

Rapid Total Fat & Moisture in All Meats (Raw and Processed)



Introduction

Fat and moisture testing for foodstuff samples has traditionally been done by wet chemistry techniques, which are laborious and time consuming and often involve skilled technicians and hazardous solvents. Various rapid techniques (NIR, FT-IR, FT-NIR, and TD-NMR) have been introduced, but none have been universally accepted, due to the need for often extensive calibration development and maintenance. Near infrared (NIR) typically requires separate calibrations for every meat type (i.e. beef, chicken, pork, etc.), geographic location of a single meat type (i.e. Australian cattle vs. US cattle), and season (spring, summer, autumn, winter), yet still has challenges achieving acceptable accuracy levels.

The SMART 6™ – ORACLE™ is a combination system for rapid moisture and fat determination, coupling dual-frequency drying (iPower®) in the SMART 6 with advanced NMR technology in the ORACLE. Dual-frequency drying in the SMART 6 allows for rapid and precise moisture determination. The ORACLE is a rapid time-domain NMR (TD-NMR) instrument, incorporating breakthrough technology that allows for direct determination of fat in food products. Unlike other rapid techniques, the ORACLE is able to completely isolate the detection of fat in complex matrices, which eliminates the need for calibration development. Together, the SMART 6 – ORACLE system delivers rapid, accurate, and precise total moisture and fat in raw and processed meats, while removing the cost and time of calibration maintenance and development associated with NIR.

To demonstrate the ability of the SMART 6 – ORACLE to accurately and reliably determine the moisture and fat content in meats, an assortment of 13 samples were obtained and analyzed. The samples were selected to represent a range of matrices and relative component concentrations.

Key System Benefits

- **No Method Development:** with an extensive library of optimized moisture methods, and no fat method development, the SMART 6 – ORACLE system can analyze any meat sample with no calibration development
- **Rapid:** less than 5 minute analysis
- **Accurate:** extensively validated against Soxhlet and other wet chemical analyses for a variety of meat samples, including CRMs (certified reference materials)
- **Precise:** better repeatability than wet chemical extraction techniques, regardless of operator
- **Stable:** no recalibration or calibration maintenance
- **AOAC Approved Methodology:** AOAC 2008.06 for coupled microwave moisture analysis with TD-NMR fat analysis for meat products

Experimental

To complete each analysis, the samples were pre-dried on the SMART 6 (ca. 3 – 4 minutes) and then prepared for analysis in the ORACLE. Once inserted into the ORACLE magnet, the samples are rapidly conditioned (30 s) using the QuikPrep™ prior to NMR analysis (35 s). The sample size was 2 grams. Each sample was analyzed at least in duplicate for the reference analyses (AOAC approved methods), and at least 3 times for the SMART 6 – ORACLE analyses.

Note: High-throughput analyses can be enabled through the use of batch automation, using an optional robot and high capacity heater blocks (100 positions).



Figure 1: SMART 6 – ORACLE moisture and fat systems

Table 1: Accuracy

Sample	Moisture			Fat		
	SMART 6	Oven	Difference	ORACLE	Soxhlet Extraction	Difference
Hot Dog	52.97	53.66	0.69	30.25	30.09	0.15
Beef	67.57	67.82	0.25	12.08	11.94	0.14
Beef (Deboned)	67.01	66.86	0.15	15.95	15.68	0.27
Chicken	72.65	73.05	0.40	7.95	7.84	0.11
Chicken (High Fat)	66.43	66.69	0.26	18.33	17.95	0.38
Chicken Msc	70.10	70.43	0.33	13.87	13.78	0.09
Turkey	68.27	68.15	0.12	13.64	13.37	0.27
Pork	70.23	70.08	0.15	10.26	10.14	0.12
Fish (Salmon)	74.45	74.63	0.18	4.08	4.00	0.08
Fish (Catfish)	66.56	67.09	0.53	15.60	15.57	0.03
Potted Meat	69.99	70.00	0.01	12.87	13.04	0.17
Bacon	34.05	33.96	0.09	54.73	54.60	0.13
Viscera	68.05	68.70	0.65	16.05	15.49	0.56
		Average	0.29		Average	0.19

Table 2: Repeatability

Sample	Component	Replicates			Average	Range	Std. Dev.
		1	2	3			
Hot Dog	Moisture	53.06	52.96	52.90	52.97	0.16	0.08
	Fat	30.13	30.34	30.27	30.25	0.21	0.11
Beef	Moisture	67.65	67.47	67.60	67.57	0.18	0.09
	Fat	12.06	12.00	12.18	12.08	0.18	0.09
Beef (de-boned)	Moisture	66.66	67.49	66.87	67.01	0.83	0.43
	Fat	16.00	15.88	15.98	15.95	0.12	0.06
Chicken (low fat)	Moisture	72.87	72.35	72.74	72.65	0.52	0.27
	Fat	7.97	8.05	7.83	7.95	0.22	0.11
Chicken (high fat)	Moisture	65.81	66.53	66.94	66.43	1.13	0.57
	Fat	18.04	18.74	18.22	18.33	0.70	0.36
Chicken (MSC)	Moisture	70.13	70.18	69.98	70.10	0.20	0.10
	Fat	13.85	13.61	14.15	13.87	0.54	0.27
Turkey	Moisture	68.06	68.23	68.53	68.27	0.47	0.24
	Fat	13.61	13.53	13.79	13.64	0.26	0.13
Pork	Moisture	70.38	70.06	70.25	70.23	0.32	0.16
	Fat	10.30	10.24	10.24	10.26	0.06	0.03
Fish (Salmon)	Moisture	74.51	74.22	74.61	74.45	0.39	0.20
	Fat	4.03	4.10	4.10	4.08	0.07	0.04
Fish (Catfish)	Moisture	67.29	66.33	66.07	66.56	1.22	0.64
	Fat	15.22	15.44	16.15	15.60	0.93	0.49
Potted Meat	Moisture	69.98	70.03	69.96	69.99	0.07	0.04
	Fat	12.99	12.76	12.85	12.87	0.23	0.12
Bacon	Moisture	34.15	33.75	34.26	34.05	0.51	0.27
	Fat	54.51	55.14	54.55	54.73	0.63	0.35
Viscera	Moisture	67.58	68.25	68.32	68.05	0.74	0.41
	Fat	16.12	15.76	16.28	16.05	0.52	0.27

Conclusion

These results suggest the ability of the SMART 6 – ORACLE to reliably determine the moisture and fat content in meat samples with an accuracy closely matching that of the reference methods. In addition, there are inherent repeatability advantages over the reference methods, which are error prone due to a strong dependence on a range of experimental factors (e.g. extraction time, solvent composition, temperature, etc.).

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