

## Phytosterols and Phytostanols Effect on Health

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**Received:** October 25, 2017; **Published:** November 11, 2017

Phytosterols (PS) are triterpenes with a very similar chemical structure to cholesterol, which stabilize phospholipid bilayers in plant cell membranes [1]. PS can be occurred in saturated form (which is called phytostanols) or in unsaturated form. Human cannot synthesize them, therefore, the PS are available orally from vegetables, plant oils, plant extracts, or plant origin supplements such as vegetable oils, nuts, seeds, grain products, fruits and vegetables [2]. The intake of naturally occurring PS from the general diet is about 200 - 400 mg/d [3], and the daily intake of phytostanols is about 30 - 50 mg/day [4].

PS have many technological and nutritional characteristics. They can be used to detect vegetable oil purity and adulteration [5]. Some of them are antioxidants and can affect vegetable oil stability. PS may be useful in prevention of both cardiovascular diseases (CVD) and cancer. PS are absorbed in smaller proportion (less than 5% for  $\beta$ -sitosterol and 16% for campesterol) than cholesterol (56%) [6]. PS interfere with cholesterol absorption, and thereby reduce serum total and low-density lipoprotein (LDL) cholesterol levels [7]. Phytostanols reduce cholesterol absorption more than phytosterols. As an example, sitosterol can reduce cholesterol absorption by 50%, whereas sitostanol can reduce it by 85% [8].

Daily consumption of foods fortified with PS in amounts of up to 2 g/day is equally effective in lowering plasma atherogenic LDL-C levels by up to 10%, and thus may reduce cardiovascular diseases risk. At higher daily intakes (9 g/day), the effects of phytostanols appear more pronounced [9].

In mammals, the central nervous system (CNS) is the most cholesterol rich organ by weight. Cholesterol metabolism is tightly regulated in the CNS and all cholesterol available is synthesized in situ. Recent studies indicate that a disturbed cholesterol metabolism is involved in CNS disorders, such as Alzheimer's disease, multiple sclerosis, and amyotrophic lateral sclerosis. In contrast to circulating cholesterol, dietary PS, can cross the blood-brain barrier and accumulate in the membranes of CNS cells. Therefore, the physiological roles of PS in the healthy and diseased CNS should be more studied [10].

In PS effect on LDL reduction, food composition is also important [11,12]. Besides the type of food carrier used, the frequency and the time of intake seems to be important as well [11].

In addition to their cholesterol-lowering actions, PS possess anti-cancer effect against cancer of the prostate, colon, lung, stomach, ovary and estrogen-dependent human breast cancer [13,14]. It has been speculated that PS inhibit the production of carcinogens, cancer-cell growth, invasion and metastasis, and promote apoptosis of cancerous cells. PS consumption may also increase the activity of antioxidant enzymes and thereby reduce oxidative stress [14].

In recent years, other biological properties have also been associated with the consumption PS, such as anti-inflammatory, anti-atherogenic, and antioxidant activities, as well as antipyretic, and antidiabetic properties [15].

PS are susceptible to oxidation (either via enzymes or autoxidation) to form hydroxy, epoxy, keto and triol derivatives which are collectively known as phytosterol oxidation products (POP). These derivatives have different biological functions. POP may cause atherogenicity and inflammation. They have also distinct levels of cytotoxicity [16]. Indeed, POP have been reported to exert, *et al*, cytotoxic effects comparable to those attributed to cholesterol oxidation products.

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Volume 12 Issue 1 November 2017

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