The Extraction of Fat from Low, Middle, and High-Fat Foods

Abstract

Fat extractions are an important aspect of food testing and safety. They are critical to the accurate calculation of nutrition facts and quality assurance. Traditionally, fat extractions are done using acid prehydrolysis and the Soxhlet method, which is laborious, manual, and time consuming. Thus, faster and automated methods are needed. The EDGE® automated extraction system, was used to extract the fat from different food samples using an acid prehydrolysis protocol before extraction. The direct extraction of each food was also completed. Foods considered low, medium, and high-fat were all extracted with excellent recoveries and RSDs. The EDGE is an ideal choice for food laboratories that need to obtain intact fat extracts and wish to incorporate automation into their workflow.

Introduction

Fat extractions are required by food manufacturers as a part of food formulation. Manufacturers also test the fat extracts from food to ensure the freshness and quality of their products. As consumers grow more educated in the quality and content of the foods they consume, the accurate reporting of nutrition facts, particularly fat, is even more critical. In the manufacturing process, the fastest and most accurate testing methods are always desired. Often, food samples must be prehydrolyzed using acid in order to free bound fat for extraction. Subsequently, most fat extracts are obtained from prehydrolyzed samples using the Soxhlet method, which is tedious, manual, time consuming, and requires several hundred milliliters of solvent.

The EDGE is an automated extraction system that allows for the intact extraction of fat. The EDGE utilizes Q-Cup® technology to extract, filter, and cool the fat extracts from various food samples. In this application note, several foods with different amounts of fat, varying from low-fat to high-fat, were extracted using the EDGE with and without prehydrolysis. The traditional Soxhlet extraction was also done on these matrices, and the results were compared. The results from the EDGE were comparable with excellent RSD values. Thus, the EDGE is an ideal choice for a food laboratory seeking to extract fat from their food samples as an intact extract.

Materials and Methods

Reagents

Food samples were purchased from a local grocery store. Hydrochloric acid (37%) was purchased from Fisher Scientific. Petroleum ether and 3-mm glass beads were purchased from VWR.

Sample Preparation - EDGE Extraction without Acid Hydrolysis

A sample of each food was homogenized using a food blender. The homogenized food, with the exception of raw eggs, was weighed (the sample size is indicated on page 3, in **Table 1**) directly into a Q-Cup containing the S1 Q-Disc® stack (C9+G1+C9 sandwich). The configuration for the Q-Cup is displayed in **Figure 1A** (on page 3). No Q-Screen® was used.

The sample was extracted using petroleum ether into preweighed 60 mL vials containing three 3-mm glass beads to help prevent bumping during evaporation. The samples were extracted using the EDGE Method for Fat from Non-Hydrolyzed Samples. Each cycle was collected separately.

EDGE Method for Fat from Non-Hydrolyzed Samples

Q-Disc: S1 Q-Disc® stack (C9+G1+C9 sandwich)

Cycle 1
Extraction Solvent: Petroleum Ether
Top Add: 30 mL
Bottom Add: 0 mL
Rinse: 0 mL
Temperature: 140 °C
Hold Time: 05:00 (mm:ss)

Cycle 2
Extraction Solvent: Petroleum Ether
Top Add: 30 mL
Bottom Add: 0 mL
Rinse: 0 mL
Temperature: 140 °C
Hold Time: 05:00 (mm:ss)

Wash
Wash Solvent: Petroleum Ether
Volume: 30 mL
Temperature: 30 °C
Hold: 00:15 (mm:ss)

The resulting extracts were evaporated to a constant weight using a Q-Dry™ solvent evaporator at 40 °C and placed in an oven at 100 °C for 30 minutes. The extraction vials were allowed to cool to room temperature and were then weighed. The fat yield was determined by subtracting the weight of the vial and beads from the weight of the final dried extract in the vial.

Sample Preparation - EDGE Extraction with Acid Hydrolysis

A sample of each food was homogenized using a food blender. The homogenized samples were weighed (at the sample size indicated on page 3 in **Table 1**) into glass beakers. A volume of 45 mL of boiling water and 55 mL of 8 M HCl were added to each sample. The mixture was stirred with the sample using a glass stir rod. The beaker was covered with a watch glass and boiled for one hour on a hot plate. After boiling, the sample was collected in a Whatman Grade 1 filter placed inside a plastic funnel. The sample was filtered by gravity. The beaker containing the sample was rinsed with water to ensure complete transfer of the sample. The filters were rinsed with 100 mL of water and oven dried for one hour at 100 °C. The filters were then placed into a Q-Cup containing a Q-Support™, layered on a G0 Q-Disc. This configuration, called G0, is indicated on page 3 in **Figure 1B**. A Q-Screen was placed directly on top of the sample using the Q-Screen tool to keep the entire sample submerged below the solvent level. The samples were extracted using the EDGE Method for Fat of Hydrolyzed Samples. The samples were extracted into preweighed 60 mL vials containing three 3-mm glass beads to help prevent bumping during evaporation. Each cycle was collected separately.

EDGE Method for Fat of Hydrolyzed Samples

Q-Disc: G0

Cycle 1
Extraction Solvent: Petroleum Ether
Top Add: 30 mL
Bottom Add: 0 mL
Rinse: 0 mL
Temperature: 140 °C
Hold Time: 05:00 (mm:ss)

Cycle 2
Extraction Solvent: Petroleum Ether
Top Add: 30 mL
Bottom Add: 0 mL
Rinse: 0 mL
Temperature: 140 °C
Hold Time: 05:00 (mm:ss)

Wash
Wash Solvent: Petroleum Ether
Volume: 30 mL
Temperature: 30 °C
Hold: 15 s

The resulting extracts were evaporated to a constant weight, using a Q-Dry solvent evaporator at 40 °C and placed in an oven at 100 °C for 30 minutes. The extraction vials were allowed to cool to room temperature and were then weighed. The fat yield was determined by subtracting the weight of the vial and beads from the weight of the final dried extract in the vial.

Results

For each of the six food types, Soxhlet extractions were done to obtain the fat percentage using the AOAC methods for each matrix in **Table 1** (page 3). These fat values were considered to be the reference values for each food. The fat from each matrix, except for raw eggs, was extracted using only the EDGE with no prehydrolysis. The recoveries are shown in **Table 2** (page 3). The recoveries ranged from 96-101%, indicating excellent recoveries, and the RSD values were all less than 2.4%, showing good repeatability. However, the fat from raw eggs was not extracted without hydrolysis because the temperature required for fat extraction is above the minimum temperature used to cook an egg, which is 65 °C.

Hydrolysis is required in order to extract fat from eggs. Furthermore, all six matrices were prehydrolyzed prior to fat extraction. The final recoveries are displayed in **Table 2**. They range from 95-104%; thus, the recoveries were ideal. Also, the RSD values ranged from 0.1-2.8%, indicating excellent repeatability.

Conclusion

The EDGE was successfully used alone and in conjunction with acid prehydrolysis to extract the fat from various food matrices with excellent recoveries and RSDs for both methods. The EDGE extracted, cooled, and collected the fat extracts in less than 15 minutes. Foods that are considered low-fat, medium-fat, and high-fat were all extracted, indicating that this is a versatile method that can be used for a wide variety of matrices. Also, the fat extract obtained from the EDGE was intact, enabling its further analysis. The EDGE provides an option for fat extractions using prehydrolysis methods and a method not requiring hydrolysis, making it a flexible tool that meets the needs of fat extraction laboratories.

Table 1. Sample Size for Each Food Matrix

Matrix	Sample Size (g)
Raw Eggs	3
Coconut Flour	2
Nutella	1
Chocolate Bar	2
Hazelnut Paste	1
Peanut Butter	1

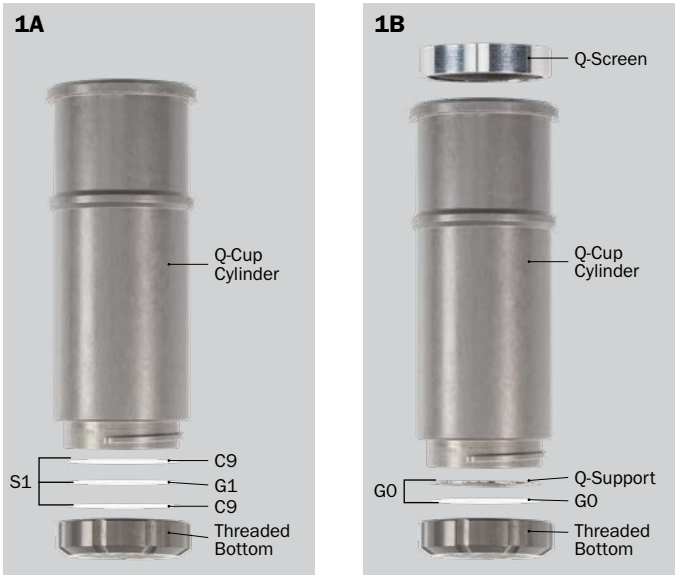

Figure 1. Positioning of the G1 and C9 Q-Discs, used in the extraction of the non-hydrolyzed samples (**A**) and the positioning of the Q-Support and G0 Q-Disc, a combination called G0 used in the extraction of the hydrolyzed samples (**B**).

Table 2. Fat Recoveries for Soxhlet Extraction, EDGE Extraction, and Prehydroylzed EDGE Extraction

	Soxhlet Method	Soxhlet Extraction (% Fat)	EDGE Extraction (% Fat)	RSD (%)	Recovery (%)	Prehydrolyzed EDGE Extraction (% Fat)	RSD (%)	Recovery (%)
Raw Eggs	AOAC 925.32	9.4	n/a	n/a	n/a	9.4	0.1	100.0
Coconut Flour	AOAC 922.06	13.3	13.2	0.5	99.2	13.8	0.3	103.8
Nutella	AOAC 922.06	31.3	30.1	0.7	96.2	30.6	0.9	97.8
Chocolate Bar	AOAC 963.15	29.2	28.7	0.6	98.3	27.7	0.1	94.9
Hazelnut Paste	AOAC 948.22	71.5	72.2	2.4	101.0	69.5	0.2	97.2
Peanut Butter	AOAC 948.22	51.8	49.8	0.8	96.1	50.2	2.8	96.9

United States (Headquarters)
800-726-3331
704-821-7015
info@cem.com

France
33 (01) 69 35 57 80
info.fr@cem.com

Germany, Austria, Switzerland
(49) 2842-9644-0
info@cem.de

Ireland
+353 (0) 1 885 1752
info.ireland@cem.com

Italy
(39) 35-896224
info.srl@cem.com

Japan
+81-3-5793-8542
info@cemjapan.co.jp

United Kingdom
(44) 1280-822873
info.uk@cem.com

www.cem.com