Improved Process Control for Cheese Products

Introduction

In cheese-making, there is a delicate balance between moisture, fat, and protein levels that plays an important role in the quality, flavor and mouth-feel of the final product. Accurately monitoring moisture, fat, and protein throughout the production process not only ensures the best quality finished product, but also has a direct impact on achieving optimum yields, and in turn, profitability.

The SMART 6™ – ORACLE™ is a combination system for rapid moisture and fat determination with results in less than 5 minutes. The SMART 6 moisture and solids analyzer utilizes dual-frequency energy to rapidly analyze any product, wet or dry, in 3 minutes or less. ORACLE eliminates the need for method development by completely isolating the signal from fat molecules, even in complex sample matrices. Sprint® is a direct protein measurement system, which utilizes dye-binding technology to ensure only true protein is detected, not total nitrogen, which can result in erroneous measurements when non-protein nitrogen is present. Sprint does not require regular calibrations, and methods are easy for any lab user to create. Competitive, rapid technologies (NIR, FT-IR, TD-NMR) require ongoing, expensive calibrations and method development for each unique sample due to variations in color, texture, and consistency.

In this study, results for moisture, fat, and protein analysis using CEM's rapid testing technology compare favorably to reference chemistry with an average difference of less than 0.10 % for all tests. Using only a handful of pre-programmed methods, CEM provides highly accurate and precise results in minutes with better precision than both reference chemistry and competitive rapid technologies.

Key System Benefits

- **Rapid** – Results in under 5 minutes
- **Accurate** – Not sensitive to color, texture, or consistency changes. Nitrogen-containing additives in the final product will not skew protein results.
- **Precise** – CEM technology removes repeatability challenges associated with reference chemistry such as extraction time, temperature, solvent composition, and operator technique.
- **No Calibration** – CEM provides pre-programmed cheese methods, which results in significant savings in calibration development and maintenance (e.g. NIR, FT-NIR).
- **AOAC Approved Methodology**[1-3]

Experimental

To demonstrate the performance of CEM's rapid testing technology, four different natural and processed cheese samples were commercially obtained and evaluated for moisture, fat, and protein. For moisture and fat analysis, a 2 g sample of each cheese type was pre-dried in the SMART 6, then transferred to the ORACLE for fat determination. Natural mozzarella, mascarpone and feta cheeses were measured using the natural cheese method. Processed American cheese was evaluated using a single processed cheese method. For protein analysis, a 0.5 g sample was placed in the Sprint system, where it was automatically homogenized, mixed with iTag® binding solution, and measured via absorption at 480 nm. Sprint methods were created by measuring 3 representative samples (low, medium, high protein content) of known concentration in triplicate to create a response curve. Once developed, methods do not require re-calibration. Reference testing for moisture (air oven), fat (Mojonnier) and protein (Kjeldahl) were performed in duplicate to establish a basis of comparison.

Results and Discussion

The accuracy and precision of CEM's rapid testing technology for quantifying moisture, fat and protein in cheese samples is illustrated in Tables 1 and 2 below. **Table 1** shows the difference between CEM technology and reference methods, which ranged from 0.1 – 0.24 % moisture, 0.02 – 0.18 % fat, and 0.01 – 0.08 % protein. Because protein is measured directly, a correction factor to account for non-protein nitrogen is not required. As shown in **Table 2**, standard deviations ranged from 0.11 – 0.13 % moisture, 0.04 – 0.13 % fat, and 0.02 – 0.18 % protein. These results illustrate the ability of CEM's rapid testing technology to reliably match reference chemistry results for a wide range of cheese types with excellent precision.

Table 1: Accuracy of CEM technology compared to reference methods

Sample	% Moisture			% Fat			% Protein		
	SMART 6	Oven	Difference	ORACLE	Mojonnier	Difference	SPRINT	Kjeldahl	Difference
Natural Mozzarella	47.68	47.80	0.12	19.87	19.85	-0.02	19.91	19.90	-0.01
Processed American	38.96	38.97	0.01	32.16	32.07	-0.09	10.61	10.53	-0.08
Mascarpone	43.41	43.25	-0.16	49.84	49.78	-0.06	4.87	4.85	-0.02
Feta	55.87	56.11	0.24	21.19	21.37	0.18	14.76	14.77	0.01

Table 2: Precision of CEM technology

Sample	Component	Replicates					Average	Range	StDev
		1	2	3	4	5			
Natural Mozzarella	Moisture	47.69	47.59	47.90	47.63	47.57	47.68	0.33	0.13
	Fat	19.90	19.91	19.80	19.88	19.88	19.87	0.11	0.04
	Protein	19.70	19.87	20.19	19.85	19.85	19.89	0.49	0.18
Processed American	Moisture	38.81	38.92	39.10	38.86	39.09	38.96	0.29	0.13
	Fat	32.09	32.00	32.34	32.18	32.21	32.16	0.34	0.13
	Protein	10.59	10.73	10.55	10.57	10.53	10.59	0.20	0.08
Mascarpone	Moisture	43.22	43.50	43.35	43.52	43.45	43.41	0.30	0.12
	Fat	49.82	49.91	49.94	49.73	49.78	49.84	0.21	0.09
	Protein	4.84	4.87	4.88	4.84	4.82	4.87	0.06	0.02
Feta	Moisture	56.06	55.85	55.83	55.81	55.80	55.87	0.26	0.11
	Fat	21.12	21.30	21.25	21.11	21.15	21.19	0.19	0.08
	Protein	14.71	14.70	14.79	14.87	14.72	14.76	0.17	0.07

Conclusion

Using the SMART 6 – ORACLE system, accurate moisture and fat values were obtained in less than 5 minutes. The combination system provides better precision than reference chemistry in a fraction of the time required to run oven and extraction analyses. The Sprint system accurately quantified protein in all samples in less than 4 minutes without the use of hazardous chemicals or high temperatures. Altogether, CEM's rapid testing technology provides highly accurate and precise results in minutes, allowing for better process control and ultimately, increased savings compared to reference methods.

References

(1) **AOAC PVM 1:2004** – Rapid Determination of Moisture/ Solids and Fat in Dairy Products by Microwave and Nuclear Magnetic Resonance Analysis

(2) **AOAC 967.12** – Protein in Milk

(3) **AOAC 930.29** – Protein in Dried Milk