

Quality
is in our nature



Gamma-Linolenic Acid (GLA)

Fighting inflammation



Essential fatty acids (EFAs), like omega-3 and omega-6, are not produced by the body and must be obtained through diet or supplementation.¹ Omega-3s are important for proper neural, visual and reproductive function while omega-6s are critical for proper tissue development.

Both types of fatty acids play a role in generating anti-inflammatory compounds in the body. It is recommended that omega-6 and omega-3 fatty acids be consumed in a ratio of approximately 4:1 to maximize health benefits.²

Gamma-linolenic acid (GLA) is an omega-6 fatty acid made in the body from the essential omega-6 fatty acid, linoleic acid (LA). While young, healthy individuals can synthesize GLA from LA, a large percentage of the population is unable to produce GLA effectively due to dietary deficiencies, alcohol abuse, smoking, viral infection, medical conditions or aging.³ Dietary supplementation with GLA ensures adequate levels of long chain omega-6 fatty acids are present in the body.



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The primary sources of GLA are commercialized plant seed oils, namely borage (*Borago officinalis*), evening primrose (*Oenothera biennis*) and black currant (*Ribes nigrum*). Microorganisms that produce GLA include cyanobacteria (*Spirulina maxima* and *S. platensis*) and fungi (i.e. *Mucor javanaicus* and *Mortierella isabellina*). Small amounts of GLA are also found in human milk and organ meats.²

Borage oil contains the highest level of GLA (22-25%); evening primrose oil the lowest (8-10%); and black currant oil values are

intermediate (~15%). Hemp (*Canabis sativa* L) seeds, a relatively new introduction to the GLA market, contain about 40% oil, with 2-3% GLA. Other sources of GLA in development include Echium (*Echium plantagineum*) oil (10-11%), and biotechnology-derived safflower (35%) and canola (36-40%) oils.

While evening primrose is the most established source of GLA in the market, borage is becoming the preferred source due to its high seed oil content and high proportion of GLA.⁴



Health Benefits

Linoleic acid (LA) is the precursor for the synthesis of long chain omega-6 fatty acids—gamma-linolenic acid (GLA), dihomo-gamma linolenic acid (DGLA) and arachidonic acid (AA). Not all these omega-6s behave the same. LA and AA promote inflammation increasing the risk of chronic disease; whereas GLA, through the formation of DGLA, may reduce inflammation.

By adding GLA in the diet, the rate limiting conversion of LA to GLA can be avoided resulting in more efficient production of long chain omega-6 fatty acids and eicosanoids.⁵ Eicosanoids like prostaglandins and leukotrienes aid in regulating pain, swelling and inflammation, water retention, blood clotting, nerve transmission, allergic response, steroid production, and hormone synthesis.⁵

Dietary GLA is converted directly to DGLA. Increased levels of DGLA promote synthesis of anti-inflammatory metabolites⁶ (i.e. 1-series prostaglandins (PGE₁)) and reduce biosynthesis of AA derived pro-inflammatory metabolites (i.e. 2-series prostaglandins, 4-series leukotrienes and platelet activating factor).

Many of the beneficial effects of GLA are attributed to increased tissue levels of PGE₁ known to suppress chronic inflammation.⁷ The most promising research demonstrates efficacy of dietary GLA in the treatment of rheumatoid arthritis and other inflammatory disorders.⁸ Numerous clinical studies

have demonstrated that GLA supplementation reduces joint pain, swelling and tenderness, and decreases the need for non-steroidal inflammatory drugs.^{9,10}

GLA has been found to be effective in treating diabetic neuropathy¹¹ (loss of peripheral nerve function), atopic eczema¹², cyclical mastalgia (premenstrual breast pain)⁷, aging and hyperactivity disorders. It could be considered a novel anti-tumor agent in treating certain cancers like breast¹³, prostate, ovarian and pancreatic carcinomas⁹ and human gliomas.¹⁴

Animal and/or human studies investigating the role of GLA in cardiovascular health have shown that dietary GLA reduces LDL-cholesterol¹⁵, plasma triacylglycerols¹⁶, blood pressure and smooth muscle proliferation.¹⁷

GLA may also be useful with dry eye conditions since PGE₁ is linked with healthy mucosal tissue and tear film.^{18,19} Inconsistent results have been found for its effect on multiple sclerosis.²⁰ New research shows GLA could be a potential therapeutic for chronic fatigue syndrome.²¹

Biological activity of various sources of GLA remains unclear - research is continuing to evaluate GLA clinical efficacy.



Applications

Conventional solvent extraction, cold pressing or supercritical fluid extraction can be used to extract GLA from plants. The chosen method depends on seed type, desired market attributes, product form, and cost. Processing research is investigating the best way to concentrate or enrich GLA content.

GLA is used as a natural health product and dietary supplement, usually taken in capsule form and often sold in combination with flaxseed or fish oils, or minerals and vitamins. GLA is commonly used in cosmetic products like lotions, creams and shampoos. New technologies for encapsulating

oils and manufacturing EFA powders are providing options for inclusion of GLA in food products, including breads and beverages.

Evening primrose oil was granted approval for the treatment of atopic eczema in the United Kingdom in 1988 and subsequently approved for pharmaceutical use in many countries. Canada's Bioriginal Food and Science Corporation has been granted GRAS (Generally Recognized As Safe) status in the U.S. for its BioAsteri product—a GLA functional food ingredient made from borage oil and available in both oil and powder forms.



Canadian Research Expertise

Canadian Centre for Agricultural Research in Health and Medicine (CCARM)

St. Boniface General Hospital

Winnipeg, MB

- Investigating health benefits of functional ingredients on cardiovascular disease and its determinants (**G. Pierce**)
- Lipoprotein nutrition, metabolism and coronary heart disease (**M. Moghadasian**)

Richardson Centre for Functional Foods and Nutraceuticals

Winnipeg, MB

- Dietary factors controlling cholesterol and plant sterol metabolism in humans and in animal models; human dietary fatty acid absorption and oxidation; human energy metabolism (**P. Jones**)

University of Prince Edward Island

Canada Research Chair in Psychoneuroimmunology

Charlottetown, PE

- Study of omega-3/6 fatty acids to treat symptoms of neurodegenerative diseases such as Alzheimer's, multiple sclerosis and Parkinson's (**C. Song**)

University of Sherbrooke

Canada Research Chair on Use of Dietary Fatty Acids and Cognitive Functions During the Aging Process

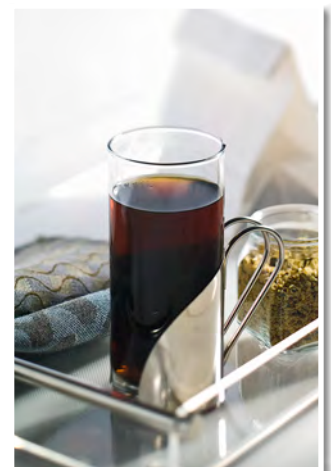
Sherbrooke, QC

- Effect of PUFAs on cognitive functions (**S. Cunnane**)

University of Toronto

Toronto, ON

- Nutrition and metabolism of lipid-lowering ingredients in functional foods (**D. Jenkins, C. Kendall**)



Canadian Suppliers

- **Bioriginal Food and Science Corporation**
Saskatoon, SK | www.bioriginal.com
- **Manitoba Harvest**
Winnipeg, MB | www.manitobaharvest.com
- **CHI Hemp Industries Inc.**
Victoria, BC | www.chii.ca
- **Omega Nutrition Canada Inc.**
Vancouver, BC | www.omeganutrition.com
- **Hemp Oil Canada, Inc.**
Ste. Agathe, MB | www.hempoilcan.com
- **Ruth's Hemp Foods**
Toronto, ON | www.ruthshempfoods.com
- **Hempola**
Barrie, ON | www.hempola.com

The Canadian Advantage in the Global Marketplace

Quality
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Natural Resources • Canada's abundant natural resources are proven building blocks for a high tech industry that produces an array of high quality agri-food products.

World-Class Standards • Canada's regulatory and food inspection systems are internationally recognized, resulting in world-class standards and products that are safe, nutritious and high quality.

Innovative Research • Canada has developed a strong network of research facilities across the country where scientific innovators are focused on developing leading-edge products and new technologies.

Collaborative Teamwork • Collaboration among governments, health institutions, universities and industry has helped this vibrant sector prosper by encouraging innovation and manufacturing of diverse agri-food products with proven health benefits.

To learn more about Canada's functional food and natural health products industry, visit: www.agr.gc.ca

Agriculture and Agri-Food Canada
1341 Baseline Rd., Tower 5, 2nd Floor
Ottawa, Ontario K1A 0C5
E-mail: ffn-afn@agr.gc.ca

References

1. Stuchlik, M. and S. Zak. 2002. Biomed. Papers 146:3-10.
2. Kris-Etherton, P.M. 2000. Am. J. Clin. Nutr.71:179-188.
3. Horrobin, D.F. 1992. Prog. Lipid Res.31:163-194.
4. Laurence, R. 2004. RIRDC Publication 04/040. Australian Government: Rural Industries Research and Development Corporation. Accessed at <http://www.rirdc.gov.au/reports/EOI/04-040.pdf>
5. Pass, E. and G. Pierce. 2002. Evening primrose oil. Accessed at <http://www.sbrc.ca/ncarm/epo.htm>
6. Johnson, M.M. *et al.*, 1997. J. Nutr. 127:1435-1444.
7. Horrobin, D.F. and M.S. Manku. 1989. Prostaglandins Leukot Essent Fatty Acids. 37:255-261.
8. Kapoor, R. and Y.S. Huang. 2006. Curr. Pharm. Biotechnol. 7:531-534.
9. Calder, P.C. and R.B. Zurier. 2001. Curr. Opin. Clin. Nutr. Metabol. Care 4:115-121.
10. Zurier, R.B. *et al.*, 1996. Arthritis and Rheumatism 39:1808-1817.
11. Jamal, G.A. 1994. Diabetic Med. 11:145-149.
12. Morse, N.L. and P. M. Clough. 2006. Curr. Pharm. Biotechnol. 7:503-524.
13. Menendez, J.A. *et al.*, 2005. J Natl Cancer Inst. 97:1611-5.
14. Das, U.N. 2007. Med. Sci. Monitor 13:RA119-131.
15. Fukushima, M. *et al.*, 1997. Lipids 32:1069-1074.
16. Laidlaw, M. and B.J. Holub. 2003. Am J. Clin. Nutr.77:37-42.
17. Fan, Y.Y. *et al.*, 1997. J. Nutr.127:1765-1771.
18. Barabino, S. *et al.*, 2003. Cornea 22:97.
19. Furse, R.K. *et al.*, 2001. J. Immunol. 167:490.
20. McGregor, L. 1989. Acta Neurolog. Scand. 80:23-27.
21. Pur, B.K. 2007. J. Clin. Pathol 60:122-124.

Author: C.A. Patterson, PhD, PAg
The Pathfinders Research & Management Ltd.

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