Elevated total cholesterol and low-density-lipoprotein (LDL) cholesterol concentrations are well-established risk factors for coronary heart disease (CHD).\textsuperscript{1} Outcomes from large clinical trials suggest that lowering total and LDL cholesterol levels with hydroxymethylglutaryl-coenzyme A reductase inhibitors (statins) reduces the morbidity and mortality associated with heart disease. Statins are also the preferred agents for decreasing LDL cholesterol levels.\textsuperscript{1}

Unfortunately, not all patients attain their lipid goals with statin therapy alone.\textsuperscript{1} The 2004 National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) guideline update supports aggressive LDL cholesterol reductions to as low as 70 mg/dL for additional benefit in certain patient populations.\textsuperscript{2} This poses a potential therapeutic problem if the degree of reduction required from baseline exceeds the LDL-cholesterol-lowering capacity of available statins.

Another example of such a problem is the patient on maximal doses of statins who has reached his or her treatment goal but experiences dosage-related adverse effects, such as myalgias or elevations in liver transaminases. Although statin discontinuation is not always warranted in this situation, a dosage reduction resulting in less-effective LDL cholesterol management may be considered if statins are deemed the causative agent.\textsuperscript{3} Combination therapies may be warranted in this case to boost the LDL-cholesterol-lowering effectiveness of the lower-dose statin.

Further, not all patients with hypercholesterolemia will need a statin. For patients with no or one risk factor for heart disease (LDL cholesterol goal of <160 mg/dL),

Purpose. The efficacy and safety of phytosterols for the management of dyslipidemia are reviewed.

Summary. Phytosterols have been evaluated in over 40 clinical trials. The incorporation of 2 g of phytosterols daily into margarine, mayonnaise, orange juice, olive oil, low-fat milk, yogurt, and tablets is associated with significant reductions in low-density-lipoprotein (LDL) cholesterol from baseline over 1–12 months in adults with normal or high cholesterol, in children, and in patients with type 2 diabetes mellitus. Phytosterol dosages of 1.6–3 g daily have been shown to reduce LDL cholesterol by 4.1–15\% versus placebo within the first month of therapy. One meta-analysis found mean reductions of 10–11\%, but results vary. Several placebo-controlled trials found that the addition of phytosterols to statin therapy was associated with reductions of 7–20\% in LDL cholesterol for up to 1.5 years. Overall, phytosterols are useful for reducing LDL cholesterol in patients who cannot reach their treatment goal by diet alone or who are taking maximum tolerated doses of statins. These products offer an alternative to statins in patients who cannot take statins or whose statin dosage is restricted because of potential drug interactions or concomitant diseases. Commonly reported adverse effects are primarily gastrointestinal in nature.

Conclusion. Phytosterol therapy produces an average 10–11\% reduction in LDL cholesterol concentration, but it is unknown whether this effect persists beyond two years. Phytosterol products are well tolerated and have few drug interactions, but their long-term safety has not been established. Current evidence is sufficient to recommend phytosterols for lowering LDL cholesterol in adults.

Index terms: Dosage; Drug interactions; Hypercholesterolemia; Phytosterols; Toxicity
Phytosterols

The Clinical Consultation section features articles that provide brief advice on how to handle specific drug therapy problems. All articles are based on a systematic review of the literature. The assistance of ASHP’s Section of Clinical Specialists and Scientists in soliciting Clinical Consultation submissions is acknowledged. Unsolicited submissions are also welcome.

therapeutic lifestyle changes that include a diet low in saturated fat, low in cholesterol, and high in fiber and daily physical activity may be enough to satisfy lipid goals. Patients with moderate risk (LDL cholesterol goal of <130 mg/dL) may not necessarily require statin therapy, depending on the severity of risk factors.1 Patients with active acute liver disease or unexplained liver enzyme elevations should not take statins.3,4 For over 50 years, plant sterols and stanols have been known to reduce total and LDL cholesterol.1,5 The NCEP1 and the American Heart Association4 recognize the benefits of plant sterols and stanols—collectively known as phytosterols—as an adjunct to therapeutic lifestyle changes in adults with elevated cholesterol levels. Two grams of esterified phytosterols daily achieves an approximate 9–20% reduction in LDL cholesterol in dyslipidemic patients, including those already taking statins.1,4

This article reviews the efficacy and safety of phytosterols in the management of dyslipidemia.

Chemistry

Sterols are an important part of the physiology of cell membranes.4 Cholesterol, a sterol produced by mammals, provides structural integrity to cell membranes and affects the fluidity of the cell. Plants produce plant sterols. While over 40 types of plant sterols exist, the three most abundant varieties are sitosterol, campesterol, and stigmasterol. Plant sterols are present in small amounts in fruits, vegetables, nuts, seeds, legumes, and edible oils; marketed sources are primarily derived from soybean and pine tree oil. Plant stanols are hydrogenated or saturated versions of plant sterols and are found in similar dietary sources. It is theorized that the chemical modification from a sterol to a stanol improves the LDL-cholesterol-lowering capacity. In contrast to plant sterols, plant stanols are minimally absorbed through the gastrointestinal tract.6 The typical total plant phytosterol dietary consumption in the Western diet is 150–350 mg daily.7,8

Phytosterols closely resemble the structure of cholesterol, differing only by their side chains.8 Early studies of up to 18 g of ground crystalline phytosterol daily produced varying lipid-lowering effects.8,9 Unpleasant taste and large bulky dosages prompted the use of phytosterol esterification, a process that augments lipid solubility in foods and increases delivery of the product to the small intestine. Esterification reduced the effective dose to 1/10 of the original total daily dose needed.10 Unesterified versions may be combined with lecithin to avoid the need to disperse the phytosterols in a fatty matrix.11

Mechanism of action

Esterified phytosterols are hydrolyzed by cholesterol reductase postprandially in the small intestine to active forms.12 Thus, it is important for the products to be consumed with meals for activation to occur. Free phytosterols are then available to limit cholesterol absorption and displace it from incorporating into micelles. Plant stanols may also promote increased movement of cholesterol into the intestinal lumen by inducing expression of adenosine triphosphate binding cassette transporter 1, causing increased cholesterol elimination in the feces.13-15 Although reductions of up to 40% in dietary cholesterol absorption have been observed with plant stanol administration, a compensatory increase in cholesterol synthesis counteracts some of this effect.16 Plant sterols produce similar effects on cholesterol absorption.

Clinical studies

Phytosterols have been evaluated in over 40 clinical trials. Overall, the incorporation of 2 g of phytosterols daily into margarine, mayonnaise, orange juice, olive oil, low-fat milk, yogurt, and tablets is associated with significant reductions in LDL cholesterol from baseline over 1–12 months in adults with normal or high cholesterol levels, in children, and in patients with type 2 diabetes mellitus.3,17,18 The use of 1.6–3 g of esterified phytosterols daily has been shown to reduce LDL cholesterol by 4.1–15% versus placebo within the first month of therapy.7 One meta-analysis observed mean reductions in LDL cholesterol of 10–11%, but results vary.7

In a study by Miettinen et al.,19 153 hypercholesterolemic patients replaced 24 g of their daily dietary fat intake with margarine with or without sitostanol ester 2.6 g for 6 months. After the 6 months, patients taking the sitostanol ester took a reduced daily dose of 1.8 g, while the other group remained on the 2.6-g dose. The group taking the higher dosage experienced additional reductions in LDL cholesterol at 12 months, averaging 14% from baseline. The group treated with half the dose after 6 months maintained serum cholesterol levels present at 6 months at the 12-month evaluation but did not further reduce LDL cholesterol.

Increasing the phytosterol daily dose beyond 3 g does not offer additional benefit and, in some cases, has been shown to be inferior to dosages limited to 2 g daily.15,19,20 Dosages of <1 g do not offer a benefit.5,16 The full effects of therapy may take up to eight weeks. High-density lipoprotein (HDL) cholesterol concentrations and triglycerides are not con-
sistently affected, though a recent nine-week trial in which patients with metabolic syndrome received 2 g of stanol esters daily revealed significant reductions in non-HDL cholesterol (12.8%, \( p = 0.011 \)) and triglycerides (27.5%, \( p = 0.044 \)) versus placebo. 16,21 The different types of phytosterol products, wide range of daily doses, inclusion of studies with small populations, and short trial durations may have influenced the findings of these analyses.

Direct trials comparing the efficacy of plant stanols to plant sterols are limited, though both have produced similar reductions in LDL cholesterol in most short-term studies. 6 Plasma sterol levels increase when patients take plant sterols but not with plant stanols. 22,23 There is also a concern that effectiveness diminishes over time, attributable to a theoretical reduction in cholesterol excretion into the bile. 6 A few long-term (over one year) trials have suggested that there is no difference in efficacy between plant sterols and plant stanols in patients with normal and elevated cholesterol levels, but these results are inconsistent. 24,25 Free (unesterified) versions also have similar effects but have been studied less than the esterified products. 7 Unfortunately, the maximum study duration for phytosterols in the literature is less than two years. More comparative trials of longer durations are needed to evaluate the persistence of effectiveness over time.

The source of phytosterols (e.g., soybean, pine tree oil) and the type of food or formulation in which the phytosterol is dispersed do not appear to have affected efficacy in most studies. 5 Food matrices containing phytosterols that are lower in fat appear to produce similar results as those that are higher in fat. 26 One trial noted improved reductions in LDL cholesterol with the same amount of phytosterols (1.6 g daily for three weeks) in a low-fat milk source compared with bread and cereal. 27

It is important to note that unlike statins, no controlled trials to date have investigated the effect of phytosterols on the morbidity and mortality associated with heart disease. Animal models suggest that phytosterols prevent the formation of cholesterol-induced atheromas in a dose-dependent fashion 26,29 but do not promote regression of existing atherosclerotic plaque. 30 A few small trials observed a reduction in C-reactive protein after the initiation of phytosterol monotherapy and in combination with statins, but others did not observe this reduction. 31-34 More research is warranted to determine the effects of phytosterols on C-reactive protein. Overall, epidemiologic projections hypothesize that consuming phytosterols as esters or in free form will reduce coronary lifetime risks by 20%. 17

Combination with other lipid-lowering agents

Statins. Phytosterols are not a substitute for statins in the secondary prophylaxis of heart disease; statins remain the first-line treatment in patients with a prior myocardial infarction. 1 Other high-risk populations indicated for initial treatment with a statin include patients with diabetes, carotid artery stenosis, stroke, transient ischemic attack, or a 10-year Framingham cardiac risk of >20%. Baseline LDL cholesterol concentrations that exceed the therapeutic goal by 30 mg/dL or more should also be considered for initial treatment with a statin.

Combination therapy with phytosterols is helpful for patients who do not reach their LDL cholesterol goal with statins alone. Patients treated with statins may experience a compensatory increase in cholesterol absorption, a pharmacologic target of phytosterols. 18 A subgroup analysis showed that patients who had markers suggestive of increased absorption and reduced production of cholesterol responded suboptimally to statin therapy in the landmark Scandinavian Simvastatin Survival Study. 35 This patient population appeared to have lower reductions in LDL cholesterol and cardiovascular complications compared with those of patients without markers for increased cholesterol absorption. Further study is needed to determine the importance of this finding. Phytosterols, which decrease the absorption of cholesterol and promote increased synthesis (via compensatory mechanisms), could potentially be the ideal treatment for this group of poor responders. 20

Several placebo-controlled trials found that the addition of phytosterols to existing statin therapy was associated with greater reductions in LDL cholesterol (7–20% for up to 1.5 years), though not all reductions were consistently deemed statistically significant. 36-42 Patients with higher baseline LDL cholesterol values while on statins appear to have the strongest response to the addition of phytosterols. 5 Some of these results are detailed in Table 1. The reduction associated with combining phytosterols with statins is higher than or comparable to the expected 5–7% reduction in LDL cholesterol that is seen with doubling the statin dose. 43 Phytosterols can be statin dose sparing, particularly in patients who are sensitive to adverse effects at higher statin doses or who are on restricted statin doses because of concomitant medications or diseases. 17

Other lipid-modifying agents. Triple therapy with statins, bile acid sequestrant, and margarine containing esterified phytosterol resulted in a 67% reduction in LDL cholesterol in one trial. 44 This therapy may be helpful in patients with resistant hyperlipidemia or who may not be able to tolerate maximum doses of phytosterols, statins, or both due to adverse effects.

When added to fibrates, margarine containing plant sterol is associated with an approximate 9%
**Phytosterols**

Several small studies found that phytosterols used alone or in combination with statins reduced LDL cholesterol in patients with diabetes mellitus. These reductions were similar to those observed in patients without diabetes mellitus (LDL cholesterol decreased 14%). Phytosterols do not appear to affect glucose control.16,47

### Phytosterols in diabetes mellitus

Phytosterols may offer an alternative for these patients in the future because they are minimally absorbed, unlike plant sterols. One pilot study evaluated the efficacy of at least 1 g of plant stanol daily during pregnancy and lactation.49 There was no change in LDL cholesterol or any other lipid value from baseline, but the dose used was subtherapeutic. More studies are needed, particularly using higher doses, to determine the role of plant stanols in this population.

Data regarding phytosterol use in children are limited. Plant stanols produce similar LDL cholesterol reductions in children as in adults with high cholesterol following a low-fat, low-cholesterol diet.50-54 One study evaluated the use of a mean 1.5 g of plant stanol ester in margarine daily to 81 healthy children older than six years. LDL cholesterol significantly decreased by 7.5% from baseline at three months ($p = 0.0001$).52

The American Heart Association and the NCEP do not specifically encourage the use of phytosterols in children. Due to limited data, phytosterols are not recommended in children less than six years of age.17

### Adverse effects

In general, phytosterols are well tolerated and recognized as safe.55-59 A meta-analysis of 42 randomized, double-blind, placebo-controlled trials found that adverse effects are generally mild, transient, and dose related.16 Commonly reported adverse effects are primarily gastrointestinal in nature (nausea, dyspepsia, diarrhea, constipation, flatulence, feces discoloration, gastroesophageal reflux, appetite changes). Phytosterols may result in reduced absorption and transport of hydrocarbon carotenes, specifically α-carotene, β-carotene, and lycopene.14 LDL cholesterol is also a carrier for fat-soluble vitamins, so if the levels are reduced, there is less transport. This is also observed with other lipid-lowering strategies such as cholestryamine and wheat.

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**Table 1. Changes in Low-Density-Lipoprotein (LDL) Cholesterol Associated with the Addition of Phytosterols to Existing Statin Therapy**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>n</th>
<th>Patient Characteristics</th>
<th>Statin Regimen</th>
<th>Phytosterol Regimen</th>
<th>% Change in LDL Cholesterol</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>148</td>
<td>Hypercholesterolemia, LDL cholesterol of ≥130 mg/dL</td>
<td>Varied</td>
<td>Stanol ester 5.1 g/day for 8 wk</td>
<td>−10</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>37</td>
<td>30</td>
<td>Familial hypercholesterolemia, triglycerides of &gt;250 mg/dL</td>
<td>Varied</td>
<td>Stanol ester 2.5 g/day for 8 wk</td>
<td>−11</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>38</td>
<td>75</td>
<td>Hypercholesterolemia, mean LDL cholesterol = 206 mg/dL</td>
<td>Cervinastin sodium 0.4 mg/day</td>
<td>Stanol ester 2 g/day for 4 wk</td>
<td>−7</td>
<td>0.29</td>
</tr>
<tr>
<td>42</td>
<td>54</td>
<td>Body mass index of &lt;32 kg/m², mean LDL cholesterol = 122 mg/dL</td>
<td>Varied</td>
<td>Stanol ester 2.5 g/day for 85 wk</td>
<td>−13.1</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sterol ester 2.5 g/day for 85 wk</td>
<td>−8.7</td>
<td>NSb</td>
</tr>
</tbody>
</table>

*aStatin plus phytosterol compared with statin plus placebo.

bNS = not significant.
Phytosterols

Phytosterols have been associated with a reduced risk of cardiovascular disease. However, the reduction of fat-soluble vitamins would have been concern that the absorption of fat-soluble vitamins would be reduced by phytosterols, though reductions are likely to be clinically insignificant.

Although the addition of high-fat products enriched with phytosterols may seem counterintuitive to a low-fat, heart-healthy diet, their consumption has been associated with significant increases in total body weight or body mass index. Subsequently, a meta-analysis of 42 trials of phytosterols did not observe significant changes in blood pressure or heart rate or concentrations of serum hepatic transaminases, glucose, uric acid, or blood urea nitrogen.

Recent animal and human studies suggest that phytosterols cross the blood-brain barrier. One trial in patients with hypercholesterolemia on statins and phytosterol supplements did not demonstrate significant changes in neurocognitive behavior or mood over 85 weeks.

Phytosterols have been associated with a shortened lifespan of red blood cells (RBCs) in rats, possibly because cholesterol is replaced by phytosterols in the erythrocyte membrane. It is theorized that the RBCs would become more fragile, resulting in anemias. RBC fragility was unaffected in one study using phytosterol-containing margarine in combination with statins. Anemia is not a common adverse effect of phytosterol use.

Other less-commonly reported adverse effects include increased mean thyrotropin and fibrinogen concentrations. Additional study is warranted to elucidate the significance of these findings.

Precautions and contraindications

There are a number of studies that suggest a positive association between elevated serum phytosterol concentrations and CHD risk. Others have found that moderately increased phytosterol levels are associated with a reduced risk of cardiovascular events.

Some investigators have expressed concerns that supplemental phytosterols could lead to atherosclerosis, based on the clinical experience with sitosterolemia; however, this idea is controversial. Sitosterolemia is an extremely rare inherited disorder associated with the accumulation of phytosterols, normal total cholesterol, anemia, and an elevated CHD risk. Since plant stanols are minimally absorbed and have a significantly shorter half-life than do plant sterols, it is theorized that this potential adverse effect is primarily associated with plant sterol supplementation. About 5% of consumed plant sterol supplements are absorbed.

Plant sterol oxidation also results in oxysterols, which are atherogenic. Nonetheless, oxysterols are not only seen in patients with sitosterolemia but in healthy patients. Until additional data accumulate, phytosterol supplementation should be avoided in patients with this disorder. Also, since it may be difficult to identify a patient with sitosterolemia, the use of phytosterols should be avoided in patients without high cholesterol.

Published data on the safety of phytosterols in pregnancy or lactation are limited. There is no evidence to suggest teratogenic effects in humans. Until additional experience becomes available, phytosterols are generally not recommended in pregnancy. One small animal study found that fewer pregnancies were associated with local intravaginal and intrauterine application of phytosterols. The significance of this remains to be determined, since these routes are not used for phytosterols. Higher oral doses in animals are associated with reduced sperm concentration and testicular weight.

Drug interactions

Drug interactions with phytosterols are minimal. No significant pharmacokinetic interactions have been noted between statins and phytosterols to date. Cholestyramine administration should be separated from phytosterol use by two to four hours to avoid binding of the latter in the gut.

Vitamin K levels are not affected by the consumption of phytosterols. A small study of patients taking 4.5 g of phytostanols for eight weeks concomitantly with warfarin did not show a change in the International Normalized Ratio. The dosage of anticoagulants should not be affected by concomitant administration of phytosterols.

Dosing and administration

The safest and most effective supplemental dosage of phytosterols referenced by most sources is approximately 2 g daily. The accepted dosing range is generally 1–3 g daily. Daily doses of <1 g are not effective, and daily doses beyond 2–3 g do not show...
Phytosterols are useful for reducing LDL cholesterol in patients who cannot reach their LDL cholesterol goals by diet alone (lower-risk groups) or who are taking maximum tolerated doses of statins (higher-risk groups). These products offer an alternative to statins in patients who cannot take statins (active liver disease) or whose statin dosage must be restricted because of potential drug interactions (concomitant fibrate administration) or diseases (renal disease). Patients with normal cholesterol levels should not be encouraged to take these products based on a lack of efficacy and safety data in this population.

The NCEP ATP III does not differentiate between stanol esters or sterol esters. Therefore, product selection can be based on patient preference and cost. Of course, patients’ taste preferences and convenience preferences should also be considered early. Cost is another concern with some of the products. Phytosterol-containing foods are typically more expensive than the same foods without phytosterols. Some patients, in an effort to save money, may ask whether cholesterol lowering is observed with smaller serving sizes than recommended. It is not known if a benefit would be observed, though some products with higher concentrations of phytosterols may offer a benefit at lower doses. FDA allows products to claim that their use reduces patients’ risk of heart disease if they contain the following daily amounts: 1.3 g of plant sterol esters, 3.4 g of plant stanol esters, or 800 mg of free phytosterols. One A Day Cholesterol Plus (Bayer Healthcare) does not contain this specified amount and should not be recommended for cholesterol lowering.

Patients should consider the caloric and fat content of available products to avoid excessive intake. The fat content in some food sources such as margarine contributes to increased saturated fat consumption. While the phytosterol-containing spreads may be a good substitute for patients desiring a replacement for regular margarine or butter, they may not be the best way to introduce phytosterols into a diet that does not already incorporate butter spreads. Because of the sugar content and acidity, orange juice formulations should be used with caution in patients with diabetes mellitus and reflux esophagitis. Dairy products containing phytosterols may be useful in patients trying to increase their calcium intake through diet, though these products may not be available in all markets.

Phytosterols supplied as supplements are another alternative but will contribute to the overall “pill burden” for the patient. It is important to clarify to patients that vitamins containing phytosterols must be taken

### Table 2. Selected Phytosterol-Containing Products

<table>
<thead>
<tr>
<th>Product (Manufacturer)</th>
<th>Phytosterol Content</th>
<th>Product Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benecol Light Spread (Unilever)</td>
<td>1000 mg/tbsp</td>
<td>1 tbsp twice daily</td>
</tr>
<tr>
<td>Benecol Light Spread (McNeil Nutritional)</td>
<td>850 mg/tbsp</td>
<td>1 or 2 tablets daily</td>
</tr>
<tr>
<td>Smart Balance Omega Plus (Smart Balance)</td>
<td>450 mg/tbsp</td>
<td>1 tablet twice daily</td>
</tr>
<tr>
<td>Minute Maid Heartwise orange juice (Coca Cola Company)</td>
<td>1000 mg/8 oz</td>
<td>8 oz daily</td>
</tr>
<tr>
<td>LifeTime low-fat cheese (Lifeline)</td>
<td>650 mg/oz</td>
<td>2 oz daily</td>
</tr>
<tr>
<td>Rice Dream Heartwise rice milk (Hain Celestial Group)</td>
<td>650 mg/8 oz</td>
<td>16 oz daily</td>
</tr>
<tr>
<td>Centrum Cardio (Wyeth Consumer)</td>
<td>400 mg/tablet</td>
<td>1 tablet twice daily</td>
</tr>
<tr>
<td>One A Day Cholesterol Plus (Bayer Healthcare)</td>
<td>100 mg/tablet</td>
<td>1 tablet daily</td>
</tr>
<tr>
<td>Benecol Chews (McNeil Nutritional)</td>
<td>850 mg/chewable tablet</td>
<td>1 or 2 tablets daily</td>
</tr>
<tr>
<td>Cholestoff (Nature Made)</td>
<td>450 mg/caplet</td>
<td>2 caplets twice daily</td>
</tr>
</tbody>
</table>

*Information from package labeling.

1Sterol esters.

2Phytosterols.

3Free phytosterols.
twice daily for the full effect, especially since most vitamins are taken once daily. Whether one product is superior to another is unknown.

A diet rich in fruits and vegetables, concomitant multivitamin administration, or both should be considered to counteract potential reductions in β-carotene absorption. Phytosterols should be avoided in children and in women who are pregnant or lactating until additional safety data become available. More research is needed to evaluate whether the reduced absorption associated with plant stanols versus plant sterols is clinically relevant. Reduced systemic absorption of plant stanols may be a potential advantage, but their adverse-effect profile is similar to that of plant sterols. Most products on the market contain sterol esters, with the exception of Benecol (McNeil). Studies evaluating effectiveness and safety beyond two years are needed.

Definitive studies may never be available for phytosterols. Large trials enrolling 10,000–15,000 people would be needed to provide appropriate power for an anticipated CHD reduction of 12–20%.

Surrogate marker (e.g., reduction in intima media thickness) trials may be available in the future. Although the products are helpful in lowering LDL cholesterol, it is unknown whether a morbidity or mortality benefit exists.

Conclusion

Phytosterol therapy produces an average 10–11% reduction in LDL cholesterol concentration, but it is unknown whether this effect persists beyond two years. Phytosterol products are well tolerated and have few drug interactions, but their long-term safety has not been established. Current evidence is sufficient to recommend phytosterols for lowering LDL cholesterol in adults.

References

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Phytosterols


