



## ORACLE

### Fat Analyzer

The first ever rapid fat analyzer with no method development.

## 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 (TD-NMR, NIR, FT-IR, and FT-NIR) have been introduced, but none have been universally accepted due to the need for often extensive calibration development and maintenance.

The ORACLE is a rapid time-domain NMR (TD-NMR) instrument incorporating breakthrough technology that allows for direct determination of fat/oil in foodstuffs. 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. To allow for rapid moisture/solids as well as fat testing, the ORACLE can be coupled with a SMART 6 moisture/solids analyzer.

To demonstrate the ability of the ORACLE and SMART 6 to accurately and reliably determine the fat and moisture content in foodstuffs, an assortment of 21 samples were obtained and analyzed. The samples were selected to represent a broad range of both matrix types as well as relative component concentrations.

## Key Benefits of ORACLE

- Direct technique, requiring no calibration
- Rapid (less than 5 minutes for moisture and fat)
- Bulk measurement (insensitive to color and granularity)
- Better repeatability than reference methods



Robot and high capacity heater blocks (100 positions)  
with ORACLE

## 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). Samples sizes ranged from 2 – 3 grams. Each sample was analyzed at least in duplicate for the reference analyses (AOAC approved methods), and at least 9 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).

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## Results and Discussion

The accuracy of the SMART 6 and ORACLE results is summarized in Table 1, where the average reference results are compared with the average of the SMART 6 and ORACLE results. The average difference ranged from 0.01 - 0.60 % for moisture/solids, and from 0.01 – 0.15 % for fat. Repeatability is summarized in Tables 2 and 3, where the standard deviations ranged from 0.04 – 0.52 % for moisture/solids, and from 0.03 – 0.64 % for fat.

These results suggest the ability of the SMART 6 – ORACLE to reliably determine the moisture/solids and fat content in foodstuff 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.).

**Table 1: Accuracy**

Sample	Moisture/Solids			Fat		
	SMART 6	Oven	Difference	ORACLE	Solvent Extraction	Difference
Guacamole	21.55	21.51	0.04	9.88	9.89	0.01
Cheese Dip	29.25	29.39	0.14	11.44	11.48	0.04
Cheese (enzyme modified)	46.65	46.12	0.53	18.57	18.56	0.01
Fake Cream	27.01	27.03	0.02	16.27	16.25	0.02
Pudding	15.22	15.13	0.09	2.70	2.68	0.02
Beverage Mix	18.62	18.52	0.10	3.25	3.29	0.04
Chili	18.26	18.10	0.16	3.87	3.92	0.05
Hot Dog	53.06	53.66	0.60	30.10	30.09	0.01
Beef	67.48	67.82	0.34	12.04	11.94	0.10
Chicken	72.52	73.05	0.53	7.98	7.84	0.14
Pork	70.16	70.08	0.08	10.30	10.14	0.16
Fish (Salmon)	74.44	74.63	0.19	4.06	4.00	0.06
Potted Meat	70.02	70.00	0.02	12.89	13.04	0.15
Skim Milk	90.73	90.74	0.01	0.19	0.18	0.01
Yogurt	20.92	21.10	0.18	0.86	0.81	0.05
Whole Milk	88.03	87.88	0.15	3.41	3.41	0.00
Ice Cream	39.12	39.07	0.05	13.51	13.56	0.05
Processed Cheese	46.63	46.07	0.56	21.36	21.44	0.08
Natural Cheese	39.74	39.52	0.22	29.85	29.90	0.05
Cream cheese	54.60	54.77	0.17	33.58	33.70	0.12
Sour Cream	24.94	25.23	0.29	17.54	17.69	0.15
		Average	0.21		Average	0.06

**Table 2: ORACLE Repeatability**

Sample	Replicates										Average	Range	Std. Dev.
	1	2	3	4	5	6	7	8	9	10			
Guacamole	9.84	9.94	9.93	9.91	9.86	9.85	9.86	9.91	9.81	9.85	9.88	0.04	0.13
Cheese Dip	11.45	11.51	11.47	11.47	11.33	11.41	11.44	11.50	11.48	11.35	11.44	0.06	0.18
Cheese (enzyme modified)	18.68	18.59	18.62	18.63	18.47	18.60	18.60	18.51	18.45	18.50	18.57	0.08	0.23
Fake Cream	16.18	16.24	16.16	16.23	16.32	16.28	16.29	16.35	16.35	16.25	16.27	0.07	0.19
Pudding	2.72	2.67	2.64	2.67	2.75	2.72	2.77	2.71	2.68	2.65	2.70	0.04	0.13
Beverage Mix	3.28	3.29	3.29	3.15	3.28	3.29	3.16	3.25	3.23	3.24	3.25	0.05	0.14
Chili	3.85	3.91	3.88	3.78	3.88	3.91	3.86	3.86	3.86	3.89	3.87	0.04	0.13
Hot Dog	30.13	30.34	30.27	30.19	29.95	29.83	30.25	30.02	29.76	30.28	30.10	0.20	0.58
Beef	12.06	12.00	12.18	12.10	12.00	12.04	11.93	12.17	11.99	11.97	12.04	0.08	0.25
Chicken	7.97	8.05	7.83	8.04	8.04	8.08	8.10	7.48	8.12	8.08	7.98	0.19	0.64
Pork	10.30	10.24	10.24	10.46	10.39	10.25	10.28	10.21	10.39	10.24	10.30	0.08	0.25
Fish (Salmon)	4.03	4.10	4.10	4.11	4.12	4.02	3.84	4.09	4.10	4.11	4.06	0.09	0.28
Potted Meat	12.99	12.76	12.85	12.84	12.89	12.99	13.13	12.85	12.90	12.72	12.89	0.12	0.41
Skim Milk	0.17	0.19	0.20	0.20	0.21	0.16	0.19	0.21	0.15	0.18	0.19	0.02	0.04
Yogurt	0.84	0.87	0.84	0.89	0.85	0.86	0.89	0.84	0.89	0.88	0.86	0.02	0.05
Whole Milk	3.43	3.41	3.40	3.42	3.41	3.39	3.41	3.39	3.40	3.41	3.41	0.01	0.03
Ice Cream	13.56	13.46	13.54	13.48	13.51	13.48	13.57	13.55	13.54	13.47	13.51	0.04	0.10
Processed Cheese	21.22	21.47	21.27	21.41	21.45	21.34	21.34	21.41	21.40	-	21.36	0.11	0.25
Natural Cheese	29.82	29.82	29.89	29.90	29.82	29.93	29.88	30.23	29.68	29.95	29.85	0.04	0.08
Cream Cheese	33.63	33.63	33.58	33.65	33.40	33.74	33.67	33.68	33.50	33.67	33.58	0.10	0.25
Sour Cream	17.40	17.58	17.56	17.71	17.45	17.36	17.55	17.68	17.83	-	17.54	0.12	0.31

**Table 3: SMART 6 Repeatability**

Sample	Replicates										Average	Range	Std. Dev.
	1	2	3	4	5	6	7	8	9	10			
Guacamole	21.53	21.57	21.58	21.50	21.61	21.51	21.58	21.59	21.56	21.44	21.55	0.05	0.17
Cheese Dip	29.36	29.19	29.30	29.18	29.28	29.36	29.30	29.20	29.10	29.27	29.25	0.08	0.26
Cheese (enzyme modified)	46.59	46.60	46.59	46.71	46.89	46.64	46.69	46.63	46.61	46.59	46.65	0.09	0.30
Fake Cream	26.94	26.94	27.15	27.01	27.05	26.94	27.03	27.11	26.97	26.99	27.01	0.07	0.21
Pudding	15.10	15.23	15.32	15.21	15.27	15.25	15.11	15.27	15.21	15.26	15.22	0.07	0.22
Beverage Mix	18.67	18.63	18.64	18.59	18.56	18.64	18.66	18.69	18.52	18.61	18.62	0.05	0.17
Chili	18.29	18.10	18.22	18.39	18.22	18.28	18.24	18.23	18.21	18.42	18.26	0.09	0.32
Hot Dog	53.06	52.96	52.90	53.03	53.12	53.26	53.01	53.14	53.26	52.87	53.06	0.14	0.39
Beef	67.65	67.47	67.60	67.63	67.46	67.49	67.53	67.45	67.19	67.30	67.48	0.14	0.46
Chicken	72.87	72.35	72.74	72.41	72.40	72.53	72.49	72.42	72.57	72.43	72.52	0.17	0.52
Pork	70.38	70.06	70.25	70.37	70.10	70.00	70.06	70.22	69.98	70.18	70.16	0.14	0.40
Fish (Salmon)	74.51	74.22	74.61	74.50	74.58	74.37	74.32	74.59	74.41	74.31	74.44	0.14	0.39
Potted Meat	69.98	70.03	69.96	70.08	70.10	70.10	69.93	70.00	70.00	69.98	70.02	0.06	0.17
Skim Milk	90.73	90.72	90.72	90.72	90.74	90.68	90.70	90.72	90.74	90.63	90.73	0.01	0.02
Yogurt	20.92	20.91	20.95	20.87	20.94	20.85	20.86	20.94	20.94	20.94	20.92	0.03	0.08
Whole Milk	88.02	88.02	88.02	88.06	88.04	88.01	88.05	87.98	88.01	87.96	88.03	0.02	0.04
Ice Cream	39.16	39.16	39.06	39.10	39.14	39.10	39.19	39.18	39.16	39.20	39.12	0.04	0.10
Processed Cheese	46.55	46.68	46.79	46.53	46.60	46.68	46.77	46.96	46.72	-	46.63	0.11	0.26
Natural Cheese	39.79	39.75	39.72	39.76	39.70	39.66	39.72	39.86	39.78	39.69	39.74	0.04	0.09
Cream cheese	54.57	54.58	54.53	54.64	54.69	54.49	54.51	54.53	54.58	54.49	54.60	0.06	0.16
Sour Cream	24.88	24.86	25.03	25.07	24.88	24.78	25.07	25.19	25.34	-	24.94	0.10	0.21