Transferability of quantitative applications between different Fourier transform near infrared spectrometers used for quality control in the animal feed industry

Maxim Yu Filippov[1]* and Volker J. Frost[2]

[1]Provimi Russia-Research, Service & Consulting Dept., Moscow, 117556, Russia
[2]BUCHI Labortechnik AG – NIR Division, Flawil, 9230, Switzerland
*Corresponding author: mfilippov@ru.provimi.com

Introduction

Feed producers organise their business in networks not just for distribution but also for production sites, especially if it is necessary to cover large areas such as Russia. Quality control laboratories in these sites – clients – are often connected to a central R&D laboratory master. Usually the master laboratory provides protocols and guidelines to perform control of samples, also in the case of non-destructive techniques like near infrared spectroscopy, and they should ensure that all plants are aligned.

This study describes a ring test conducted by Provimi Russia Research, Service & Consulting Department to check the possibility of easily transferring the same applications into a network of FT-NIR spectrometers without additional adaptation and without using correction factors for each unit.

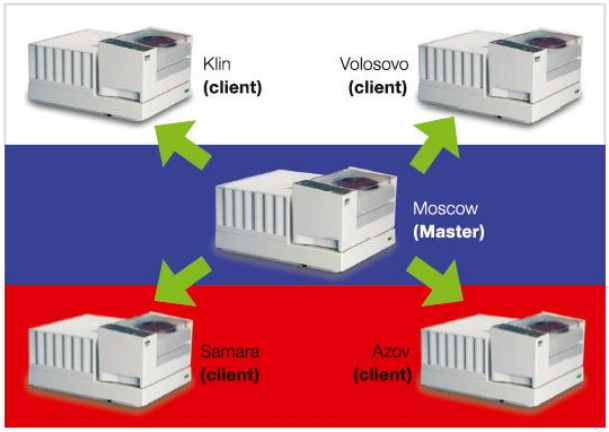

Figure 1. Provimi Russia FT-NIR Network

Materials and Methods

Near infrared spectroscopy

Five FT-NIR spectrometers (NIRFlex N-500; BÜCHI Labortechnik AG, Switzerland) were installed in Provimi Russia quality control laboratories: 2 in 2005 (Moscow and Klin) and three in 2006 (Samara region, Rostov region and St. Petersburg region). Since 2005, using a wavelength range from 4.000 to 10.000 cm-1 at a resolution of 8 cm-1, the spectrometer in Moscow (Master Unit), has been used to create quantitative calibrations able to measure the chemical composition of feed raw materials and finished products. The quantitative calibrations were created to screening the main chemical composition of samples with the aid of chemometric software (NIRCal; BÜCHI Labortechnik AG, Switzerland) and using the technique of Evaluation Set. These calibrations have then been transferred to the four Client Units without introduction of any correction factors.

Samples

In 2009, two kilograms of 18 different samples including complete feed, concentrates and commodity raw materials – grains, corn fish meal etc. – were each ground, mixed and split into 5 parts. All 18 samples (400g each) were put in plastic bags and sealed immediately. During week 2 of 2009, these ring test samples were analysed by the five laboratories for two parameters - moisture and protein content.

Wet Chemistry

In Moscow, wet chemistry analysis was performed on the same samples. For moisture analysis, the method used was ISO 6496; for crude protein the method used was ISO 5983.

Reference paper as:
M.Y. Filippov and V.J. Frost (2012).Transferability of quantitative applications between different Fourier transform near infrared spectrometers used for quality control in feed industry, in: Proceedings of the15th International Conference on Near Infrared Spectroscopy, Edited by M. Manley, C.M. McGoverin, D.B. Thomas and G. Downey, Cape Town, South Africa, pp. 357-359.

Results and Discussion

The eighteen samples comprising finished products and raw materials sent to all the FT-NIR spectrometer network were as follows: wheat grain, wheat, barley grain, barley, corn, sow feed pellets 1 and 2, sow feed 1 and 2, pig starter feed pellet, bran, fish meal, pig concentrate, meat meal, soybean meal and sunflower meal. In Figure 2 and 3 the detailed results obtained with the test samples of pig starter feed are shown as an example.

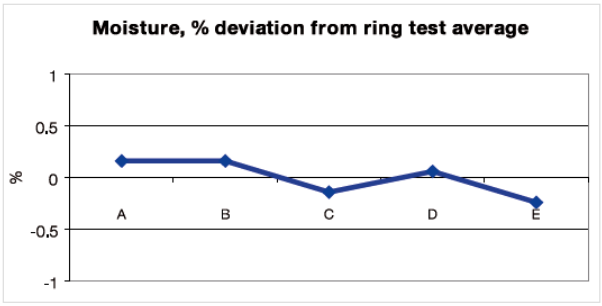

Figure 2. Moisture ring-test results with pig starter feed sample. A=Azov client unit; B=Klin client unit; C=Volosovo client unit; D=Samara client unit; E=Moscow master unit.

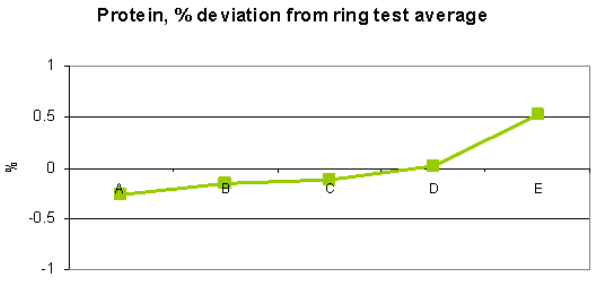

Figure 3. Protein ring-test results with pig starter feed sample. A=Azov client unit; B=Klin client unit; C=Volosovo client unit; D=Samara client unit; E=Moscow master unit.

The most important result nonetheless come from the comparison of standard deviations obtained with all different samples, as well as a comparison between the ring test average and the corresponding wet chemistry. The results are listed in Tables 1 to 3 with a graphical summary in Figure 4.

Table 1. Ring test samples 1 to 6: statistical comparison results.

Parameter		Wheat Grain	Wheat	Barley Grain	Barley	Corn	Sows Feed 1 Pellets
Moisture [%]	Ring test average (Ave)	10.1	10.7	10.3	10.7	11.8	11.1
	St. Dev.	0.3	0.2	0.1	0.5	0.4	0.2
	Δ (Ave – Wet Chem.)	0.2	0.4	0.8	0.4	0.5	0.4
Protein [%]	Ring test average (Ave)	12.0	11.7	12.0	10.1	9.7	16.1
	St. Dev.	0.1	0.2	0.3	0.8	0.2	0.3
	Δ (Ave – Wet Chem.)	0.1	0.2	2.2	0.3	0.5	0.6

Table 2. Ring test samples 7 to 12: statistical comparison results.

Parameter		Sow Feed	Sow Feed 2 Pellets	Sow Feed 2	Pig Starter Feed	Pig Starter Feed Pellets	Bran
Moisture [%]	Ring test average (Ave)	11.2	11.3	11.3	10.6	10.6	12.2
	St. Dev.	0.2	0.2	0.2	0.2	0.3	0.4
	Δ (Ave – Wet Chem.)	0.5	0.6	0.6	0.7	0.7	0.2
Protein [%]	Ring test average (Ave)	15.7	13.4	13.3	19.6	19.8	13.4
	St. Dev.	0.2	0.3	0.6	0.3	0.3	0.4
	Δ (Ave – Wet Chem.)	0.2	0.4	0.5	0.8	0.7	0.2

Table 3. Ring test samples 13 to 18: statistical comparison results.

Parameter		Fish Meal	Pig Concentrate	Poultry Concentrate	Meat Meal	Soy Bean Meal	Sunflower Meal
Moisture [%]	Ring test average (Ave)	9.2	8.8	8.8	4.9	10.6	8.4
	St. Dev.	0.4	0.5	0.4	0.1	0.3	0.4
	Δ (Ave – Wet Chem.)	0.5	1.1	1.1	0.2	0.4	0.5
Protein [%]	Ring test average (Ave)	66.5	42.8	37.0	52.6	46.6	36.9
	St. Dev.	0.3	0.6	0.8	0.6	0.4	0.2
	Δ (Ave – Wet Chem.)	1.1	0.8	0.5	1.1	0.2	0.3

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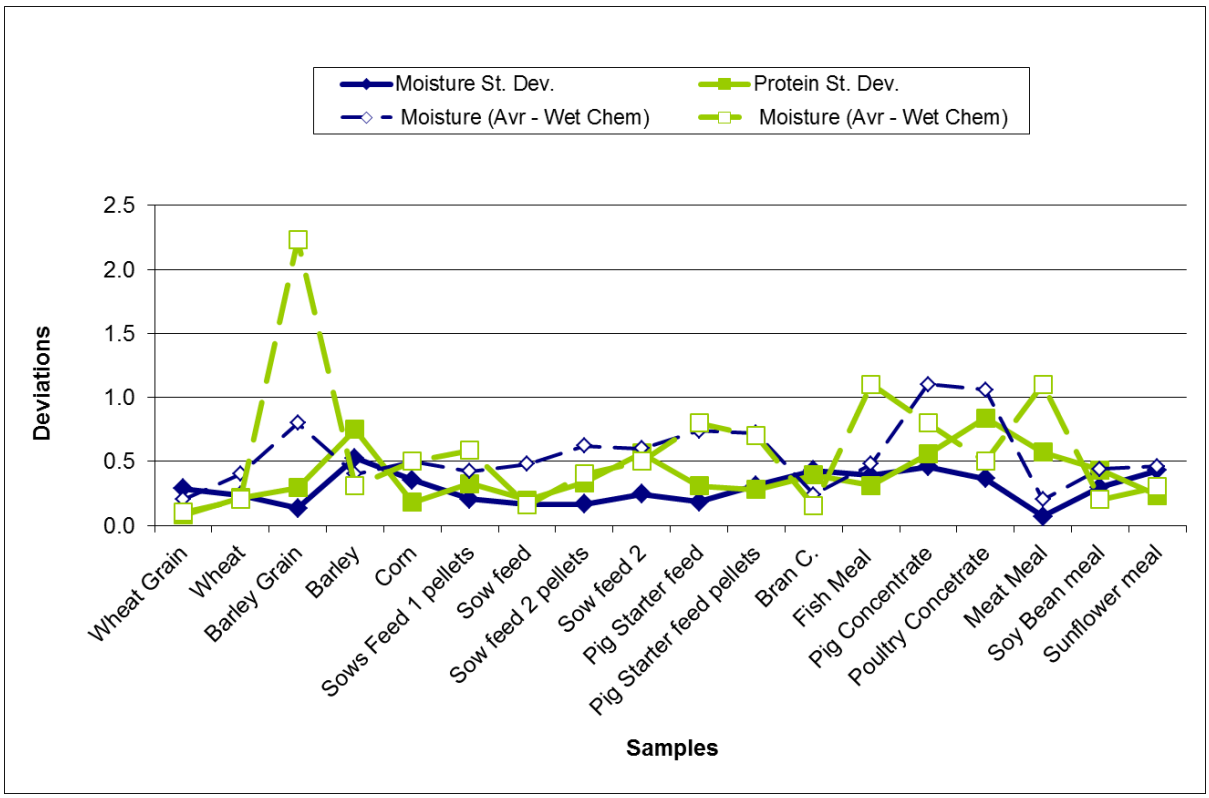

Figure 4. Ring test samples: graph of statistical comparison results.

Conclusion

The statistics of results obtained show that the five FT-NIR spectrometers using the same applications without correction factors produce analytical results which are within the range of specification of Provimi Russia's quality control policies.

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