Protein in Yogurt

Introduction

As the global dairy market continues to grow, yogurt in particular stands out as one of the fastest rising sectors. This is especially true with the increased popularity of Greek yogurt and recent advent of non-dairy yogurt alternatives, such as almond, coconut, and soy. A 2015 study showed that yogurt consumption on a daily basis rose from 4.7 % in 1999 to 9.3 % in 2013 from a survey population of 33,932 US adults.[i] Much of yogurt's growth can be attributed to its health benefits, which include being a good source of protein, probiotics, fruits, and other nutrients.

Protein is an essential measurement for yogurt manufacturers as it directly influences product thickness and definition (i.e. Greek yogurt has approximately twice the amount of protein as traditional yogurt). Yogurt is produced by adding live bacterial cultures to milk after it has been exposed to elevated temperature(s) and subsequently cooled. Bacterial cultures ferment the lactose in the previously heat-treated milk, which produces lactic acid. This decrease in pH, in combination with the previous heat treatment, causes milk proteins (casein and whey) to denature from higher order structures and form clusters. Yogurt thickens as the proteins unwind and bind together. In general, the higher the protein content the thicker the yogurt.

The Sprint® protein analyzer is an ideal solution for yogurt manufacturers for testing both in-process and finished yogurt products. The technology is based on a rapid green chemistry process allowing for direct protein detection in less than 5 minutes. A proprietary iTag® solution is mixed with the sample and binds directly to the backbone of the proteins, specifically the basic amino acids (Lysine, Arginine, and Histidine). This rapid and direct protein detection technique is not influenced by nitrogen containing adulterants and does not use any hazardous reagents associated with wet chemical techniques, such as Kjeldahl. Additionally, the unwinding (denaturation) of proteins during the yogurt production process does not reduce the Sprint's efficacy but rather exposes more of the backbone for binding with iTag solution.

Key System Benefits

- Rapid, less than 5 minutes
- Direct protein detection, not total nitrogen
- Green chemistry- no harsh, high temperature chemicals
- More repeatable than Kjeldahl and combustion techniques
- Automates AOAC Methods 967.12 (Milk) and 930.33 (Ice Cream & Frozen Desserts)
- Not susceptible to adulteration

Samples

To demonstrate the accuracy and precision of the Sprint, data was collected for nine in-process samples and 15 finished yogurt samples of various protein levels. The Sprint values were compared to Kjeldahl values obtained following AOAC 991.20 (crude protein) and AOAC 991.21 (true protein). The in-process samples included yogurts, milk retentates, and milk permeates, and the finished product samples included varieties of both traditional and Greek yogurts, with and without fruit.

Sample Preparation and Analysis

Various yogurt, milk permeate, and milk retentate samples were analyzed using the Sprint protein analyzer. Each sample was stirred using a spatula or disposable pipette to ensure proper mixing prior to analysis.

Note: For best results, yogurt samples containing fruit should be homogenized using a food processor.[ii] Any large fruit particles should be avoided during sampling. If large fruit particles are present in the subsample, it may be difficult to obtain a representative aliquot. If solids are visible in liquid samples, tempering may be necessary as described in AOAC 925.21.

Image 1. Sprint protein analyzer

Results

The accuracy and precision of the Sprint protein analyzer are demonstrated in Tables 1 – 6. It should be noted that the Sprint can be setup to correlate to either crude or true protein. The data in Tables 1 – 4 is crude protein and data in Tables 5 – 6 is true protein.

As shown in Tables 1 and 2, the differences between Sprint and Kjeldahl ranged from 0 – 0.12 % crude protein with a standard deviation range of 0 – 0.08 % for in-process yogurts, permeates, and retentates. Tables 3 and 4 show an average difference range between Sprint and Kjeldahl of 0 – 0.07 % crude protein with a standard deviation range of 0 – 0.08 % for finished product yogurts. The yogurts shown in these two tables varied considerably in protein content, flavor, and inclusions (i.e. fruit). Tables 5 and 6 show an average difference range between Sprint and Kjeldahl of 0 – 0.07 % true protein and standard deviation range of 0.01 – 0.03 % for three varieties of Greek yogurt.

These results indicate the Sprint is able to reliably match existing reference chemistry results for protein analysis of yogurt, permeate, and retentate samples throughout the manufacturing and membrane separation processes. The data also shows that the Sprint can achieve a high degree of repeatability for a wide range (ca. 0.20 – 13.50 % protein) of in-process and finished yogurt samples.

Table 1. Accuracy of Sprint for Crude Protein in In-process Yogurts, Permeates, and Retentates

	% Protein		
Sample	Sprint	Kjeldahl	Difference
Yogurt 1, In-Process	1.77	1.79	0.02
Yogurt 2, In-Process	2.49	2.47	0.02
Yogurt 3, In-Process	3.80	3.77	0.03
Yogurt 4, In-Process	4.21	4.33	0.09
Retentate 1	6.03	6.02	0.01
Retentate 2	9.54	9.64	0.10
Retentate 3	13.40	13.28	0.12
Permeate 1	0.18	0.20	0.02
Permeate 2	0.52	0.52	0.00
		Average	0.04

Table 2. Precision of Sprint for Crude Protein in In-process Yogurts, Permeates, and Retentates

	Replicates (% Protein)					
Sample	1	2	3	Average	Range	StDev
Yogurt 1, In-Process	1.77	1.77	1.76	1.77	0.01	0.01
Yogurt 2, In-Process	2.49	2.49	2.48	2.49	0.01	0.01
Yogurt 3, In-Process	3.80	3.81	3.80	3.80	0.01	0.01
Yogurt 4, In-Process	4.21	4.21	4.21	4.21	0.00	0.00
Retentate 1	6.03	6.03	6.03	6.03	0.00	0.00
Retentate 2	9.59	9.45	9.57	9.54	0.14	0.08
Retentate 3	13.35	13.46	13.39	13.40	0.11	0.06
Permeate 1	0.17	0.18	0.19	0.18	0.02	0.01
Permeate 2	0.52	0.52	0.51	0.52	0.01	0.01

Table 3. Accuracy of Sprint for Crude Protein in Finished Yogurts

	% Protein		
Sample	Sprint	Kjeldahl	Difference
Yogurt 1, Plain	3.56	3.50	0.06
Yogurt 2, Plain	4.07	4.07	0.00
Yogurt 3, Plain	4.29	4.33	0.04
Yogurt 1, Fruit	3.18	3.11	0.07
Yogurt 2, Fruit	3.57	3.60	0.03
Yogurt 3, Fruit	3.76	3.71	0.05
Yogurt, Greek, Plain	10.15	10.20	0.05
Yogurt, Greek, Honey	8.32	8.28	0.04
Yogurt, Greek, Blueberry	8.50	8.54	0.04
Yogurt, Greek, Peach	7.18	7.15	0.03
Yogurt, Greek, Pineapple	7.17	7.13	0.04
Yogurt, Greek, Strawberry	8.11	8.18	0.07
		Average	0.04

Table 4. Precision of Sprint for Crude Protein in Finished Yogurts

	Replicates (% Protein)					
Sample	1	2	3	Average	Range	StDev
Yogurt 1, Plain	3.57	3.54	3.56	3.56	0.03	0.02
Yogurt 2, Plain	4.07	4.10	4.05	4.07	0.05	0.03
Yogurt 3, Plain	4.28	4.29	4.30	4.29	0.02	0.01
Yogurt 1, Fruit	3.19	3.17	3.17	3.18	0.02	0.01
Yogurt 2, Fuit	3.57	3.58	3.57	3.57	0.01	0.01
Yogurt 3, Fruit	3.76	3.75	3.76	3.76	0.01	0.01
Yogurt, Greek, Plain	10.19	10.20	10.07	10.15	0.13	0.07
Yogurt, Greek, Honey	8.32	8.32	8.32	8.32	0.00	0.00
Yogurt, Greek, Blueberry	8.50	8.49	8.50	8.50	0.01	0.01
Yogurt, Greek, Peach	7.16	7.20	7.20	7.18	0.04	0.02
Yogurt, Greek, Pineapple	7.23	7.08	7.18	7.17	0.25	0.08
Yogurt, Greek, Strawberry	8.11	8.11	8.10	8.11	0.01	0.01

Table 5. Accuracy of Sprint for True Protein in Finished Yogurts

	% Protein		
Sample	Sprint	Kjeldahl	Difference
Greek, Plain	10.35	10.28	0.07
Greek, Vanilla	7.99	8.02	0.03
Greek, Coconut Vanilla	7.53	7.53	0.00
		Average	0.03

Table 6. Precision of Sprint for True Protein in Finished Yogurts

	Replicates (% Protein)					
Sample	1	2	3	Average	Range	StDev
Greek, Plain	10.35	10.37	10.32	10.35	0.05	0.03
Greek, Vanilla	8.00	7.98	7.98	7.99	0.02	0.01
Greek, Coconut Vanilla	7.55	7.53	7.52	7.53	0.03	0.02

[i] Nielsen SJ et al., Trends in Yogurt Consumption - US Adults - 1999-2012, The FASEB Journal, April 2015, vol 29(1).
[ii] CEM recommends homogenizing samples with commercial grade food processors, such as the Robot Coupe.

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