

Metabolic monitoring of German Simmental cows during early lactation based on milk infrared spectroscopy

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1. Introduction

- Ketosis = metabolic condition characterized by an elevated level of ketone bodies in blood with or without clinical signs of disease
- Infrared spectroscopy = physical analysis method based on irradiation of substances with infrared rays (Fig. 1)

2. Objectives

- Development of a cost-effective and systematic monitoring tool for ketosis based on infrared spectra of milk samples

3. Materials and methods

- Twenty-six German Simmental dairy herds with automatic milking system were visited once a week over a period of seven weeks
- Clinical examination, milk and blood sampling of cows between day 5 and day 50 in milk were performed
- Ketosis = blood beta-hydroxybutyrate (BHBA) concentration ≥ 1.2 mmol/l
- A linear discriminant analysis (LDA) model was developed to predict the probability of ketosis (KET-PRBLTY) based on differences in milk IR-spectra between healthy and ketotic cows
- The model was optimized by the exclusion of all borderline samples (BHBA 1.2 mmol/l – 1.7 mmol/l) and by application of 10-fold cross-validation
- The final model was used to develop a “traffic light system” for ketosis based on its predictions (Fig. 4)

4. Results

- A total of 1078 examinations were performed on 358 animals
- 10% of samples had blood BHBA levels ≥ 1.2 mmol/l
- Differences between the infrared spectra of healthy and ketotic cows were detected (Fig. 2)
- The developed model is identifying cows without ketosis with better accuracy than cows with ketosis (Fig. 3)
- The optimized “traffic light system” shows good performance (Fig. 5)

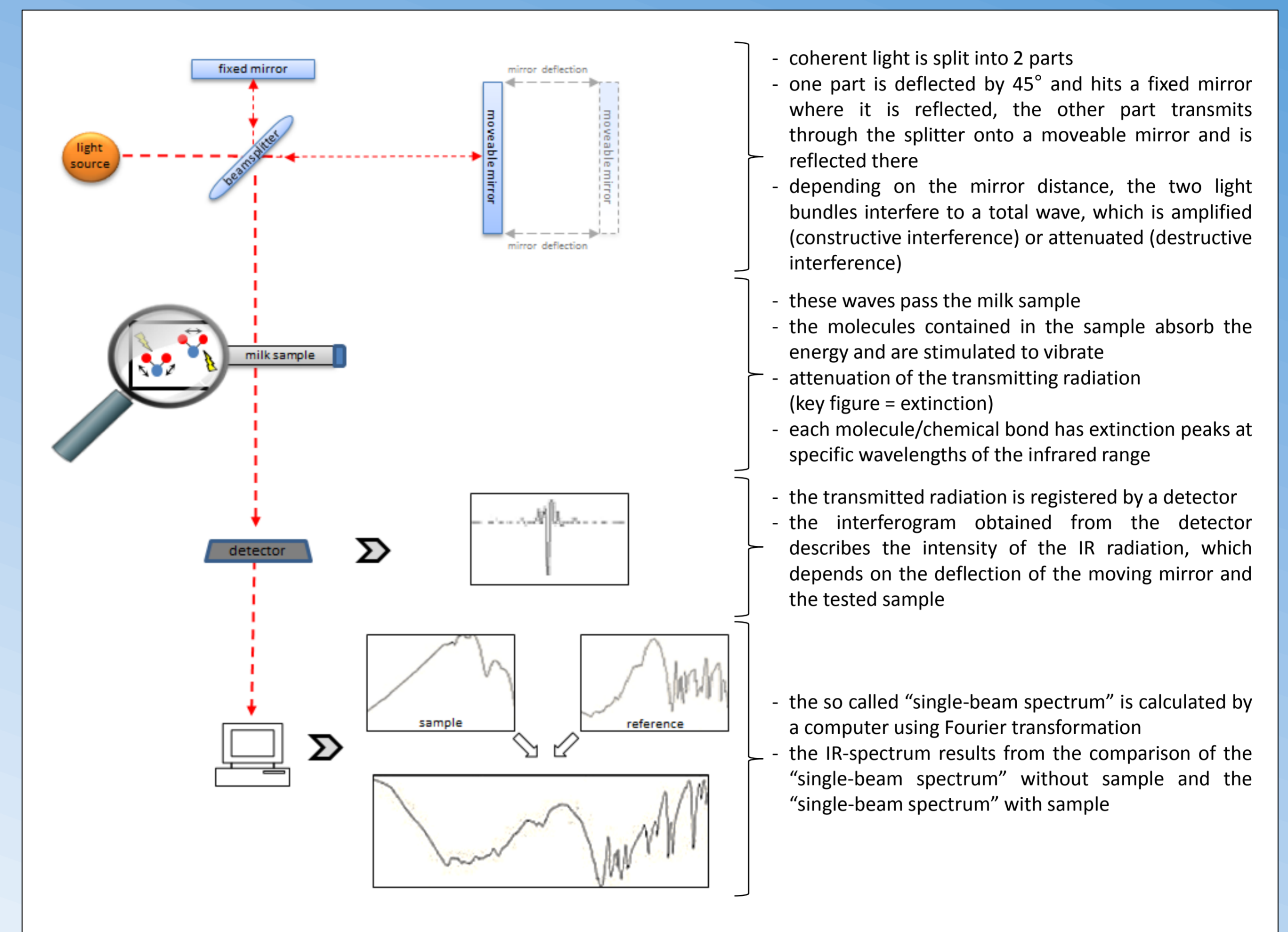


Fig. 1: principles of infrared spectroscopy

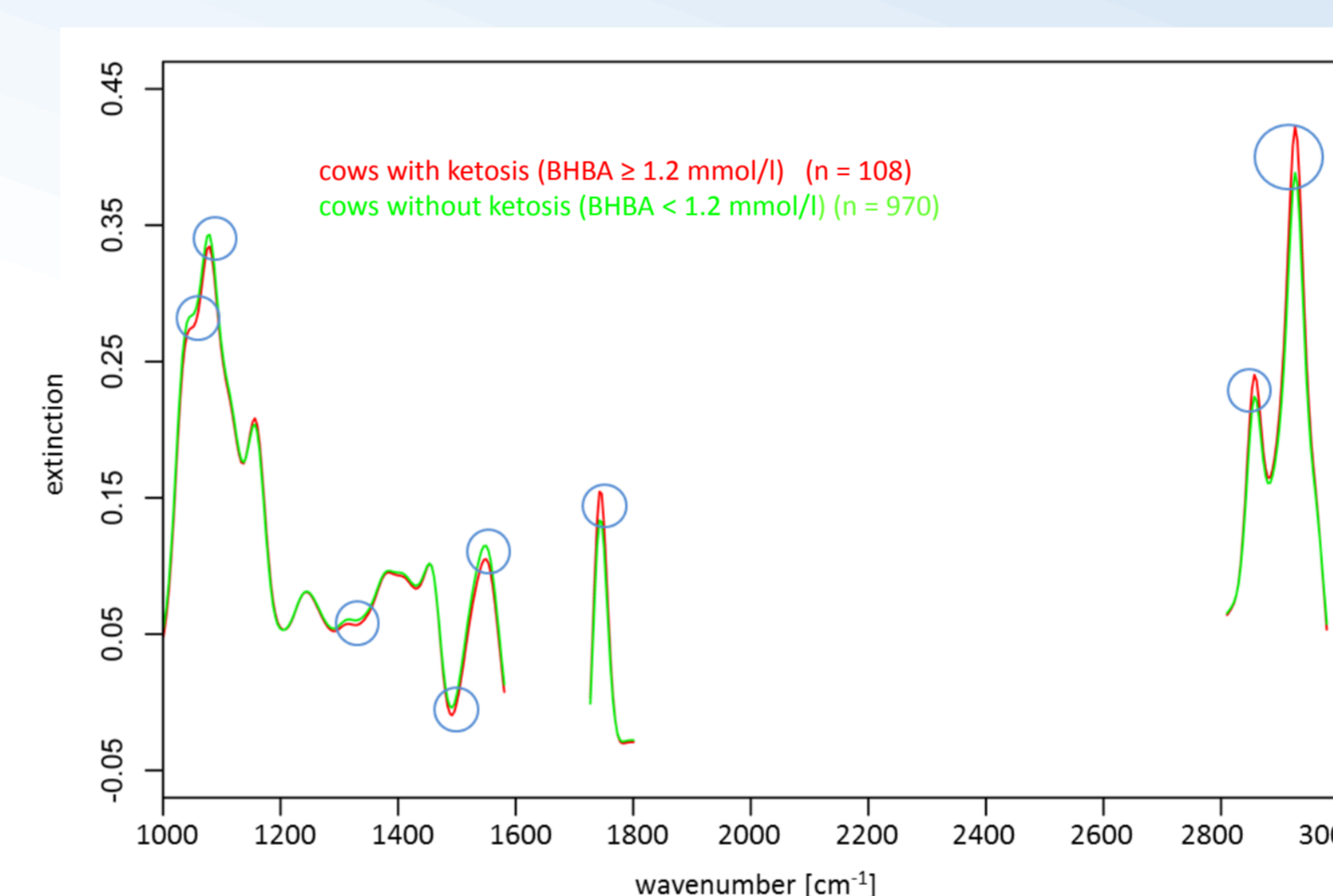


Fig. 2: IR-spectra of healthy and ketotic cows

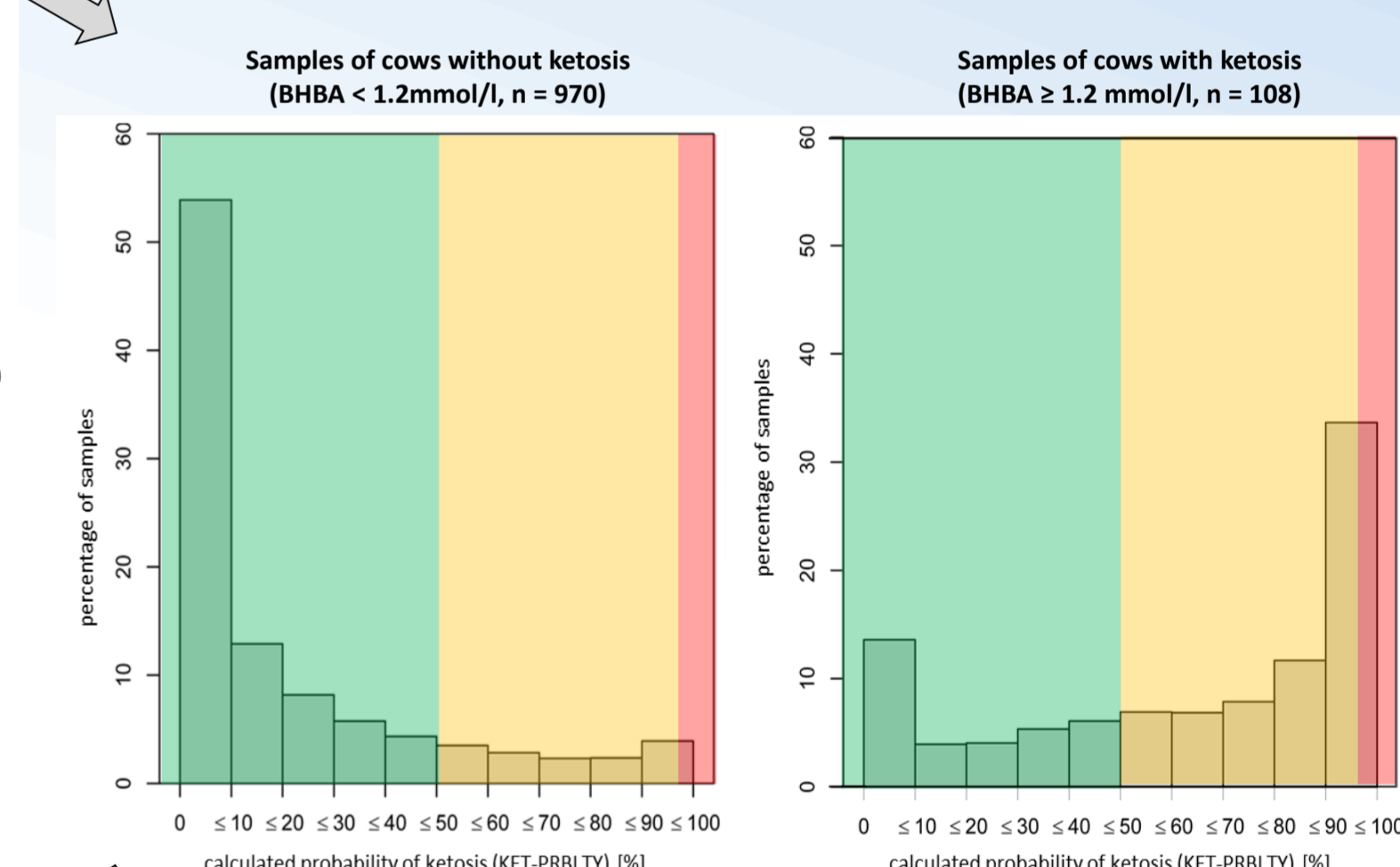


Fig. 3: calculated probabilities of ketosis by LDA

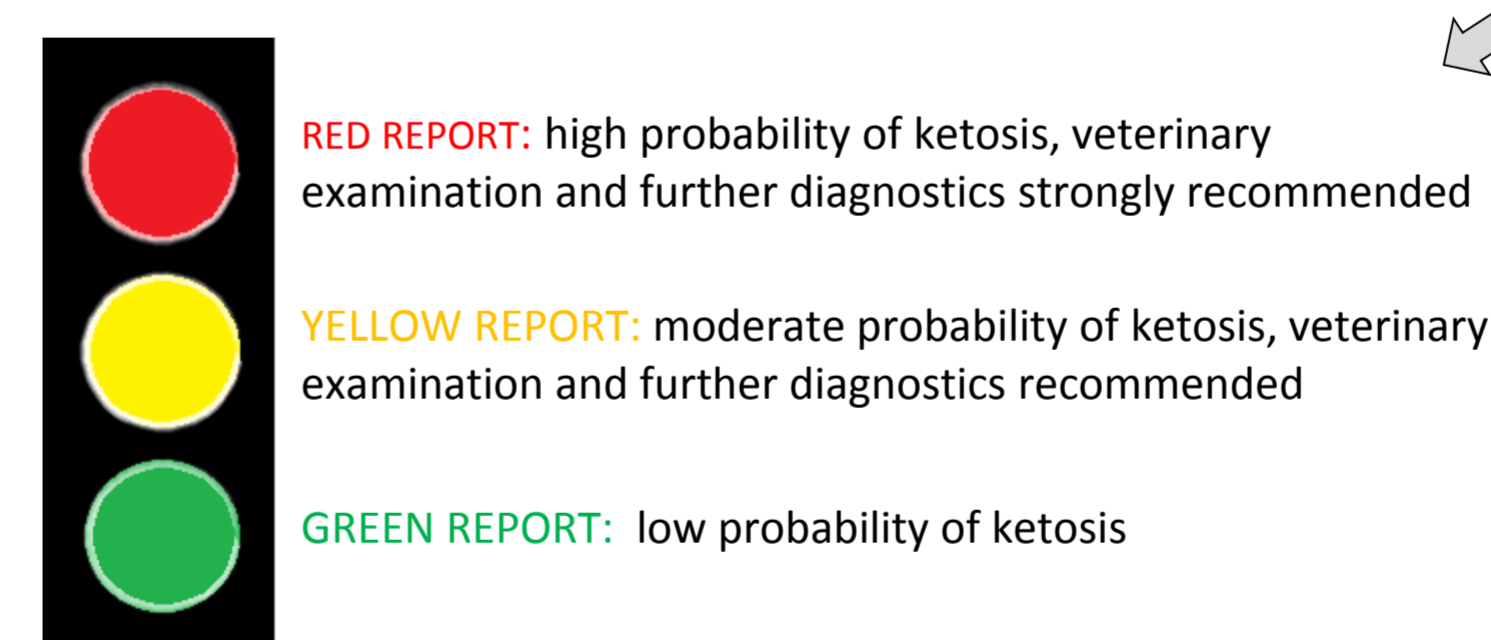


Fig. 4: “traffic light system” for ketosis

Optimized "traffic light system" for ketosis	
Percentage of correct reports (BHBA < 1.2 mmol/l) on all "green" reports	95%
Percentage of animals without ketosis (BHBA < 1.2 mmol/l) on all "yellow" reports	71%
Percentage of animals with ketosis (BHBA ≥ 1.2 mmol/l) on all "yellow" reports	29%
Percentage of correct reports (BHBA ≥ 1.2 mmol/l) on all "red" reports	68%

IN TOTAL:
91% GREEN REPORTS 7% YELLOW REPORTS 2% RED REPORTS

Fig. 5: key figures of the optimized “traffic light system” for ketosis