Complete Process Control for Snack Food Manufacturing

Introduction

Moisture analysis using an air-oven method typically takes at least an hour to perform. This is longer than the mix cycle of most dough-state, extruded snacks. Because of the short mixing period of snack food doughs, true at-line process control has historically been nearly impossible. For this reason, moisture testing is typically only performed on final product as a quality control measure. Various rapid, indirect techniques (NIR, FT-IR) have been introduced, but are limited in the types of products that can be tested, and require expensive calibrations for each sample type. Infrared moisture balances decrease test time compared to traditional oven methods, but still require up to 25 minutes to completely dry samples with moderate moisture levels[1]. Furthermore, infrared moisture balances struggle to completely dry high-moisture doughs and liquids, which tend to recondense inside the drying cavity.

The SMART 6™ moisture/solids analyzer is uniquely designed to handle the wide variety of sample types in snack food manufacturing, from dry powder ingredients to high-moisture doughs, hydrates, and liquid brews. The SMART 6 utilizes dual-frequency energy, specifically microwave and infrared, to rapidly analyze moisture content. Low-frequency microwaves penetrate the entire sample to rapidly remove volatiles through dipole rotation, while high-frequency infrared energy evenly heats the surface through molecular vibration. The two energy sources work in unison, providing benefits over microwave-only and infrared-only analyzers, with results in approximately 3 minutes. For rapid moisture/solids and fat analysis in less than 5 minutes, simply pair the SMART 6 with CEM's ORACLE™. The SMART 6 comes pre-programmed with a library of optimized drying methods for pairing with the ORACLE.

This study demonstrates that the SMART 6 can rapidly analyze a wide range of snack food products for moisture with an average difference of less than 0.02%, compared to reference methods.

Key Benefits

- **Rapid, at-line testing** - Results in minutes.
- **Accurate** - Not sensitive to color, density, or consistency changes. Works with all sample types, from 0.01-99.90% solids.
- **Direct Loss on Drying** – SMART 6 is a direct, primary method, with no calibration required.

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Experimental

To evaluate the performance of the SMART 6 moisture/solids analyzer, ten different samples were commercially obtained: Baked and fried potato chips, biscuit dough, brownie batter, butter-flavored crackers, cheese puffs, tortilla chips, pretzels, vanilla wafers, and vegetable chips. For moisture determination, a 2 g sample of each product was analyzed in the SMART 6. Reference testing for moisture content was performed in triplicate to establish a basis of comparison.

Results

Results for percent moisture, using the SMART 6, ranged from 0.00 – 0.04 % difference, compared to oven methods, demonstrating the high degree of accuracy of the SMART 6 analyzer, as shown in **Table 1**. **Table 2** highlights the precision of the SMART 6 dual-frequency drying capabilities, which was ≤ 0.07 % standard deviation for all samples analyzed.

Table 1: Accuracy of Smart 6 Dual-Frequency Technology, Compared to Oven Drying

		Percent Moisture	
Sample	**SMART 6**	**Oven**	**Difference**
Fried Potato Chip	1.26	1.25	-0.01
Cheese Puff	1.61	1.60	-0.01
Baked Potato Chip	1.98	1.99	0.01
Butter Cracker	2.67	2.67	0.00
Vegetable Chip	2.84	2.85	0.01
Corn Tortilla Chip	2.86	2.84	-0.02
Pretzel	3.91	3.89	-0.02
Vanilla Wafer	3.98	3.98	0.00
Brownie Batter	19.52	19.51	-0.01
Biscuit Dough	33.20	33.16	-0.04

Table 2: Precision of Smart 6 Dual-Frequency Technology

	Percent Moisture Replicates							
Sample	**1**	**2**	**3**	**4**	**5**	**Average**	**Range**	**Std. Dev.**
Fried Potato Chip	1.28	1.28	1.27	1.24	1.22	1.26	0.06	0.03
Cheese Puff	1.65	1.62	1.62	1.58	1.58	1.61	0.07	0.03
Baked Potato Chip	2.02	1.99	1.97	1.96	1.95	1.98	0.07	0.03
Butter Cracker	2.68	2.68	2.66	2.65	2.69	2.67	0.04	0.02
Vegetable Chip	2.85	2.85	2.85	2.84	2.82	2.84	0.03	0.01
Corn Tortilla Chip	2.88	2.87	2.86	2.86	2.82	2.86	0.06	0.02
Pretzel	3.94	3.92	3.92	3.89	3.87	3.91	0.07	0.03
Vanilla Wafer	4.02	4.01	3.96	3.95	3.95	3.98	0.07	0.03
Brownie Batter	19.53	19.58	19.51	19.47	19.50	19.52	0.11	0.04
Biscuit Dough	33.14	33.21	33.31	33.16	33.16	33.20	0.17	0.07

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Conclusions

Using dual-frequency energy, the SMART 6 moisture/solids analyzer rapidly dried all samples in approximately 3 minutes, regardless of moisture content. Infrared-only analyzers take much longer to completely dry high-moisture samples and are ineffective at completely driving off bound moisture in dry, solid samples. By combining microwave with infrared energy, the benefits of both sources are realized and the result is rapid, complete drying for all sample types, with excellent precision and accuracy.

References

[1] Bradley, Robert L. Jr. (2006) Moisture and Total Solids Analysis. S. S. Nielsen. Food Analysis (4th Ed. pp. 85-215) West Lafayette, IN. Springer.

[2] http://cem.com/fat-analysis/

United States (Headquarters)
800-726-3331
704-821-7015
Fax: 704-821-7894
info@cem.com

France
33 (01) 69 35 57 80
Fax: 33 (01) 60 19 64 91
info.fr@cem.com

Germany, Austria, Switzerland
(49) 2842-9644-0
Fax: (49) 2842-9644-11
info@cem.de

Ireland
+353 (0) 1 885 1752
Fax: +353 (0) 1 885 1601
info.ireland@cem.com

Italy
(39) 35-896224
Fax: (39) 35-891661
info.srl@cem.com

Japan
+81-3-5793-8542
Fax: +81-3-5793-8543
info@cemjapan.co.jp

United Kingdom
(44) 1280-822873
Fax: (44) 1280-822873
info.uk@cem.com

www.cem.com

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