Application Note 201

Freezing Point Depression

Application note: Determination of the Freezing Point Depression of Milk
Application note no.: 201

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Introduction

The LactoScope method for the prediction of the freezing point depression (FPD) of milk is based on a method described by J. Koops et al. (1989). The FPD is predicted from the sample conductivity and infrared measurements for the concentrations of fat, protein and lactose of a sample. The cell and electronics required for the conductivity measurement have been integrated in the LactoScope FTIR and are available as an extra option to the instrument.

A model for the FPD calibration has been published by Koops et al. It was derived through means of multiple linear regression (MLR) with reference to cryoscopic determinations of the FPD and based on a set of 126 samples, for which the range in FPD had been extended through the addition of water, lactose and salt.

This document describes the results of a case study carried out with Swiss milk samples, taken from various sites of the country. Results obtained for the model of Koops et al. are compared to results obtained for an MLR model derived on the basis of the Swiss sample set.

Materials & Methods

Milk samples

37 fresh non preserved tank milk samples (from alpine and low regions in the country), of which 9 were spiked with up to 6% of water. Range in fat: 3.78- 4.67%; protein: 3.15– 3.66%; lactose: 4.38-4.88%; FPD:0.493-0.535°C. (See table 2 for correlation's among the components/parameters)

Sample treatment

Samples kept cold were analyzed as such, utilizing instantaneous heating to 40 °C through means of the inline heater of the Lactoscope FTIR.

Methods

Infrared analysis

Fat, protein and lactose contents (in %m/m) of the samples were determined using the basic calibration for milk.

Freezing point determinations

FPD reference values were obtained through single determinations on an Advanced Milk Cryoscope.

Results

Results obtained for the set of 37 samples analyzed in duplicate), are shown in table 1. In the second column, results obtained for the MLR model published by Koops et al. are given. A slight slope & intercept adjustment (1.06 , -0.026), results in a standard error of estimate (SEE) of 0.0037 °C. Column 3 displays the results of the MLR calibration on the basis of the set of 37 samples. The SEE calculated for this model is 0.0035°C.

Table 1 - Regression results for Swiss sample set

	MLR model Koops et al.		MLR model Swiss samples	
	coeff	std err	coeff	std err
fat in %	10.86	-	11.0	3.3
protein in %	11.62	-	15.1	4.2
lactose in %	71.82	-	81.7	3.9
conductivity in mS	33.12	-	29.0	2.4
offset	-108	-	-133	26
slope adjustment	1.06	0.04	n / a	n / a
Intercept adjustment	-26	22	n / a	n / a
N	37(*2)		37(*2)	
adjusted R-squared	0.89		0.91	
SEE in m°C	3.70		3.45	

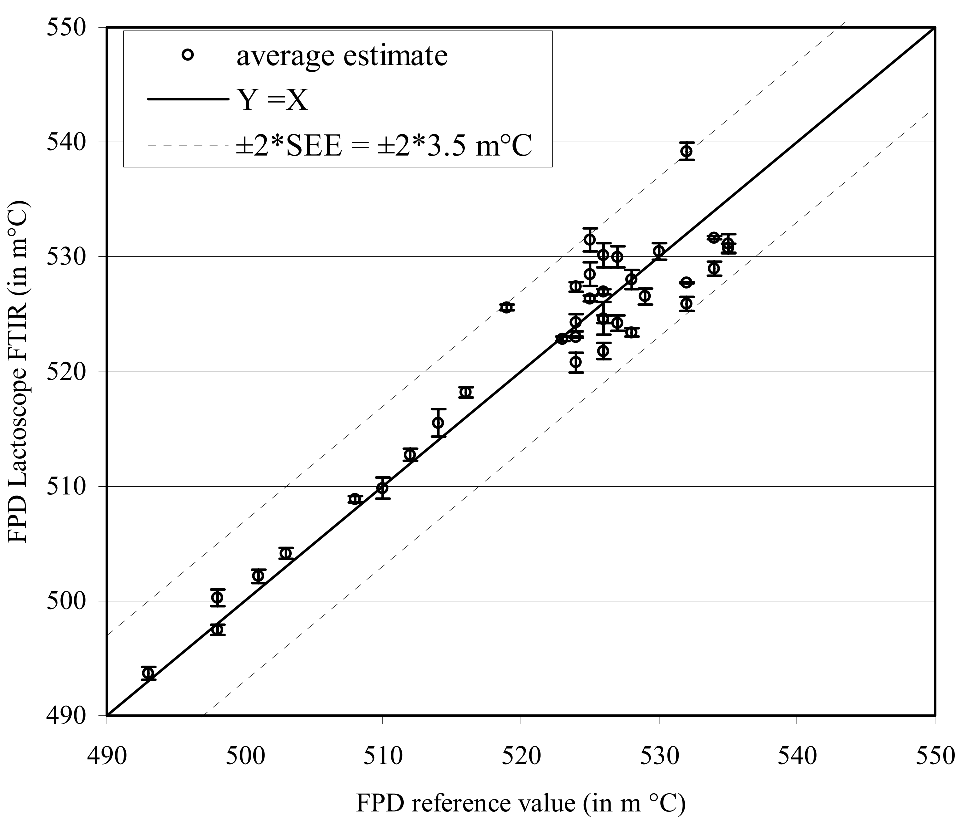
where
*2 : samples analyzed in duplicate
SEE : standard error of estimate

Figure 1 provides a graph of the MLR calibration results, plotted are average estimates (circles) for the Lactoscope FPD measurements in duplicate (indicated by error bars) against the FPD reference values. The repeatability of the Lactoscope FPD measurements is characterized by a standard deviation (SD) of 0.001 °C.

Conclusions

The method of Koops et al. for the determination of the FPD of milk samples is readily applicable with the Lactoscope FTIR. Based on the combined results of field trials carried out by Koops et al. and the results of the present study, the standard error of the prediction normally can be better than 0.005 °C.

Figure1 - FPD by Lactoscope FTIR



The FPD parameter can be used to analyse Raw and Homogenized Milk. Standardized milk will require different product definitions with separate Slope and Bias (Intercept) settings.

Also Cream can be analyzed for FPD.