risque faible d'acétonémie (=)

Risque de balance énergétique négative (BEN) (+)
La vache est en déficit énergétique, elle puise dans ses réserves de graisses corporelles et risque de tomber en acétonémie.

Risque modéré d'acétonémie (++)
Objectif : moins de 15% = ☺; entre 15 et 25% = 😐 ; plus de 25% = ☹

Risque important d'acétonémie (+++)
Objectif : moins de 5% = ☺; entre 5 et 10% = 😐 ; plus de 10% = ☹

	Nb. vaches total	Risque MODERE		Risque IMPORTANT	
		Nb. vaches	%	Nb. vaches	%
Primipares à moins de 60 JEL	1	1	100%		
Primipares de 61 à 120 JEL	6				
Multipares à moins de 60 JEL	2				
Multipares de 61 à 120 JEL	5				

2) Historique du troupeau au cours des 12 d

Le graphique reprend la répartition des vaches du troupeau à moins des 12 derniers contrôles. Le nombre de vaches à moins de 120 JEL

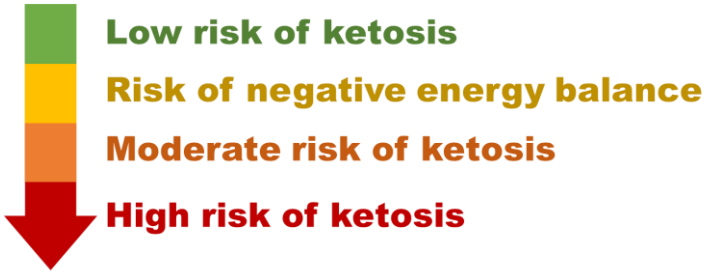
3) Liste d'attention

Le tableau ci-dessous reprend, pour toutes les vaches à moins de 120 jours en lactation présentes dans votre troupeau au dernier contrôle, leur score acétonémie pour les 3 derniers contrôles.

Nom	N° trav	Boucle	N° lact	N° ctrl	JEL	Lait (kg)	MG %	Prot %	Score acétonémie des 3 derniers contrôles		
									-2	-1	20190705
JOYEUSE	1	BE156532695	1	2	50	20.3	2.54	3.18		+	++
JALOUSE	17	BE758691211	1	3	113	21.3	3.56	3.03	++	=	+
HISTOIRE	111	BE257950664	3	3	97	26.8	3.45	3.43	=	=	=
JAQUETTE	109	BE358691213	1	3	85	21	4	3.56		=	=
HUSSARDE	99	BE157950657	3	1	10	30.2	3	3.23			=
JOVIALE	96	BE856532697	1	3	108	16.1	3.55	3.53	=	=	=
JAPONAISE	68	BE958691210	1	3	98	10.8	3.4	3.34	=	=	=
HOUPPE	63	BE557950668	3	1	29	28.4	3.41	3.14			=
JUVENILE	37	BE556532693	1	3	91	20.5	2.73	2.99	+	=	=
HOMONYME	33	BE657950659	3	2	71	28.5	2.91	3.06		=	=
HONORINE	32	BE957950635	3	3	99	23.7	3.29	3.44	=	=	=
INVAINCUE	28	BE356233092	2	3	113	16.8	4.24	3.78	=	=	=
HUGUETTE	26	BE957950649	3	3	83	19.7	3.18	3.39		=	=
JADE	16	BE258691219	1	3	108	23	3.07	2.94	=	=	=

Using blood BHB & NEFA MIR predictions to enhance CÉTOLAIT score

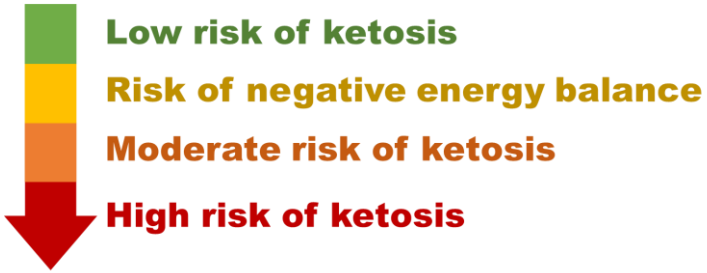
- "CÉTOLAIT score"



- Currently obtained by a decision tree (empirically defined with target values from the literature) which uses 4 milk traits predicted by MIR
  - fat/protein, BHB, acetone → to predict the ketosis level
  - C18:1 *cis*-9 (corrected for herd effect) → to predict the NEB level

Using blood BHB & NEFA MIR predictions to enhance CÉTOLAIT score

- "CÉTOLAIT score"



- First validation results (on data from 357 cows with MIR data & blood BHB measures)

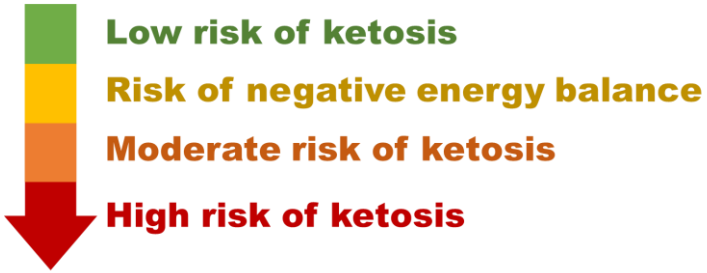
	CétoLait Score			
	LOW	NEB	MODERATE	HIGH
Healthy Blood BHB < 1,2 mmol/L	**688**	**314**	356	29
Subclinical ketosis Blood BHB [1,2; 2,6] mmol/L	82	19	**176**	**50**
Clinical ketosis Blood BHB > 2,6 mmol/L	3	2	**14**	**19**

Specificity = 72%

Sensitivity = 71%

Using blood BHB & NEFA MIR predictions to enhance CÉTOLAIT score

- "CÉTOLAIT score"



- First validation results (on data from 357 cows with MIR data & blood BHB measures)
  - Specificity = 72% & Sensitivity = 71%
  - + positive feedback from the field

→ Opportunity to enhance the score by including blood BHB and NEFA MIR predictions ?

Both traits were added in the decision tree and validation was performed on a new data set including ~ 800 records

→ Specificity and sensitivity increased of 3% and 4%

Take home message

- Large-scale screening for ketosis can be performed through milk recording
  - indicators of ketosis (blood BHB and NEFA) can be predicted by MIR analysis of milk
  - all cows can be tested, every test-day
  - herd-level management tool (not a diagnosis) → complementary to the vet!
  - indicator trait for genetic evaluation

- European collaboration is a strength
  - to develop and release robust and global MIR calibration equations
  - while allowing for country specific implementation of decision-support tools

Thank you for your attention!

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