

Chlorella is rich in highly polar sphingolipids, which suppress colonic inflammation

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[Study objectives]

Colorectal diseases (ulcerative colitis, colorectal cancer, etc.) are increasing in East Asian countries including Japan, and one of the causes is thought to be the westernization of the diet. For example, the amounts of lipids, livestock products, and oil and fats taken from diet are about 3 times, 4 times, and 3 times higher, respectively, than those in 60 years ago. It is known that excessive intake of saturated fatty acids damages the intestinal barrier, and excessive intake of red and processed meat rich in n-6 polyunsaturated fatty acids and heme iron promotes intestinal inflammation.

Plant-derived lipids, particularly glycolipids, have been reported to have various actions that contribute to human health, including prevention of intestinal disorders. Chlorella contains various nutrients including fat-soluble ingredients, and it is known that the nutrients contained differ depending on the strain of Chlorella. In this study, we performed detailed analysis of lipids to evaluate the nutritional function of *Chlorella pyrenoidosa* species.

[Study method]

The highly polar sphingolipids and glycolipids as well as their fatty acid composition in dried powder of *Chlorella pyrenoidosa* were analyzed by gas chromatography mass spectrometry (GC-MS) to evaluate chlorella as a food to prevent colorectal diseases.

[Results]

- 1) Among the total lipids contained in *Chlorella pyrenoidosa*, n-3 polyunsaturated fatty acids such as α -linolenic acid account for 45.6 mol% of fatty acids. Of the n-3 polyunsaturated fatty acids, 62.2% are bound to glycolipids, and therefore their oxidative stability is considered very high (Table 1).
- 2) *Chlorella pyrenoidosa* contains about 5.7 g/100 g of glycolipids, of which monogalactosyl diacylglycerol (MGDG) is the major glycolipid.
The content of glycolipids in leafy vegetable such as spinach, parsley, and perilla leaf is about 0.5 to 2.0 g per 100 g dry weight. Therefore, chlorella is a plant food rich in glycolipids such as MGDG (Table 1).
- 3) The content of n-3 polyunsaturated fatty acids in *Chlorella pyrenoidosa* was about 2800 mg/100 g. Among them, the content of hexadecatrienoic acid, hexadecatetraenoic acid, and α -linolenic acid was 700 mg, 270 mg, and 1800 mg, respectively (Table 2).
- 4) *Chlorella pyrenoidosa* is rich in highly polar sphingolipids and the content is 73.5 mg/100 g, which is about 2 times that in rice bran (about 35.3 mg/100 g), a representative source of sphingolipids, and therefore *Chlorella pyrenoidosa* is considered to be a good source of highly

polar sphingolipids (Table 3).

The results of this study indicate that *Chlorella pyrenoidosa* is a diet containing abundant glycolipids rich in n-3 polyunsaturated fatty acids and highly polar sphingolipids with high oxidative stability, and may help prevent colon diseases such as ulcerative colitis and colorectal cancer.

Table 1. Lipid content and fatty acid composition in *Chlorella pyrenoidosa*

	Total lipids	Neutral lipids	Glycolipids	Phospholipids
Content g/100 g	16.6 ± 0.3	3.4 ± 0.3	5.7 ± 0.2	7.2 ± 0.3
Fatty acid composition mole%				
Saturated fatty acids	18.1	20.6	3.8	40.1
Monounsaturated fatty acids	16.6	18.1	7.0	23.8
Polyunsaturated fatty acids	65.3	61.3	89.2	36.1
(n-3 series)	45.6	39.1	71.4	20.4

Table 2. Types and contents of main fatty acids in *Chlorella pyrenoidosa*

		(mg/100 g)
Saturated fatty acids		Palmitic acid 920, stearic acid 170
Monounsaturated fatty acids		Oleic acid 370, octadecenoic acid 370
Polyunsaturated fatty acids	n-3 series	α-linolenic acid 1800, hexadecatrienoic acid 700, hexadecatetraenoic acid 270
Polyunsaturated fatty acids	n-6 series	Linoleic acid 930

Table 3. Content of highly polar sphingolipids in *Chlorella pyrenoidosa* and comparison with rice bran

				(mg/100 g)
Chlorella	Brown rice	Polished rice		Rice bran
73.5	13.3	2.5		35.3

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Author: Shinji YAMASHITA¹, Taiki MIYAZAWA², Ohki HIGUCHI², Hideo TAKEKOSHI³,

Teruo MIYAZAWA² and Mikio KINOSHITA¹

Affiliation: ¹Department of Life Sciences, Obihiro University of Agriculture and Veterinary Medicine, Obihiro 080-855, Japan

²Food Biotechnology Innovation Project, Industry Creation Hatchery Center (NICHe), Tohoku University, Sendai 980-8579, Japan

³Production and Development Department, Sun Chlorella Co., Ltd., Kyoto 600-8177, Japan

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