



Courtesy of Canola Council of Canada

Plant sterols or phytosterols and their esters are natural, fat-like compounds structurally similar to cholesterol.

Commonly known sources include vegetables, fruits, legumes, vegetable oils (i.e. safflower, sunflower, corn, soy, olive, canola) and tall oil - a by-product of the coniferous wood pulp industry.

More than 50 years of research has proven natural plant sterols can effectively lower blood cholesterol,¹ enhance the immune system and decrease the risk of certain cancers.²



Phytosterols and Stanols Healthy Canadian Ingredients

Over 40 plant sterols have been identified with β -sitosterol, stigmasterol and campesterol being the most abundant. These sterols are usually present as free sterols or fatty acid esters. Plant stanols are saturated sterols (contain no double bonds in the chemical structure) and are less abundant in nature than sterols. Stanols are more resistant to oxidation and are as effective as sterols in reducing cholesterol absorption.

Health Benefits

Cholesterol, the predominant sterol in animals, is produced by the human body and obtained through diet. The human body requires cholesterol as it is a precursor for steroid hormones like testosterone and estrogen,³ bile acids, and serves as a stabilizer for cell membranes. High blood total cholesterol and low-density lipoprotein (LDL) cholesterol levels are the main risk factors for coronary heart disease⁴ (CHD) and other diseases related to atherosclerosis. LDL is the major cholesterol carrier in the blood.

Plant sterols differ from cholesterol by the presence of a methyl or ethyl group in the side chain. This difference prevents plant sterols and stanols from being absorbed in the intestines. Most ingested plant sterols pass through the gut and are excreted.⁵ Phytosterols also compete with cholesterol absorption and uptake in the small intestine⁶ thereby reducing the level of cholesterol in the blood stream and reducing the risk of CHD. Phytosterols have no effect on the levels of triacylglycerol or HDL cholesterol.⁶

Sterols and stanols complement a healthy diet low in saturated fat and cholesterol and high in fruits, vegetable and whole grains. Studies show daily intake of 2-3 g sterols⁷ and/or stanols lowers LDL cholesterol levels by 10% and likely lowers CHD risk by 12-20% in the first 5 years and by 20% over a lifetime.⁸ By combining phytosterols with other functional ingredients, like soy protein and viscous fibers in a low saturated fat diet, cholesterol levels can be reduced by up to 35%.⁹ Studies also demonstrate that plant sterols provide a safe, additional cholesterol lowering effect when used with statins.⁷ In some cases the addition of phytosterols to statin therapy had the effect equivalent to doubling the dose of statin on the levels of LDL cholesterol.¹⁰

Based upon results of clinical studies, plant sterols appear to be safe^{8,11,12} and non-toxic.^{13,14} No effect has been found on the reproductive system.^{15,16} The Food and Drug Administration (FDA) in the U.S. have granted plant sterols/stanols GRAS (generally recognized as safe) status and the EU's Scientific Committee on Foods has concluded phytosterol ester margarines and dairy products are safe for human consumption.¹⁷ The FDA also approved a health claim about how foods containing plant sterol/stanol esters may reduce the risk of coronary heart disease¹⁸ by reducing blood cholesterol levels when they are part of a diet low in saturated fat and cholesterol.



Innovative Applications

Phytosterols from vegetable oils (i.e. canola, soybean, sunflower, corn) are a by-product in the isolation of tocopherols (vitamin E) and are recovered from deodorizer distillate during oil refining.¹⁹ Sterols are purified by crystallization.

Free, non-esterified phytosterols¹⁷ from tall oil are the result of the digestion of coniferous woods. These sterols are recovered by solvent extraction, distillation and recrystallization. Tall oil contains significant levels of β -sitosterol, campesterol and the naturally occurring stanol compounds sitostanol and campestanol.

A Canadian company, Forbes Medi-Tech, has marketed its tall oil-derived phytosterol product Reducol[®] in the U.S., Australia and the E.U.

Comparison of sterol composition—wood or vegetable oil derived

Sterol	Relative content (% w/w of total sterols)	
	Wood-derived	Vegetable oil-derived
<i>Sitosterol</i>	72	45
<i>Campesterol</i>	8.2	26.8
<i>Sigmasterol</i>	0.3	19.3
<i>Brassicasterol</i>	0	1.6
<i>Sitostanol</i>	15.3	2.1
<i>Campestanol</i>	1.6	0.8
<i>Other minor sterols</i>	2.6	4.4

Esterification of plant sterols and stanols with long chain fatty acids increase their solubility in fats and oils facilitating incorporation into foods. This gives sterols and stanols the desired physical characteristics. Free sterols and stanols are poorly soluble in fat or water phases making it difficult to incorporate the free forms into foods. However, microcrystalline, lecithin-solublized forms and sterols dissolved in diacylglycerol appear to work in low-fat foods.²⁰ Research studies have shown food matrix and emulsification processes affect the efficacy of free sterols and stanols and stress the importance of evaluating new food forms for efficacy if they differ greatly from previously tested forms.²¹

Several studies have shown the efficacy of esterified plant sterols in a variety of low fat foods^{22- 25} prompting various multinational food companies to include phytosterols in specific food formulations.

Current and Potential Applications of Phytosterols in Foods

Current Uses	Potential Uses	Novel Forms
Margarines, fat spreads, soft spreadable cheeses, mayonnaise, salad dressings, low fat dairy products, milks, yoghurts and cheeses, snack and energy bars, fry oils	Baked pastry products, egg noodles and pasta, custard, ice cream, frozen desserts, muesli, bars and soups, meat products, rice beverages, cereal grains and flours, food flavourings and coffees	Encapsulation with egg proteins to increase bioavailability in foods Water soluble powders for inclusion in beverages (orange juice) and non-fat foods

Canadian Research Expertise

Canadian Centre for Agrifood Research in Health and Medicine (CCARM) (Winnipeg, MB)



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(St. Boniface General Hospital Research Center)

– Investigating the health benefits of functional ingredients on cardiovascular disease and its determinants (G. Pierce)
– Lipoprotein nutrition, metabolism and coronary

heart disease (M. Moghadasian)

Institute of Nutraceuticals and Functional Foods (INAF) (St. Foy, QC)

– Nutrition, functional foods and cardiovascular health (B. Lamarche)

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 British Columbia (Vancouver, BC)

– Research studies in dyslipidemias, atherosclerosis, phytosterols in medicine, genetic determinants of response to inflammation and atherosclerosis, and HDL metabolism as well as clinical trials of new lipid lowering medications (J. Frolich)

University of Toronto (Toronto, ON)

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



Courtesy of Saskatchewan Pulse Growers

Canadian Suppliers

1. *Cognis Canada Corp.* (Mississauga, ON)
<http://www.cognis.com>
2. *Forbes Medi-Tech Inc.* (Vancouver, BC)
<http://www.forbesmedi.com>

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