Rapidly Analyzing Fat Content Throughout the Chocolate Manufacturing Process

Introduction

The production of chocolate, from cocoa bean to final product, requires many steps and is subject to strict quality control. The one common feature of each step is the need for accurate fat analysis. The fat profile of chocolate has the greatest influence on its quality, determining texture, stability, spreadability, and mouthfeel. Both cocoa butter and milk fat are the main sources of fat used by manufactures to achieve ideal properties. With cocoa butter being the highest cost raw material for production, it is imperative to tightly control fat content. Fat content is also an important parameter to measure as a way of ensuring optimal tempering, cooling, and formulation, confirming machinery is working properly, and aiding in avoiding fat bloom.

The ORACLE™ is a rapid time domain NMR (TD-NMR) instrument incorporating proprietary technology that allows for direct determination of fat in any food sample. Unlike other rapid techniques, the ORACLE is able to completely isolate the detection of fat in complex matrices, eliminating the need for calibration. To achieve both rapid moisture/solids and fat testing, the ORACLE can be coupled with a SMART 6™ moisture/solids analyzer.

To demonstrate the ability of the SMART 6 + ORACLE to accurately and reliably determine the fat and moisture content throughout the chocolate manufacturing process, an assortment of 5 samples were obtained and analyzed.

Key System Benefits

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

Experimental

Each sample was pre-dried on the SMART 6 for approximately 3 minutes and then prepared for analysis in the ORACLE. Once inserted into the ORACLE magnet, the samples underwent a 35 second scan for NMR analysis. Altogether, the time required to obtain moisture and fat results was between 4 and 5 minutes. Sample sizes ranged from 2 – 3 grams. Each sample was analyzed in duplicate for the reference analyses (AOAC approved methods) and in triplicate for the SMART 6 + ORACLE analyses.

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

Results and Discussion

The accuracy of the SMART 6 + ORACLE results is demonstrated in **Table 1**, where the average reference results are compared with the average of the SMART 6 + ORACLE results. The average difference ranged from 0.04 - 0.14 % for moisture/solids, and from 0.00 – 0.08 % for fat. Repeatability is shown in **Table 2**, where the standard deviations ranged from 0.09 – 0.14 % for moisture/solids, and from 0.03 – 0.16 % for fat.

Table 1: Accuracy of the SMART 6 + ORACLE for Moisture/Solids And Fat in Various Chocolate Process Samples

		Replicates				
Sample	**Component**	**1**	**2**	**3**	**Average**	**Std. Dev.**
Cocoa Powder	Moisture	2.67	2.54	2.55	2.59	0.07
	Fat	10.62	10.56	10.56	10.58	0.03
Cocoa Liquor	Moisture	0.18	0.22	0.2	0.20	0.02
	Fat	53.35	53.14	53	53.16	0.18
Dark Chocolate Mini Chips	Moisture	0.38	0.31	0.27	0.32	0.06
	Fat	25.08	25.08	25.15	25.10	0.04
White Chocolate Bar	Moisture	0.78	0.76	0.81	0.78	0.03
	Fat	33.84	33.86	33.61	33.77	0.14

Table 2: Repeatability of the SMART 6 + ORACLE for Moisture/Solids and Fat in Various Chocolate Process Samples

	Moisture/Solids			Fat		
Sample	**SMART 6**	**Oven**	**Difference**	**ORACLE**	**Reference**	**Difference**
Cocoa Powder	2.59	2.55	-0.04	10.58	10.52	-0.06
Cocoa Liquor	0.20	0.20	0.00	53.16	53.03	-0.13
Dark Chocolate Mini Chips	0.32	0.30	-0.02	25.10	25.20	0.10
White Chocolate Bar	0.78	0.79	0.01	33.77	33.51	-0.26

Conclusion

These results demonstrate the ability of the SMART 6 + ORACLE to reliably determine the moisture/solids and fat content in dairy samples with an accuracy closely matching that of the reference methods. In addition, there are inherent repeatability advantages over wet chemistry 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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