Optimizing Oil Determination in Corn Milling

Introduction

Corn has become one of the most versatile and highly studied agricultural products in the history of humanity, and these days is used in nearly every aspect of daily life. Various species of corn are grown and harvested, with many being further processed to provide additives and ingredients in our food, fuel, and animal feed. This processing is typically referred to as milling, and while there are many variations to the milling process, the end goal of separating the corn into its three primary structural components, the bran, the endosperm, and the germ. Each component is rich in either sugar, starch, fiber, or oil, with its nutritional benefits dictating whether it will be used for corn syrup in food products, as ethanol for fuel, or as a supplement in feeds, sometimes referred to as distiller grains or DGS.

Milling is typically separated in wet or dry milling, with key differences depending on which components the processor is most interested in. While wet milling is a more labor and cost intensive process, it leads to a more efficient separation and recovery of each component. However, dry milling can more effectively and cheaply extract the corn components necessary for ethanol production, and still produce DGS as a secondary feed ingredient. Regardless of the milling procedure, the need for tight control of the various extraction stages is critical to optimizing the efficiency of the process, and ensuring the best bottom line. Within these process control tests, moisture and oil determination rank as some of the most critical analytical tests, since oil is not only one of the more expensive components, but also present in the lowest volume by mass. Inefficient extraction of oil can lead to huge changes in a processor's bottom line and profit margins.

Proper control of oil content requires two equally important benefits in an analytical technique: repeatability and versatility. Versatility of testing the corn at every stage of production, regardless of the state it is in, will allow better tracking of oil content from start to finish. This means samples can be tested for oil content when they arrive as shelled corn, pulled from production as stillage or a wet cake, or tested as a finished flour, or DGS to specifications for proper oil content are met. But, without good repeatability, a processor won't be able to have confidence in their results, requiring them to relax their production specs to accommodate the poor confidence in data. Fortunately, the new ORACLE™ rapid fat/oil analyzer can provide results on any corn product in just a few minutes, without calibration or solvents, and in many cases, with better data than traditional extraction techniques.

Materials and Methods

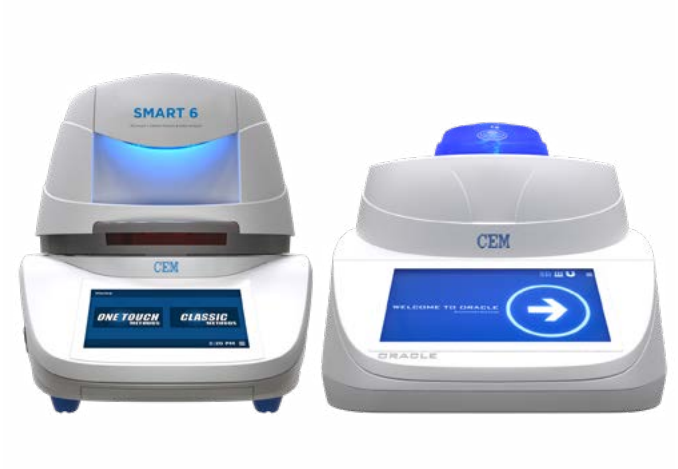
The ORACLE is the first rapid fat/oil analyzer that does not require calibration development or maintenance. Using an improved NMR technology, samples can be tested for oil content in only 30 seconds, without the influence of user error or the need for handling dangerous solvents. For the purpose of this study, the ORACLE was paired with the SMART 6™ moisture analyzer, offering a complete moisture and oil determination in less than four minutes. Samples were sourced and evaluated from four major corn milling operations, with products represented from both wet and dry milling facilities.

The first study was to determine the repeatability and reproducibility of the ORACLE, as compared to the traditional fat extraction. A lot of ten corn germ samples was homogeneously ground as sample preparation, then split into six equal aliquots. Three sets were sent to three labs for the traditional extraction method, and three were sent to CEM to be performed on three different ORACLE units.

Results

As shown in **Table 1**, the ORACLE showed an average range of 0.38% between the three instruments, compared to a 3.87% range in oil content, as determined by the accredited labs following the standard method.

The second study was a look at the precision of the ORACLE compared to the standard extraction method, for a range of samples throughout the milling process, as shown in **Table 2** (page 3). Testing samples from <1% to >50% oil, all without any calibration development or maintenance, the ORACLE produced consistent results that aligned with an R_2 of 0.9999.



Conclusion

This accuracy, coupled with the speed and safety benefits of the ORACLE, proves anyone can test samples on the ORACLE with confidence, even right on the production floor, freeing up the lab for other more rigorous analytical tests. The ORACLE allows you to test any sample at any stage of production with no system changes. With a simple, 3-step test, you can now have better reproducibility than traditional extraction techniques with AOAC accredited technology and ISO 10565 compliance for determining oil in oilseeds.

Table 1. Reproducibility of Extraction vs ORACLE

	Extraction (3 different labs)		ORACLE (3 different units)	
	Average	**Range**	**Average**	**Range**
1	52.13	3.54	52.18	0.49
2	51.47	3.15	49.84	0.69
3	49.08	4.03	50.23	0.57
4	45.72	3.84	47.04	0.77
5	39.1	4.29	39.19	0.3
6	43.94	0.59	45.99	0.15
7	45.74	5.58	47.53	0.42
8	51.81	2.68	51.81	0.51
9	45.88	6.99	47.04	0.19
10	49.24	2.29	48.66	0.01
11	48.53	5.6	48.15	0.08
	Avg Range	3.87	**Avg Range**	0.38

Table 2. Precision Compared to Reference Extraction Method

	Extraction %Fat	Extraction Range	ORACLE %Fat	ORACLE Range
De-oiled Syrup	1.60	0.14	1.62	0.06
Centrate	1.75	0.02	1.89	0.12
Evaporator	7.95	0.03	7.65	0.04
Stillage	2.01	0.01	1.95	0.03
Corn Flour	2.96	0.02	2.87	0.11
Corn Oil	97.26	0.57	97.32	0.32
Corn Germ 50%	50.97	0.76	50.30	0.26
Corn Germ 45%	46.79	2.69	47.04	0.12
Corn Germ 40%	43.16	0.47	42.51	0.09
Corn Germ 30%	33.55	0.03	33.48	0.00

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