Rapid Moisture, Solids, Fat, Protein, and Ash for Egg Processors

Abstract

Egg Processors are faced with a demand for an increasingly large variety of final products and customer requirements. Eggs must be created in liquid or powder form, egg yolks or egg whites, sugared or frozen, all to support a mix of both retail and wholesale customers. In order to remain competitive, costs must be kept low, with many egg breakers looking to improve process and quality control as a way to increase yield and profit. Critical testing points, such as fat and solids content, are used to ensure product quality. These test results can be used to make adjustments to in-process goods, reducing additional steps, such as fat reblending, which result in significant savings over time.

Introduction

CEM has spent the last 40 years developing process control equipment that has proven to not only reduce analysis time, but to do so while maintaining the accuracy and precision typically found with traditional industry standard methods. This combination allows most users of the SMART 6™, ORACLE™, Sprint®, and Phoenix BLACK™ technologies to see ROI's of less than one year. The SMART 6 can provide solids results on any egg product, liquid or powder, in just 2-3 minutes. The ORACLE fat analyzer is the first rapid fat analysis system that detects phospholipids and triglycerides, in as little as 90 seconds, to give a complete and accurate total fat analysis without the need for calibration.

Experimental Details

Moisture & Solids Analysis with the SMART 6

The SMART 6 microwave plus infrared moisture & solids analyzer uses a proprietary combination of microwave and infrared energy to rapidly analyze any product, regardless of whether it is liquid or powder, sugared or salted, frozen or raw. Most analyses are complete in less than 3 minutes. Results are comparable to the precision previously only obtainable by ASTM oven methods, which can take hours to perform. With a touchscreen interface, built-in training videos, and full LIMS integration potential, the SMART 6 is the most advanced moisture & solids analyzer on the market.

For moisture & solids analysis, a 2-gram sample was dried in the SMART 6 until a constant weight was achieved, taking approximately 3 minutes. Reference testing was performed in an air-oven for comparison. **Table 1** highlights the high degree of precision and accuracy of the SMART 6, which closely matched the air-oven method.

Table 1. Accuracy of the SMART 6 for Moisture/Solids in Egg Samples

Sample	Dried Whole Egg (% moisture)	Dried Egg Yolk (% moisture)	Egg White (% solids)	Sugar Yolk (% solids)	Salted Yolk (% solids)	Whole Egg (% solids)
1	3.78	3.99	5.85	47.82	49.47	23.74
2	3.78	3.99	5.87	47.98	49.48	23.77
3	3.79	3.99	5.90	47.74	49.56	23.81
4	3.79	3.99	5.96	47.93	49.56	23.85
Avg	3.79	3.99	5.90	47.87	49.52	23.79
Ref	3.79	3.99	5.91	47.87	49.57	23.81

Total Fat Analysis with the ORACLE

The ORACLE rapid NMR fat analyzer is the first system that can accurately test fat content with no method development, calibration, or sample validation. The ORACLE can achieve accuracy equal to standard extraction methods with no solvents. This means results that are equal to reference extraction techniques, with better consistency and repeatability than NIR technologies. Without calibration maintenance or frequent validation necessary, the ORACLE system can help save thousands of dollars a year in calibration costs, regardless of sample type.

For total fat analysis, a 2-gram sample was dried, and then inserted into the ORACLE. Total scan time was 90 seconds. Reference testing was performed by solvent extraction for comparison. The average difference between the ORACLE and reference chemistry was less than 0.08%, as shown in **Table 2**.

Table 2. Accuracy of the ORACLE for Fat in Egg Samples

Sample	Chicken Egg Yolk (% fat)	Duck Egg Yolk (% fat)	Quail Whole Egg (% fat)	Cage-Free Whole Egg (% fat)
1	30.38	28.68	12.62	8.89
2	30.29	28.78	12.72	8.71
3	30.28	28.88	12.64	8.80
4	30.24	28.82	12.80	8.71
Avg	30.30	28.83	12.72	8.78
Ref	30.30	28.92	12.60	8.88

Egg white samples are notoriously difficult to analyze for fat content due to their inherently low fat concentration. For total fat analysis of egg white products, samples were analyzed in triplicate on the ORACLE and SMART 6. The results were compared to reference values (two replicates each for both moisture/solids and fat) obtained by AOAC 950.54 (Fat in Food Dressings), and 925.30 (Solids in Food Dressings). The average difference between the ORACLE and reference chemistry was less than 0.06%, as shown in **Table 3**.

Table 3. Accuracy of the ORACLE for fat and SMART 6 for moisture for egg white powder and liquid

Sample	Total Solids (%)	Reference	Difference	Fat (%)	Reference	Difference
Egg White Powder	6.96	7.04	0.08	0.21	0.16	0.05
Liquid Egg White 1	11.37	11.32	0.05	0.06	0.06	0.00
Liquid Egg White 2	11.40	11.35	0.05	0.05	0.06	0.01
Liquid Egg White 3	11.23	11.18	0.05	0.04	0.05	0.01

Protein Analysis with the Sprint

The Sprint rapid protein analyzer is a breakthrough technology that fully automates an AOAC-approved dye-binding technique proven effective for food samples since the 1970s. Because it directly measures protein, there is no need for the calculation or calibration that is seen with Kjeldahl and combustion and it is not swayed by the presence of adulterants or other non-protein nitrogen (NPN) molecules. The hazardous chemicals and complicated gas lines and tubes used with these other methods have been replaced by CEM's patented iTag® solution. Upon introduction, the Sprint won the 2009 Presidential Green Chemistry Challenge Award, presented by the EPA, due to the lessened environmental impact. Analysis is simple enough for first day technicians to use, and results are immediately recorded and stored for future reference.

Protein content was determined by placing a 2-gram sample in a Sprint sample cup, which is automatically reacted with iTag solution. The mixture is homogenized, then filtered and the filtrate is analyzed for absorption, which correlates with protein concentration, at 480 nm.

Table 4 shows the Sprint results for various egg products, which show an average difference of only 0.11% compared to Kjeldahl analysis.

Table 4. Accuracy of Sprint for Protein in Egg Samples

Sample	Cooked Egg (% protein)	Egg Whites (% protein)	Dried Egg White (% protein)
1	10.38	82.64	81.86
2	10.44	82.64	81.81
3	10.37	82.41	81.94
4	10.40	82.31	81.76
Avg	10.40	82.50	81.84
Ref	10.40	82.58	81.82

Ash Analysis with the Phoenix BLACK

The Phoenix BLACK microwave muffle furnace is an innovative heating system for rapidly determining ash, or total mineral content, for egg samples. What previously took hours can now be accomplished in minutes with this 1200 °C ASTM-conforming muffle furnace. The Phoenix BLACK performs many high-temperature applications up to 10 times faster than traditional methods, due to the combination of microwave energy, used for rapidly heating the furnace, and quartz-fiber crucibles which promote the circulation of air throughout the entire sample.

Ash content was determined by placing a 5-gram sample in a quartz-fiber crucible and held at 550 °C for 10 minutes.

Table 5 shows the excellent repeatability of ash measurements of both egg whites and whole eggs, with results as low as 0.24%.

Table 5. Repeatability of Phoenix BLACK for Ash in Egg Samples

Sample	Egg Whites (% ash)	Whole Eggs (% ash)
1	0.26	0.93
2	0.25	0.92
3	0.24	0.95
4	0.26	0.91
Avg	0.25	0.93

Conclusion

The SMART 6, ORACLE, Sprint, and Phoenix BLACK systems provide accurate alternatives to traditional methodologies while saving time in the production environment. All of the information gained during analysis can be used to quickly and accurately make adjustments, which directly translate to bottom line savings for egg breakers.