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A Research Note

Comparison of Infra-Dry and AOAC Methods for Moisture in Food Products

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ABSTRACT

The Infra-Dry (IR) method was accurate, precise and faster than conventional (AOAC) procedures for moisture determinations in ten selected food products. The average percentage moisture by the IR method for 10 common food products and those by AOAC in parentheses are as follows: oatmeal 9.88 (9.87), cornmeal 10.86 (10.91), wheat flour 10.80 (10.80), grape nuts 4.73 (4.78), rice 12.39 (12.41), potato flakes 8.40 (8.36), bread crumbs 9.93 (9.99), noodles 9.58 (9.54), NFD milk 4.23 (4.24), and fresh milk 88.60 (88.71). The temperatures used for the IR method (135 to 155°C) were higher than those for the AOAC procedures (130°C for all products except NFD and fresh milk [100°C]); however, the times were considerably less (10 to 30 min) than for AOAC procedures (1 to 5 h). Standard deviations were generally <0.06%, except for cornmeal and noodles which were approximately 0.1%. Precisions were generally >97%. Upon removing the samples from the IR oven, results of good precision and accuracy were obtained by cooling the samples in a desiccator for 5 min or the built-in IR cooling chamber for 45 s. The recommended IR method uses a cooling chamber, is faster, and does not require a desiccator. Slightly lower precision and accuracy resulted when the entire IR oven was used. The best results were obtained using the back third of the oven. However, the slight difference in precision and accuracy is of little practical significance.

Infra-red radiation for drying total solids in milk and dairy products has been used successfully for rapid moisture determination for several years (*2,4,6*). An Infra-tester was used to determine the total solids content in several dairy products (*2*). A similar instrument, the Cenco Moisture Balance, was also used to measure total solids in milk (*5*). Both instruments use IR lamps to dry samples placed directly beneath them. Optimum time was determined for each instrument and the optimum height of the IR lamp was specified for the Infra-tester. The Cenco Moisture Balance had potentiometers built in to provide temperature adjustment (*3*).

Recently, an infra-red oven was marketed by Artek Systems Corporation (New Brunswick Scientific Co., NJ.). This instrument enables the operator to control the temperature, allowing for more rapid determinations. The oven contains six ceramic infra-red lamps which emit radiation at 5 to 6.5 μm. These lamps are mounted parallel to the oven floor at an approximate height of 11 cm.

The purpose of this study was to evaluate the IR oven as a rapid method for determining moisture content in a variety of food products.

MATERIALS AND METHODS

The equipment and instruments used were an analytical balance (0.1 mg precision), aluminum dishes with slip-on lids (>50 mm diam., <40 mm deep), steam bath, forced air oven, vacuum oven, and an IR oven supplied by Artek Systems Corporation.

The methods for determining moisture included, AOAC 14.004 for oatmeal, cornmeal, wheat flour, grape nuts, rice, potato flakes, bread crumbs and noodles, AOAC 16.032 for fresh milk, and AOAC 16.192 for NFD milk (*1*). IR oven times and temperatures were determined by trial and error until accuracy and the desired level of precision were obtained. Sample sizes for IR tests were identical to those of AOAC procedures (2.0 g), except for potato flakes (1.5 g), noodles (1.0 g) and NFDM (1.0 g). Both AOAC and IR oven drying methods are gravimetric procedures.

RESULTS

Ten food products were dried by AOAC and IR procedures. Many trials were done to establish IR oven conditions that would yield results comparable to AOAC procedures. Optimum time and temperature relationships for each product are included as footnotes in Table 1. For most products, the temperature had to be increased 15 to 25°C and the time decreased to 10 to 30 min to obtain results which closely approximated those of the AOAC procedures. Dried samples from both drying methods were handled in the same manner, which consisted of immediately placing the dried samples in a desiccator, waiting 5 min, then quickly weighing them.

An even faster method for completing moisture determinations was recommended by Artek Systems Corporation. This consisted of cooling the dried samples in the built-in IR cooling chamber. The chamber was located directly below the oven, and had a fan which could draw in and circulate ambient air to cool the samples. Several trials were done to establish a cooling time that would yield results similar to those obtained using AOAC proce-

TABLE 1. *Moisture in selected foods by IR[a] and AOAC[b] methods.*

Product	Drying procedure	Trial	Ave. moisture[c] (%)	Std. Dev. (%)	Precision[d] (%)
Oatmeal	AOAC	1	9.87	0.02	99.49
	IR	1	9.89	0.06	98.29
		2	9.87	0.06	98.19
		3	9.87	0.02	99.39
Cornmeal	AOAC	1	10.91	0.09	97.73
	IR	1	10.85	0.09	97.46
		2	10.88	0.09	97.91
		3	10.85	0.07	98.26
Wheat flour	AOAC	1	10.80	0.07	98.35
	IR	1	10.78	0.09	98.07
		2	10.83	0.04	98.81
		3	10.78	0.06	98.35
Grape nuts	AOAC	1	4.78	0.03	98.34
	IR	1	4.73	0.03	98.33
		2	4.75	0.05	96.67
		3	4.72	0.04	97.06
Rice	AOAC	1	12.41	0.02	99.44
	IR	1	12.42	0.11	97.61
		2	12.38	0.01	99.68
		3	12.37	0.04	98.96
Potato flakes	AOAC	1	8.36	0.05	98.46
	IR	1	8.38	0.06	98.34
		2	8.35	0.07	97.74
		3	8.46	0.09	97.44
Bread crumbs	AOAC	1	9.99	0.02	99.40
	IR	1	9.94	0.03	99.00
		2	9.94	0.04	98.80
		3	9.91	0.03	98.99
Noodles	AOAC	1	9.54	0.09	98.14
	IR	1	9.60	0.11	97.03
		2	9.55	0.12	97.01
		3	9.58	0.17	95.92
NFD milk	AOAC	1	4.24	0.05	96.52
	IR	1	4.24	0.06	95.63
		2	4.23	0.05	96.53
		3	4.23	0.05	96.51
Fresh milk	AOAC	1	88.71	0.05	99.85
	IR	1	88.60	0.05	99.83
		2	88.58	0.08	99.75
		3	88.63	0.06	99.79

[a]Optimum time and temperature for oatmeal and wheat flour was 10 min at 145°C; for cornmeal, grape nuts and bread crumbs, 20 min at 150°C; rice and noodles, 30 min at 155°C; potato flakes, 12 min at 145°C; NFD milk, 10 min at 135°C; and fresh milk, 25 min at 150°C.

[b]AOAC conditions for all products except NFD and fresh milk were 130°C for 1 h in a forced air oven. NFD milk was dried at 70°C, <100 mmHg for 5 h. Fresh milk predried over steam bath than at 100°C for 3 h in forced air oven.

[c]Each value represents the average of the six samples analyzed per trial.

[d]Precision was calculated by dividing the smallest value by the largest × 100.

dures (Table 2). Slightly lower accuracy and precision resulted using the entire oven as compared to the back third (Table 3). All precisions were 95% or better.

DISCUSSION

In attempting to obtain consistent results with accuracy and good precision using the IR oven, many combination of operating conditions were tried. The IR oven provides faster moisture determinations, yielding results almost identical to AOAC procedures (Tables 1 and 2).

Two methods were used to cool the dried samples. The samples, whose results are presented in Table 1, were cooled by placing them in a desiccator for 5 min, whereas those in Table 2 were placed in the cooling chamber for 45 s. The latter method (recommended by the Artek Systems Corporation) was faster and did not involve the use of a desiccator. Results obtained with the 45-s cooling time were closest in precision and accuracy to those obtained by AOAC procedures.

Slightly less accurate results were obtained using the entire oven (i.e., one sample placed under each ceramic lamp) (Table 3). This may have been due to convection in the front of the oven. Consequently, best results were obtained using only the back third of the oven (i.e., front row of samples under back row of lamps, back row of samples placed against back wall of oven). However, the slight difference in precision and accuracy is of little practical significance.

TABLE 2. *Establishment of the optimum time in the cooling chamber of the IR unit.*

Product	Drying procedure	Trial	Cooling time[a]	Ave. moisture[b] (%)	Std. Dev. (%)	Precision[c] (%)
Oatmeal	AOAC	1	5 min	10.12	0.02	99.51
	IR	1	30 s	10.16	0.06	98.63
		2	30 s	10.16	0.04	98.83
		3	30 s	10.17	0.06	98.24
Oatmeal	IR	1	45 s	10.11	0.04	98.82
		2	45 s	10.13	0.04	98.72
		3	45 s	10.15	0.02	99.31
Oatmeal	IR	1	1 min	10.06	0.04	99.11
		2	1 min	10.04	0.03	99.01
		3	1 min	10.02	0.07	97.74
Oatmeal	IR	1	2 min	10.01	0.03	99.20
		2	2 min	10.01	0.03	99.11
		3	2 min	9.96	0.04	99.10
Oatmeal	IR	1	5 min	10.13	0.02	99.51
		2	5 min	10.12	0.05	98.72
		3	5 min	10.10	0.02	99.51
Cornmeal	AOAC	1	5 min	10.69	0.01	99.72
	IR	1	45 s	10.61	0.04	98.97
		2	45 s	10.59	0.01	99.72
		3	45 s	10.63	0.04	98.97
Rice	AOAC	1	5 min	12.52	0.06	98.57
	IR	1	45 s	12.48	0.08	98.10
		2	45 s	12.42	0.09	97.92
		3	45 s	12.42	0.07	98.40
NFDM	AOAC	1	5 min	4.24	0.05	96.52
	IR	1	45 s	4.24	0.02	98.59
		2	45 s	4.22	0.02	98.59
		3	45 s	4.21	0.06	96.28
Flour	AOAC	1	5 min	10.80	0.03	99.26
	IR	1	45 s	10.74	0.05	98.61
		2	45 s	10.71	0.03	99.35
		3	45 s	10.76	0.05	98.71

[a]All AOAC samples were cooled in a desiccator; all IR samples were cooked in the IR cooling chamber, except three trials in which oatmeal was cooled in a desiccator for 5 min.

[b]Each value represents the average of six samples analyzed per trial.

[c]Precision was calculated by dividing the smallest value by the largest × 100.

TABLE 3. *Comparison of using the back third of the IR oven and the entire oven.*

Food product: Oatmeal – Moisture by AOAC = 9.87%; Std. Dev. = 0.02%.

I. Percent moisture by IR (10 min, 145°C) using only back third of oven:

Trial 1:		–(a)– 9.79	9.95	9.94 [b]
	Ave. = 9.89%	9.88	9.96	9.84
	Std. Dev. = 0.06%			
	Prec. = 98.3%			
			Front of oven	
Trial 2:		–(a)– 9.75	9.85	9.93 [b]
	Ave. = 9.87%	9.93	9.86	9.89
	Std. Dev. = 0.06%			
	Prec. = 98.2%			
			Front of oven	
Trial 3:		–(a)– 9.84	9.84	9.86 [b]
	Ave. = 9.87%	9.84	9.86	9.89
	Std. Dev. = 0.02%			
	Prec. = 99.4%			
			Front of oven	

II. Percent moisture using entire oven:

Trial 1:		–(a)–		[c]
	Ave. = 9.75%			
	Std. Dev. = 0.08%	9.80	9.82	9.86
	Prec. = 97.9%			
		9.67	9.65	9.70
			Front of oven	
Trial 2:		–(a)–		[c]
	Ave. = 9.78%			
	Std. Dev. = 0.09%	9.83	9.87	9.92
	Prec. = 97.6%			
		9.71	9.68	9.69
			Front of oven	

[a]Represents location of thermocouple.
[b]Diagram represents placement of samples in back third of oven.
[c]Diagram represents placement of samples using entire oven (each sample placed directly under a ceramic lamp).

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