Application Note 144: Measurement of Fat, TS, Protein and Lactose in High Fat Cream

Introduction:

The objective of the study was to assess the feasibility to use Near Infrared Transmission spectroscopy to measure fat, protein, lactose and total solids in a high fat cream solution. The objective is to estimate the accuracy that may be expected of an On-line NIT analyser to measure these components.

Description:

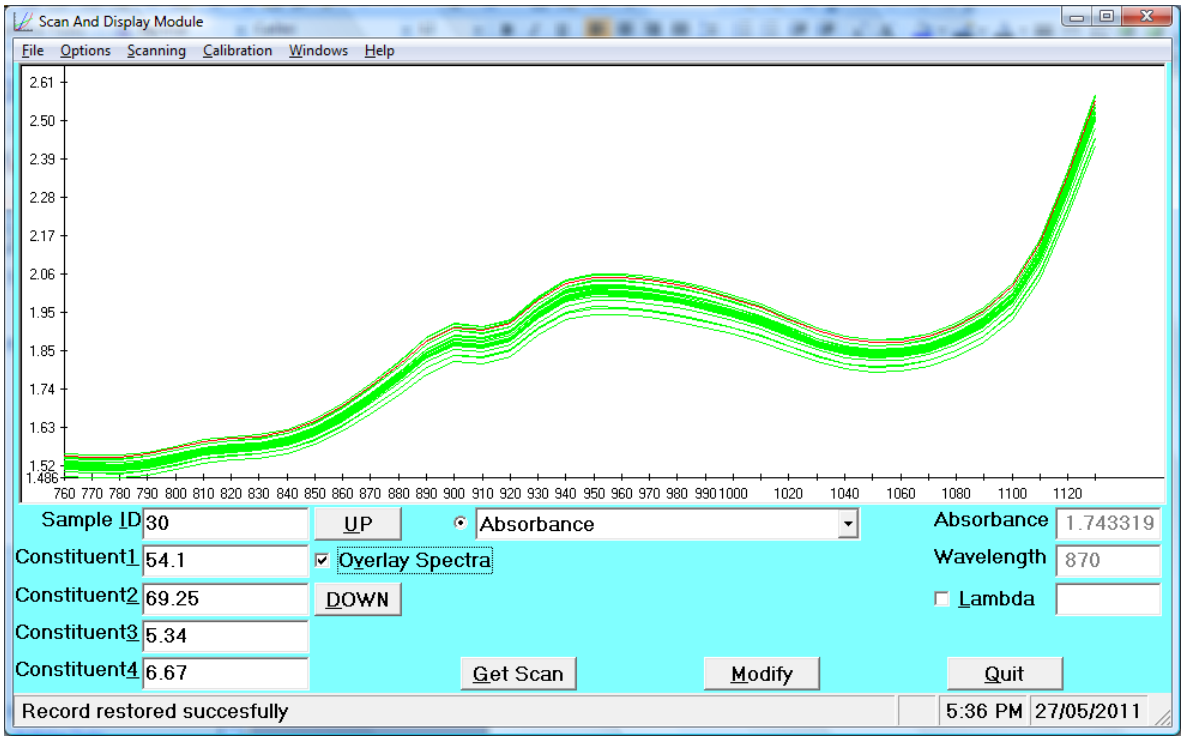
30 samples of high fat cream solution were taken in duplicate from the production line. One jar for each sample was analysed for fat, protein, lactose and total solids using a Foss FTS120 Milk Analyser. The other jar was scanned on the Next Instruments Series 3000 Food Analyser.

The data from the Foss FTS120 was combined with the NIT spectra from the Series 3000 and a Partial least Squares Regression was performed to develop calibrations for each component.

5 samples from the set were used as prediction samples against the calibrations developed.

Results:

Figure 1. shows the NIT spectra of the 30 samples.



Sample ID	Fat1	Fat2	Diff	TS1	TS2	Diff	Prot 1	Prot 2	Diff	Lact1	Lact2	Diff
1	55.01	55.22	0.21	70.3	70.75	0.45	5.53	5.51	-0.02	6.64	6.61	-0.03
2	53.82	54.13	0.31	68.96	69.26	0.3	5.48	5.49	0.01	6.65	6.64	-0.01
3	54.34	54.14	-0.2	69.43	69.46	0.03	5.4	5.44	0.04	6.72	6.73	0.01
4	54.45	54.39	-0.06	69.61	69.78	0.17	5.44	5.42	-0.02	6.72	6.73	0.01
4P	54.45	54.39	-0.06	69.61	69.78	0.17	5.44	5.42	-0.02	6.72	6.73	0.01
5	55.01	54.53	-0.48	69.97	69.5	-0.47	5.24	5.21	-0.03	6.62	6.65	0.03
6	54.59	54.49	-0.1	69.62	69.49	-0.13	5.28	5.28	0	6.71	6.74	0.03
7	53.77	54	0.23	69.06	69.17	0.11	5.35	5.38	0.03	6.95	6.99	0.04
8	54.32	54.33	0.01	69.57	69.2	-0.37	5.33	5.33	0	6.67	6.79	0.12
9	54.18	54.07	-0.11	69.37	69.15	-0.22	5.38	5.38	0	6.82	6.84	0.02
10	54.41	54.46	0.05	69.47	69.51	0.04	5.4	5.42	0.02	6.63	6.64	0.01
12	54.06	54.06	0	69.32	69.15	-0.17	5.37	5.37	0	6.81	6.81	0
14	53.76	53.84	0.08	69.21	69.15	-0.06	5.26	5.28	0.02	6.68	6.67	-0.01
15	54.15	54.25	0.1	69.46	69.2	-0.26	5.38	5.43	0.05	6.63	6.66	0.03
16	54.04	53.98	-0.06	69.34	69.25	-0.09	5.35	5.37	0.02	6.63	6.69	0.06
17	54.32	54.09	-0.23	69.6	69.31	-0.29	5.34	5.33	-0.01	6.63	6.65	0.02
18	54.24	54.18	-0.06	69.52	69.43	-0.09	5.5	5.44	-0.06	6.58	6.55	-0.03
19	54.16	53.88	-0.28	69.46	69.1	-0.36	5.28	5.39	0.11	6.67	6.7	0.03
20	54.68	54.67	-0.01	69.69	69.58	-0.11	5.31	5.55	0.24	6.45	6.56	0.11
21	54.4	54.41	0.01	69.61	69.29	-0.32	5.34	5.37	0.03	6.54	6.57	0.03
22	54	54.04	0.04	69.31	69.43	0.12	5.38	5.37	-0.01	6.75	6.78	0.03
24	54.36	54.3	-0.06	69.64	69.46	-0.18	5.39	5.38	-0.01	6.57	6.58	0.01
25	54.6	54.62	0.02	69.82	69.74	-0.08	5.33	5.19	-0.14	6.64	6.54	-0.1
26	54.72	54.54	-0.18	69.91	69.47	-0.44	5.3	5.25	-0.05	6.59	6.53	-0.06
27	54.51	54.3	-0.21	69.87	69.54	-0.33	5.36	5.32	-0.04	6.64	6.63	-0.01
28	54.22	54.09	-0.13	69.37	69.36	-0.01	5.37	5.34	-0.03	6.77	6.76	-0.01
29	54.45	54.32	-0.13	69.43	69.31	-0.12	5.49	5.39	-0.1	6.57	6.55	-0.02
30	54.18	54.02	-0.16	69.31	69.18	-0.13	5.29	5.4	0.11	6.63	6.71	0.08
	SDD		0.16			0.22			0.07			0.04

Table 1. Shows the Foss FTS120 data on duplicate aspirations.

This table shows that variability in measurements from the Foss FTS120 are:

Fat: 0.16%
TS: 0.22%
Protein: 0.07%
Lactose: 0.04%

SampleD	Fat Ref	Fat NIR	Diff	TS Ref	TS NIR	Diff	Prot Ref	Prot NIR	Diff	Lact Ref	Lact NIR	Diff
1	55.11	54.93	-0.18	70.3	70.13	-0.17	5.52	5.5	-0.02	6.62	6.58	-0.04
2	53.98	54.06	0.08	69.11	69.15	0.04	5.48	5.43	-0.05	6.64	6.65	0.01
3	54.23	54.44	0.21	69.45	69.6	0.15	5.42	5.4	-0.02	6.7	6.7	0.00
4	54.42	54.42	0.00	69.69	69.71	0.02	5.43	5.43	0.00	6.73	6.71	-0.02
4P	54.42	54.42	0.00	69.69	69.71	0.02	5.43	5.39	-0.04	6.73	6.79	0.06
5	54.77	54.47	-0.30	69.5	69.36	-0.14	5.22	5.31	0.09	6.64	6.73	0.09
6	54.54	54.61	0.07	69.56	69.58	0.02	5.28	5.27	-0.01	6.73	6.69	-0.04
7	53.89	54.07	0.18	69.12	69.25	0.13	5.37	5.37	0.00	6.97	6.74	-0.23
8	54.32	54.38	0.06	69.39	69.34	-0.05	5.33	5.33	0.00	6.77	6.75	-0.02
9	54.12	54.07	-0.05	69.26	69.29	0.03	5.38	5.38	0.00	6.83	6.7	-0.13
10	54.44	54.31	-0.13	69.49	69.39	-0.10	5.41	5.38	-0.03	6.64	6.73	0.09
12	54.06	54.07	0.01	69.24	69.18	-0.06	5.37	5.41	0.04	6.81	6.63	-0.18
14	53.8	53.92	0.12	69.18	69.29	0.11	5.27	5.39	0.12	6.67	6.63	-0.04
15	54.2	54.39	0.19	69.33	69.49	0.16	5.41	5.39	-0.02	6.64	6.65	0.01
16	54.01	54.03	0.02	69.3	69.3	0.00	5.36	5.33	-0.03	6.66	6.65	-0.01
17	54.2	54.32	0.12	69.46	69.59	0.13	5.33	5.34	0.01	6.64	6.66	0.02
18	54.12	54.04	-0.08	69.48	69.33	-0.15	5.47	5.45	-0.02	6.57	6.68	0.11
19	54.02	53.94	-0.08	69.28	69.24	-0.04	5.34	5.38	0.04	6.7	6.64	-0.06
20	54.67	54.66	-0.01	69.63	69.69	0.06	5.38	5.32	-0.06	6.5	6.62	0.12
21	54.41	54.33	-0.08	69.45	69.48	0.03	5.36	5.31	-0.05	6.55	6.62	0.07
22	54.02	53.98	-0.04	69.37	69.39	0.02	5.37	5.38	0.01	6.77	6.68	-0.09
23	54.53	54.6	0.07	69.75	69.77	0.02	5.28	5.27	-0.01	6.64	6.67	0.03
24	54.33	54.46	0.13	69.55	69.63	0.08	5.39	5.39	0.00	6.58	6.66	0.08
25	54.61	54.58	-0.03	69.78	69.68	-0.10	5.26	5.28	0.02	6.59	6.64	0.05
26	54.63	54.72	0.09	69.69	69.75	0.06	5.28	5.35	0.07	6.56	6.59	0.03
27	54.4	54.26	-0.14	69.71	69.58	-0.13	5.34	5.37	0.03	6.64	6.75	0.11

28	54.16	54.15	-0.01	69.36	69.38	0.02	5.35	5.31	-0.04	6.77	6.71	-0.06
29	54.38	54.27	-0.11	69.43	69.36	-0.07	5.44	5.41	-0.03	6.56	6.62	0.06
30	54.1	53.95	-0.15	69.25	69.16	-0.09	5.34	5.33	-0.01	6.67	6.64	-0.03
		SEP	0.12			0.09			0.04			0.08

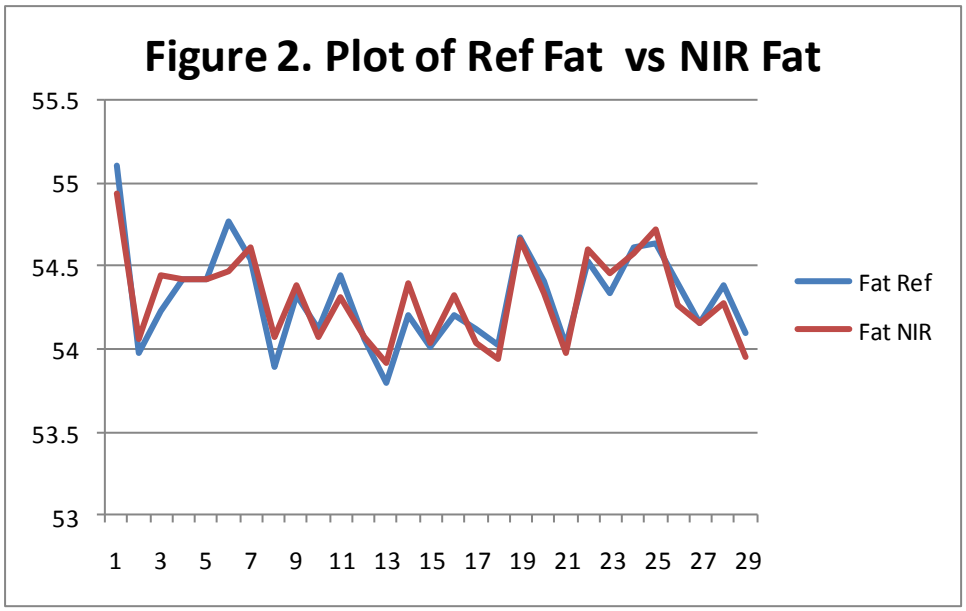
Table 2. Shows the Calibration Results obtained from the Next Instruments Series 3000 Food Analyser.

This data shows the agreement between the Series 3000 and the Foss FTS120:

Fat:	0.12%
TS:	0.09%
Protein:	0.04%
Lactose:	0.08%

It should be noted that the Standard Error Prediction, SEP, between the Series 3000 data and the FTS120 data are less than the Standard Deviation of Differences , SDD, for FTS120 repeats.

Plots of the Ref values vs. the NIR Calibration data are shown in figures 2, 3, 4, and 5



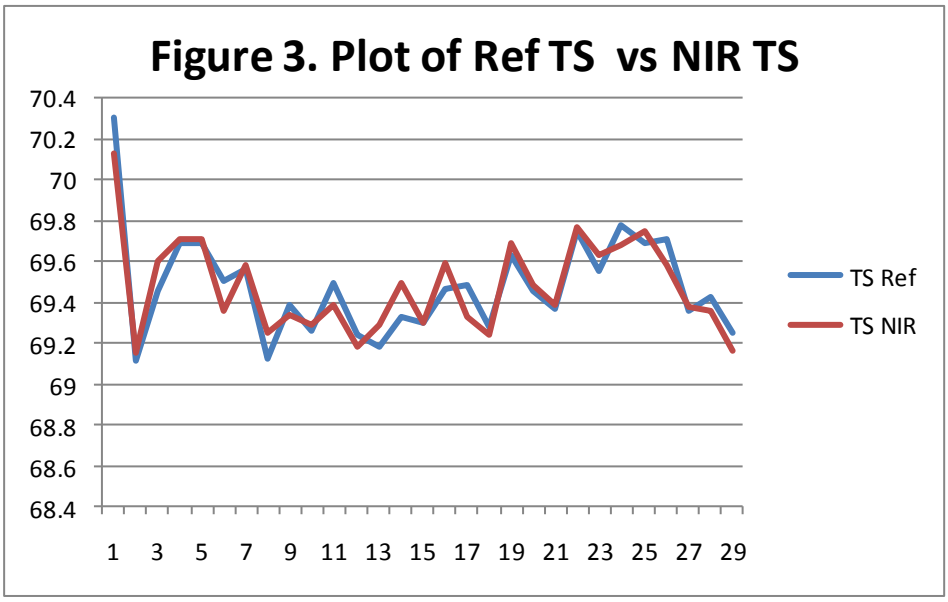


Figure 3. Plot of Ref TS vs NIR TS
70.4
70.2
70
69.8
69.6
69.4
69.2
69
68.8
68.6
68.4
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
TS Ref
TS NIR

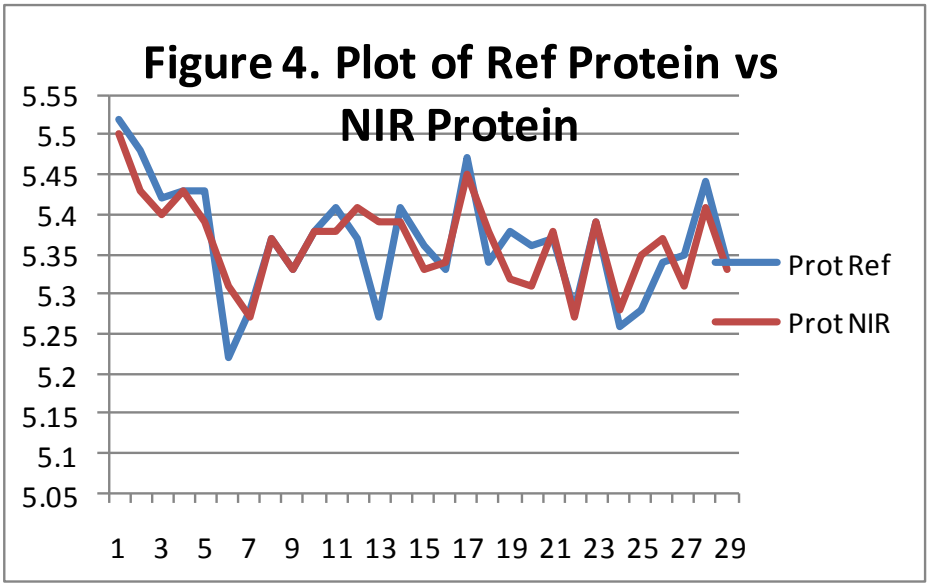


Figure 4. Plot of Ref Protein vs NIR Protein
5.55
5.5
5.45
5.4
5.35
5.3
5.25
5.2
5.15
5.1
5.05
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Prot Ref
Prot NIR

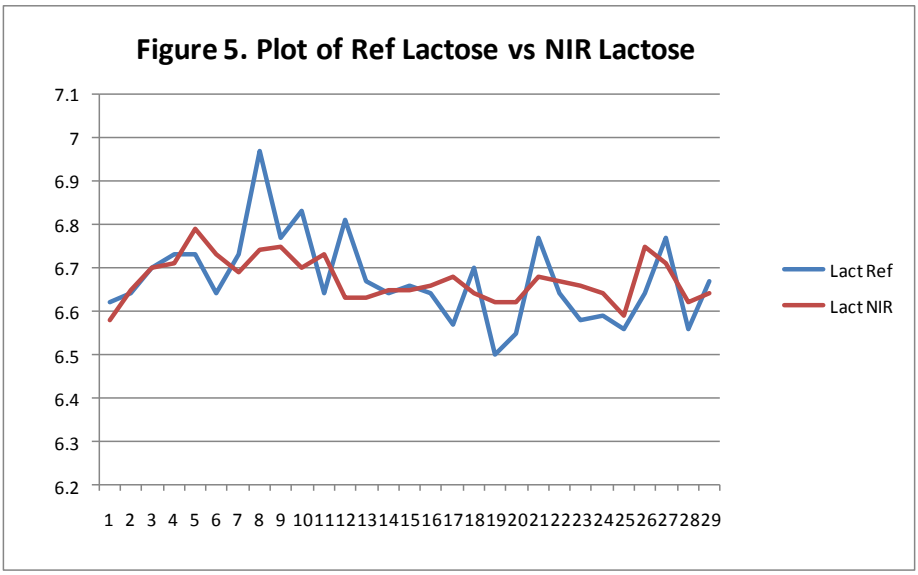


Figure 5. Plot of Ref Lactose vs NIR Lactose
7.1
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Lact Ref
Lact NIR

Prediction Data:

The spectra for 5 samples, ie, 8, 12, 20, 24 and 29 , were removed from the calibration set and the calibrations recalculated. The new calibrations were used to predict the 5 other samples. Table 3. shows the predicted results;

Table 3. Predicted results for five samples:

Sample ID	Fat Ref	Fat NIR	Diff	TS Ref	TS NIR	Diff	Prot Ref	Prot NIR	Diff	Lact Ref	Lact NIR	Diff
8	54.32	54.31	-.01	69.39	69.22	-.17	5.33	5.37	.04	6.77	6.75	-.02
12	54.06	53.99	-.07	69.24	69.13	-.11	5.37	5.43	.07	6.81	6.59	-.22
20	54.67	54.40	-.27	69.63	69.56	-.07	5.38	5.30	-.08	6.50	6.68	.18
24	54.33	54.42	.09	69.55	69.62	0.07	5.39	5.38	-.01	6.58	6.69	.11
29	54.38	54.06	-.32	69.43	69.26	-.17	5.44	5.36	-.08	6.56	6.64	.08
	SEP		0.17			0.10			0.09			0.15

This data shows that the prediction of samples not included in the calibration set is consistent with the calibration data

Discussion:

The objective of this study was to establish whether the Series 3000 Food Analyser from Next Instruments could be calibrated for Protein, Total Solids, Fat and Lactose using data from the Foss FTS120 Milk Analyser and to assess the accuracy of the Series 3000 Food Analyser.

The data from tables 1 and 2 show that the calibrations developed using Series 3000 is comparable to the data obtained from a Foss FTS 120 back scatter analyser. Figures 2, 3 and 4 show that the S3000 data tracks the Foss data extremely well. Even thought the range of fat, TS and protein are small, the differences between the S3000 and the FTS120 are much smaller than the range. The NIT lactose data does not track as well.

In conclusion the results from this study do establish that the Series 3000 Food Analyser is suitable for measuring Protein, Fat and Total Solids in high fat cream product.

NIR Technology Systems
366 Edgar Street, Condell Park, NSW, 2200, Australia
Tel: 612 9771 5444, Fax: 612 9771 5255
Email: sales@nextinstruments.net, Web: www.nextinstruments.net