

Application Note 160: Validation Study of the MultiScan Series 3000 Food Analyser for Measuring Chemical Lean in Beef, Pork and Lamb



Introduction:

The MultiScan S3000 Food Analyser is designed to measure fat, protein and moisture in meat, dairy products, olives, dough and baked goods and other paste, slurry and powdered products. In March 2012, AusMeat listed the Series 3000 as an approved analyser for measuring Chemical Lean in meat.

Approximately 1500 samples of meat have been used to develop NIR calibrations for measuring Moisture and Chemical Lean in beef, pork and lamb. A study was undertaken by Next Instruments to validate these calibrations and to demonstrate the accuracy and precision of the MultiScan S3000 Food Analyser.

This study also compares the accuracy and precision of the Series 3000 NIR Calibrations for Moisture and chemical Lean versus the traditional Oven Drying method and the CSIRO Microwave drying method for determining Moisture and then calculating Chemical Lean.

Procedure:

NIR Method

22 samples minced beef, pork and lamb were sourced from a local supermarket. 90 grams of each sample were packed into a Series 3000 sample dish and analysed in the Series 3000 Food Analyser using calibrations for Moisture and Chemical Lean on day 1. The samples were analysed again on the following day so that an assessment of the reproducibility of the Series 3000 method.

Oven Drying method

20g portions of each sample were weighed into an aluminium foil and then placed into an air drying oven at 103deg C for 16hrs. The weight loss was measured after the 16hr period and recorded. The weight loss was then used to calculate the moisture percentage. The Chemical Lean values for each sample were then computed using the following formulae;

Beef CL > 80	$CL = \text{Moisture\%} \times 1.21 + 5.44$
Beef CL < 80	$CL = \text{Moisture\%} \times 1.35 - 3.22$
Pork	$CL = \text{Moisture\%} \times 1.25 + 1.1$
Lamb	$CL = \text{Moisture\%} \times 1.27 + 1.2$

This process was repeated on day 2 to assess the reproducibility of the oven drying method.

Microwave Drying Method

20g portions of each sample were weighed into 120ml pyrex beakers and placed into a 600W microwave oven for 3 minutes. The weight loss was used to compute the moisture percentage. The Chemical Lean values were computed using the formulae above. This process was repeated on day 2 to assess the reproducibility of the microwave drying method.

Results:

Table 1 presents the predicted Moisture and Chemical Lean values from the Series 3000 and the Oven Drying method.

Moisture data

Sample ID	NIR Day 1	NIR Day2	AV NIR	Diff	Oven	Oven	AV Oven	Diff	Oven Mois - NIR Mois
					Day 1	Day 2			
1	66.8	66.6	66.7	0.1	66.9	67	67	0.1	0.3
2	67	66.4	66.7	0.4	66.45	66.6	66.5	0.1	-0.2
3	66.5	66.5	66.5	0	66.85	66.65	66.8	0.1	0.3
4	66.4	66.5	66.45	0.1	67.3	66.9	67.1	0.3	0.65
5	72.7	72.3	72.5	0.3	72.85	72.85	72.9	0	0.4
6	72.7	72.3	72.5	0.3	72.65	72.55	72.6	0.1	0.1
7	72.7	72.2	72.45	0.4	72.85	72.75	72.8	0.1	0.35
8	72.6	72.2	72.4	0.3	72.8	72.8	72.8	0	0.4
9	71.2	71.2	71.2	0	71.75	71.05	71.4	0.5	0.2
10	71	71.1	71.05	0.1	70.7	70.95	70.8	0.2	-0.25
11	70.2	70.6	70.4	0.3	70.9	70.4	70.7	0.4	0.3
12	70.5	70.8	70.65	0.2	70.6	70.45	70.5	0.1	-0.15
13	64.4	63.5	63.95	0.6	63.4	64.15	63.8	0.5	-0.15
14	63.1	63.1	63.1	0	63.65	63.7	63.7	0	0.6
15	63.2	63.7	63.45	0.4	64.05	62.9	63.5	0.8	0.05
16	64.6	63.9	64.25	0.5	64	63.05	63.5	0.7	-0.75
17	71.3	70.9	71.1	0.3	71.15	71.7	71.4	0.4	0.3
18	71.3	70.9	71.1	0.3	71.45	71	71.2	0.3	0.1
19	71.6	70.8	71.2	0.6	71	71.25	71.1	0.2	-0.1
20	71.5	71.3	71.4	0.1	71.8	71.4	71.6	0.3	0.2
21	71.4	70.9	71.15	0.4	71.55	71.5	71.5	0	0.35
22	71.6	71.4	71.5	0.1	71.1	71.75	71.4	0.5	-0.1
			Stdev	0.18			Stdev	0.23	0.32

Figures 1 and 2 shows the plots of the Series 3000 Moisture values vs the Oven Drying Moisture values for days 1 and 2.

The correlations are Moisture = 0.9849 and Chemical Lean = .9919.

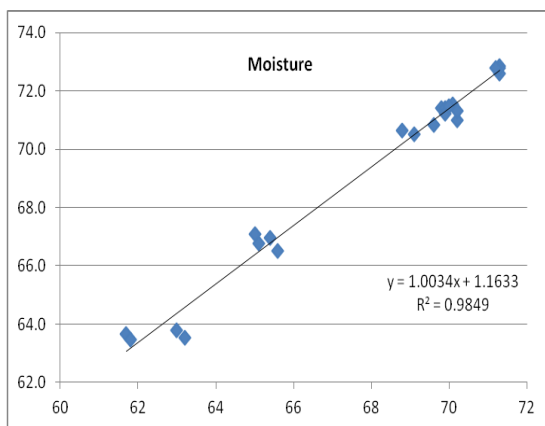


Figure 1 Moisture Plot Day 1

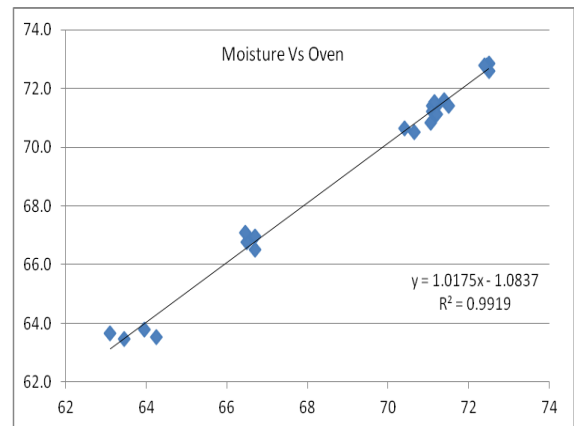


Figure 2 Moisture Plot Day 2

Chemical Lean

Sample ID	NIR CL Day 1	NIR CL Day 2	Ave NIR	Diff	CL Day1	CL Day2	Ave CL	Diff	Oven CL- NIR CL
1	86.2	85.9	86.1	0.3	86.4	86.5	86.4	0.1	0.3
2	86.4	85.7	86.1	-0.4	85.8	86	85.9	0.1	-0.2
3	85.8	85.8	85.8	0	86.3	86.1	86.2	0.2	0.4
4	85.7	85.8	85.8	-0.1	86.9	86.4	86.6	0.3	0.8
5	93.5	92.8	93.2	0.7	93.6	93.6	93.6	0	0.4
6	93.4	92.9	93.2	0.5	93.3	93.2	93.3	0.1	0.1
7	93.5	92.7	93.1	0.8	93.6	93.5	93.5	0.1	0.4
8	93.3	92.7	93	0.6	93.5	93.5	93.5	0	0.5
9	91.5	91.6	91.6	-0.1	92.3	91.4	91.8	0.6	0.2
10	91.3	91.5	91.4	-0.2	91	91.3	91.1	0.2	-0.3
11	90.3	90.8	90.6	-0.5	91.2	90.6	90.9	0.4	0.3
12	90.7	91	90.9	-0.3	90.9	90.7	90.8	0.1	-0.1
13	83.1	82.3	82.7	-0.2	82.2	83.1	82.6	0.6	-0.1
14	81.6	81.8	81.7	-0.2	82.5	82.5	82.5	0	0.8
15	82	82.5	82.3	-0.5	82.9	81.5	82.2	1	-0.1
16	83.5	82.8	83.2	0.7	82.9	81.7	82.3	0.8	-0.9
17	91.7	91.3	91.5	0.4	91.5	92.2	91.9	0.5	0.4
18	91.7	91.2	91.5	0.5	91.9	91.4	91.6	0.4	0.1
19	92	91.9	91.5	0.1	91.4	91.7	91.5	0.2	0
20	92	91.6	91.8	0.4	92.3	91.8	92.1	0.3	0.3
21	91.7	91.1	91.4	0.6	92	92	92	0	0.6
22	92	91.7	91.4	0.3	91.7	92.3	92	0.6	0.6
			Stdev	0.42			Stdev	0.28	0.39

Figures 3 and 4 shows the plots of the Series 3000 Chemical Lean values vs the Oven Drying Chemical Lean values for days 1 and 2. The correlations are Moisture = 0.9857 and Chemical Lean = .9916.

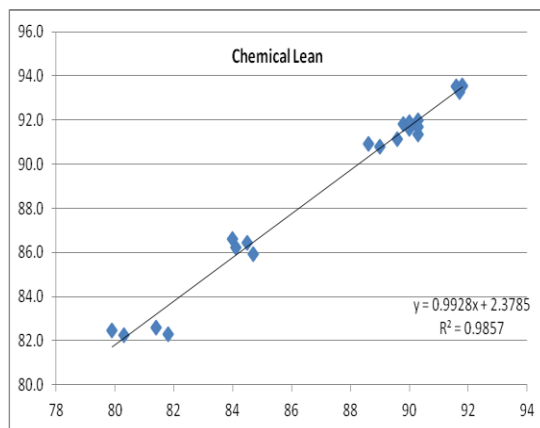


Figure 3 Chemical Lean Plot Day 1

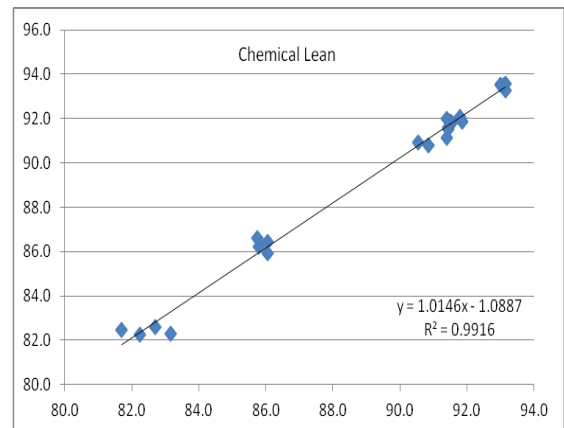


Figure 4 Chemical lean Plot Day 2

Figures 5 and 6 shows the trend plots for Moisture and Chemical Lean values predicted using the Series 3000 and Oven Drying methods.

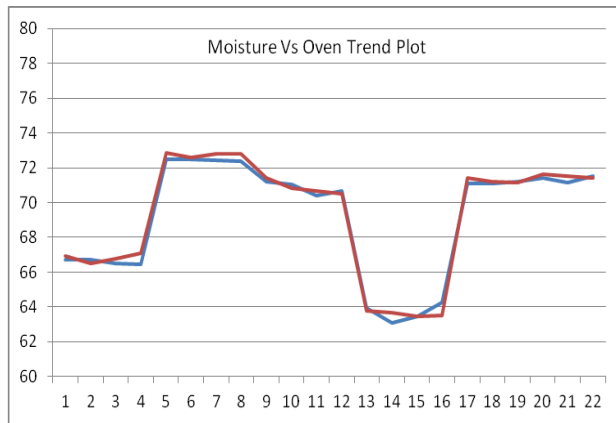


Figure 5 Moisture Trend Plot Day 1

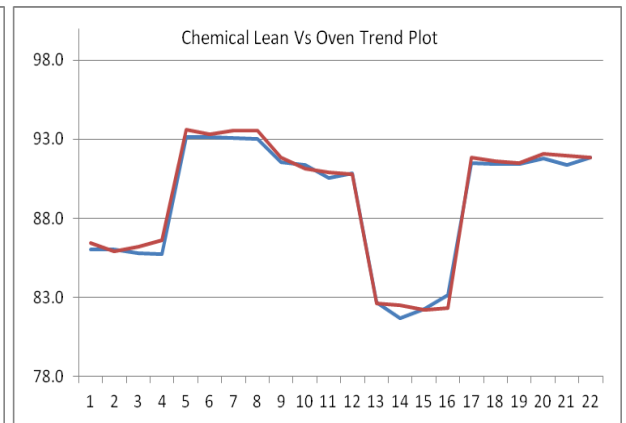


Figure 6 Chemical Lean Trend Plot Day 1

Table 2 presents the measurement of Moisture and Chemical Lean using the Microwave Drying method.

Sample ID	Day 1 Moisture	Day 2 Moisture	Ave	Diff	Day 1 CL	Day 2CL	Ave	Diff	Oven Mois - Micro Mois	Oven CL - Micro CL
1A	69.6	67.9	68.8	1.7	89.7	87.6	88.7	2.1	-1.8	-2.3
2A	66.1	67.4	66.8	-1.3	85.4	87.0	86.2	-1.6	-0.3	-0.3
3A	66.7	66.1	66.4	0.5	86.1	85.4	85.8	0.7	0.4	0.4
4A	66.8	63.9	65.4	2.9	86.3	82.8	84.5	3.5	1.7	2.1
5A	71.4	71.2	71.3	0.2	91.8	91.6	91.7	0.3	1.6	1.9
6A	72.6	70.9	71.7	1.7	93.2	91.2	92.2	2.0	0.9	1.1
7A	69.8	73.3	71.6	-3.4	90.0	94.1	92.0	-4.2	1.2	1.5
8A	71.5	69.7	70.6	1.8	92.0	89.8	90.9	2.2	2.2	2.6
9A	69.3	72.2	70.7	-2.9	89.3	92.7	91.0	-3.5	0.7	0.8
12A	69.7	69.6	69.6	0.1	89.8	89.6	89.7	0.2	0.9	1.1
13A	64.6	61.9	63.2	2.6	83.6	80.4	82.0	3.2	0.6	0.6
16A	63.5	64.2	63.8	-0.8	82.2	83.1	82.7	-0.9	-0.3	-0.4
17A	67.7	73.0	70.3	-5.2	87.4	93.7	90.5	-6.4	1.1	1.4
21A	70.7	72.7	71.7	-2.0	91.0	93.4	92.2	-2.4	-0.2	-0.2
22A	69.3	70.5	69.9	-1.2	89.3	90.7	90.0	-1.4	1.5	2.0
				2.4				2.9	1.0	1.2

Summary:

Table 3 shows the comparison for the NIR and Microwave Drying methods against the Oven Drying Method for determining Moisture and Chemical Lean.

Method	Accuracy		Precision	
	Moisture	Chemical Lean	Moisture	Chemical Lean
NIR	0.32	0.39	0.18	.47
Microwave	1.0	1.2	2.4	2.9

Discussion:

The reference method for measuring fat in meat is the Soxhlet Extraction method. Chemical Lean is the difference between the fat% and 100%. Since the Soxhlet method take 5 hours and involves heated solvents, it is not a practical method for determining Chemical Lean in a meat processing plant.

Chemical Lean has been shown to correlate highly with the moisture lost on drying a 20gram sample of minced or blended meat. The measurement of the moisture content of the meat can be performed using a wide variety of instruments. Oven Drying for 16Hrs at 103C is the standard method. Microwave eating of a sample for approximately 3-5 minutes is a much faster method however it still is labour intensive requiring the sample to be weighed before and after heating. Typically the turnaround time for a microwave CL measurement is 10-15 minutes.

Near Infrared Spectroscopy provides a rapid means of measuring fat, protein and moisture in minced meat samples. The advantages of NIR include a 90 grams of sample and taking 10 measurements for each 90 grams and averaging the 10 readings. Analysis time can be as short as 60 seconds and there is no need to look up a chart or calculate the CL as the instrument does it automatically.

The data presented in this report shows that the NIR method is five to ten times more precise than the Microwave method. The accuracy of the NIR method is 0.39 vs 1.2 for the Microwave method.