The evidence for the cholesterol lowering effects of

Plant Stanol Esters
Highlights

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- Studies investigating the cholesterol lowering effects of plant stanol esters
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Acknowledgement

The British Nutrition Foundation is a registered charity. It promotes the wellbeing of society through the impartial interpretation and effective dissemination of scientifically based knowledge and advice on the relationship between diet, physical activity and health.

The BNF wishes to thank McNeil Nutritionals Ltd. for financial support in the publication and dissemination of the finished report.
Cardiovascular disease (CVD), including stroke and coronary heart disease (CHD), is the leading cause of morbidity and mortality globally. An estimated 17.5 million people died from cardiovascular disease in 2005, representing 30% of all deaths worldwide. Of these deaths, 7.6 million were due to heart attacks and 5.7 million were due to stroke (WHO 2008). An elevated blood cholesterol concentration is one of the principal risk factors for CHD (see Frayn & Stanner 2005). Diet plays a key role in helping to lower blood cholesterol concentration (Buttriss 2005a; van Horn et al. 2008) and recently, particular attention has been paid to the role that plant stanol and sterol esters can have in lowering blood cholesterol concentrations.

What is cholesterol?

Cholesterol is a lipid which in small amounts is essential for many body processes. For example, it is a structural component of cell membranes and nerve sheaths. Cholesterol is also required for the synthesis of bile acids and steroid and adrenocortical hormones such as oestrogen and cortisol. Some of the body's supply of cholesterol is from dietary sources but diet usually makes only a minor contribution to the total cholesterol concentration in the blood. Animal-derived foods such as eggs, meat, shellfish, and organ meats such as liver, are the primary sources of dietary cholesterol. The remainder (typically the majority) has been synthesised 'endogenously', predominantly in the liver. Cholesterol synthesis is primarily driven by dietary saturated fatty acid intake (saturates). The major dietary sources of saturates are meat products, whole-milk products, and cereal products and fried foods made with fats rich in saturates (in particular butter, coconut oil and palm oil).

Cholesterol is carried around the body, in the blood, by specific transport proteins. These lipid-protein complexes, known as lipoproteins, can be classified based on their density. There are three main types of lipoproteins. Very low-density lipoproteins (VLDL) supply the body with energy from the triglyceride (derived from dietary fat) they carry, during the fasting state. Low-density lipoproteins (LDL) transport cholesterol to peripheral tissues. High levels of VLDL and LDL are associated with increased CHD risk. Finally, the function of high-density lipoproteins (HDL) is to transport cholesterol from peripheral tissues back to the liver for processing, e.g. excretion via the gall bladder as a constituent of bile. High levels of HDL reduce CHD risk.

Although there are a number of risk factors for CHD, high blood cholesterol concentration (especially high LDL cholesterol coupled with low HDL) is one of the primary modifiable risk factors. Mortality data indicates that 45% of people in Western Europe and 35% from Central and Eastern Europe who die from heart attacks have abnormal blood lipids, sometimes referred to as dyslipidaemia (BHF 2007). Among European men aged 15 or over, mean total cholesterol ranges between 4.5mmol/l and 6.2mmol/l. Among European women, the corresponding range is between 4.6mmol/l and 6.1mmol/l, compared to the target concentration of less than 5mmol/l (WHO 2006). Blood cholesterol concentration can be decreased by a combination of dietary change and increased physical activity.

### Dietary Changes to Reduce Blood Cholesterol Concentration

- Reduce consumption of all types of fat, for example by selecting lean cuts of meat and lower fat dairy products, by reducing use of oil and full fat spreads (margarine, butter), by eating fewer fried foods, and by moderating consumption of high fat foods such as cakes, biscuits and savoury snacks.
- Opt for oils/spreads that are higher in monounsaturates and polyunsaturates and lower in saturates.
- Include oil-rich fish in the diet once per week. (Those with heart disease may benefit from higher intakes*.)
- Include more fruit and vegetables in the diet, aiming for at least 5 portions of a variety of fruits and vegetables each day.
- Use less salt at the table and in cooking, and look for lower salt alternatives of manufactured foods. Reduce intake to below 6g/day (less for children).
- Include more starchy fibre-rich foods in the diet, e.g. bread, potatoes, yams, rice, pasta and oats, so that at least 50% of energy intake comes from carbohydrate and increase consumption of wholegrain foods.
- Drink alcohol sensibly, i.e. no more than 2-3 units per day for women and no more than 3-4 units per day for men. Avoid binge drinking.

*The National Institute for Health and Clinical Excellence recommends that patients who have suffered a heart attack should consume two to four portions of oil-rich fish per week (NICE 2007).

What are plant stanol esters?

Although plants usually contain only small amounts of fat, seeds are relatively concentrated sources and provide essential fatty acids. One particular group of plant-derived lipids comprises plant stanols and sterols. Considerable interest in these has developed because of their possible beneficial effects, particularly with respect to CVD (see Wahle et al. 2001).

Sterols are essential components of cell membranes that play a key role in controlling membrane fluidity and permeability. Over 250 different sterols have been isolated from plants; the most abundant are sitosterol, campesterol and stigmasterol. Stanols are saturated sterols (i.e. there are no double bonds in the structure). They are naturally occurring compounds that are found in very small amounts in plant products such as nuts, seeds and legumes. To improve their solubility, plant stanols are often combined with a fatty acid ester to produce plant stanol esters (see figure 1).
Both plant stanols and sterols have a structure very similar to that of cholesterol with only a few notable differences: they have a slightly different side chain configuration to cholesterol (Trautwein et al. 2003); and unlike cholesterol and plant sterols, plant stanols have a chemical structure that is completely saturated (Webb 2008). These structural differences affect absorption. Approximately 30-60% of total cholesterol is absorbed from the intestine into the blood, compared to only an estimated 0.15% of plant stanols and up to about 2% of plant sterols (Ostlund et al. 2002). Plant stanols and sterols are able to inhibit the absorption of both dietary cholesterol and the cholesterol incorporated into bile salts by the liver (Hallikainen et al. 2000). When plant stanol and sterol esters are present, absorption of cholesterol falls to approximately 20% (Plat 2001).

**What is the Mechanism of Action?**

As stated earlier, plant stanols and sterols are poorly absorbed from the gut. They are also capable of significantly reducing the amount of cholesterol that is absorbed. This ultimately leads to lower blood total and LDL cholesterol concentrations. Prior to being absorbed, cholesterol is firstly incorporated into a mixed micelle (the transportation vehicle for cholesterol absorption) in the upper part of the small intestine. Research findings suggest that plant stanols and sterols compete with cholesterol for space in the micelle and that this results in much less of the cholesterol reaching the blood supply and it passes unabsorbed into the large bowel. Potential mechanisms have been described by Trautwein et al. (2003) (see figure 2).

Whilst the exact mechanism of action of these plant stanols and sterols is not fully understood, studies have shown that consuming approximately 2g of plant stanols or sterols each day results in a lowering of cholesterol concentrations in individuals with elevated cholesterol (Law 2000; Katan et al. 2003; Weingärtner et al. 2008). Furthermore, plant stanols and sterols lower total and LDL cholesterol without affecting HDL (Miettinen et al. 1995), and therefore are thought to have beneficial effects on reducing CHD risk. Because of their low concentrations in plant foods, it is not possible to acquire the amount of plant stanols or sterols needed to effectively lower cholesterol by consuming plant foods alone. Some manufacturers now add plant stanol or sterol esters to particular food products, such as some spreads, yogurts and yogurt drinks. When consumed regularly with meals, these products have the potential to significantly reduce both total and LDL cholesterol concentrations. When plant stanol or sterol esters are consumed, the active plant stanol and sterol component is released from the plant stanol or sterol ester molecule, allowing it to interfere with the absorption of cholesterol. The remaining fatty acid ester is absorbed like a normal fat.

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**Figure 1: Chemical structures of cholesterol and plant stanols and sterols**

- **Cholesterol**
- **Plant Stanol: Sitostanol**
- **Plant Sterol: Sitosterol**
- **Sitostanol Ester**

**Figure 2: Mechanism of action of plant stanols**

- **Cholesterol in your gut without plant stanol**
  - More cholesterol is absorbed so higher blood cholesterol levels

- **With plant stanol cholesterol is partially blocked**
  - Less cholesterol is absorbed so lower blood cholesterol levels

**Key:**
- ○ Cholesterol
- ● Plant stanol
Studies investigating the cholesterol-lowering effects of plant stanol esters

The cholesterol-lowering effects of plant sterol esters have recently been reviewed by Weingärtner et al. (2008); the body of evidence shows that regular consumption of 1 to 3 grams of plant sterols per day lowers LDL by 5-15%. Data from published human clinical trials studying the effects of plant stanol esters on LDL concentration in healthy adults with normal to moderately-elevated total cholesterol concentrations are summarised in Table 1. Studies investigating intakes of around 2-3g per day of plant stanols, provided as their esters, have demonstrated an average control-adjusted reduction in serum LDL concentration of 10% (see table 1). Findings from these studies indicate that the beneficial effect of plant stanols on LDL concentration is established within a few weeks, and remains stable over the duration of plant stanol ester consumption (Miettinen et al. 1995).

The effect of the frequency of intake

Data from clinical studies indicate that optimal LDL lowering is attained with a plant stanol intake of approximately 2g per day, and increasing the dose above this level does not further reduce serum LDL concentrations to a significant degree (Law 2000; Katan et al. 2003). The majority of studies on plant stanol consumption have assessed the effect of giving plant stanols on two or more occasions per day. However, Plat et al. (2000) showed that consuming 2.5g of plant stanols on a single occasion during the day for 4 weeks was just as effective in lowering serum LDL concentrations as when the dose was divided over 3 meals. The authors hypothesised that plant sterol or stanol esters may remain in the intestinal lumen or the cells of the intestinal wall for some time, allowing their impact to be prolonged.

The effect of the formulation

The form of the plant stanol (free or esterified) does not seem to be important in determining the ability of the dose to reduce plasma cholesterol concentrations; both the free and esterified forms are effective; manufacturers often combine the plant stanol with a fatty acid ester to improve solubility (Jones et al. 2000). The food matrix in which the plant stanols are eaten is also of little importance; the efficacy of plant stanol is preserved in both high and low fat matrices (Salo & Wester 2005; Miettinen et al. 1995). Spreads, low-fat dairy products, mayonnaise and pasta have all been shown to be effective carrier foods (table 1).

The effect of plant stanol esters in combination with a low fat, cholesterol-reducing diet

A good diet is one of the best ways to help prevent ill health. Dietary changes such as reducing saturated fatty acid intake and consuming more wholegrain foods can be effective in reducing cholesterol concentrations (Buttriss 2005b; van Horn et al. 2008), but the cholesterol lowering effects of plant stanol esters are independent of background diet (Hallikainen & Uusitupa 1999).

Studies have shown that consuming plant stanol esters in addition to a low-fat cholesterol-reducing diet leads to an even greater effect on LDL than consuming a low-fat cholesterol-reducing diet alone (Andersson et al. 1999; Hallikainen et al. 2000). For example, a study in a Finnish population demonstrated that the addition of 2.3g plant stanols to a low fat diet [less than 30% total fat, less than 10% saturated fat and less than 300mg cholesterol per day] brought about a 23% reduction in plasma LDL concentration, of which 10% was attributed to the diet and 13% to the plant stanols (Hallikainen & Uusitupa 1999).

The effect of plant stanol esters in combination with cholesterol lowering drugs

Statins are a class of drug that helps to protect healthy, but high risk, people from heart disease and prevent repeated problems in people who’ve already had a heart attack, a stroke or peripheral artery disease (BHF 2008). They act by reducing the amount of cholesterol produced in the body.

As with a healthy diet, consuming plant stanol esters in addition to statins has a greater effect on lowering cholesterol than with statins alone. One study demonstrating this effect is that by Blair et al. (2000). In this study, 176 patients, all of whom were taking statins, consumed either 3 servings per day of plant stanol ester spread (providing them with 5.1g per day of plant stanol ester, equivalent to 3g of plant stanols) or a control spread. The combination of the plant stanol ester enriched spread with the statins resulted in a 10% greater reduction in cholesterol concentrations than the effect seen with the control spread. A similar effect has also been found in a smaller group of participants with a history of myocardial infarction and people with diabetes (Gylling et al. 1997; Gylling & Miettinen 1996). Consuming plant stanol esters in combination with statins appears to be a more effective method of reducing cholesterol than simply doubling the statin dose, which usually only results in an additional reduction in LDL cholesterol concentrations of approximately 6% (Bradford et al. 1991).

Future research

Plant stanol esters have been shown to reduce cholesterol concentrations but there is currently no direct evidence that consumption of plant stanol esters actually reduces CVD events (i.e. heart disease and stroke) at an intake of 2g per day. The UK’s National Institute for Health and Clinical Excellence (NICE) has called for trials to test both the efficacy and effectiveness of plant stanols and sterols in people who are at high risk of a first CVD event. Such trials should test the efficacy of advising people who are at high risk of experiencing a first CVD event to include food items containing plant stanols or sterols in a low-fat diet. NICE advises that the trial, which should follow a randomised placebo-controlled design, should last for at least 2 years and should consider appropriate outcomes (NICE 2008).
### Table 1: Summary of studies investigating the cholesterol-lowering effects of plant stanols

<table>
<thead>
<tr>
<th>Author(s), year</th>
<th>Study type</th>
<th>Country of research</th>
<th>No. of subjects included in analyses</th>
<th>Study population</th>
<th>Baseline LDL concentration (mmol/L)</th>
<th>Intervention</th>
<th>Change from baseline (mmol/L)</th>
<th>Overall % reduction in LDL concentration</th>
<th>Overall change in LDL concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alhasson et al. (1998)</td>
<td>RDB PC II</td>
<td>USA</td>
<td>40</td>
<td>Healthy middle-aged male and female subjects, with TC &lt; 6.0 mmol/L</td>
<td>3.9 ± 0.60</td>
<td>Sphered</td>
<td>0.9</td>
<td>0</td>
<td>2.87 ± 0.10</td>
</tr>
<tr>
<td>Andersson et al. (2001)</td>
<td>RDB PC II</td>
<td>Sweden</td>
<td>40</td>
<td>HDL cholesterol</td>
<td>4.60 ± 0.24</td>
<td>Sphered</td>
<td>0.6</td>
<td>0</td>
<td>4.20 ± 0.22</td>
</tr>
<tr>
<td>Bakstow &amp; Loxton (1996)</td>
<td>RDB PC II</td>
<td>Australia</td>
<td>60</td>
<td>Hypercholesterolaemic adults with TC 4.0 ± 0.4 mmol/L</td>
<td>3.39 ± 0.25</td>
<td>Sphered</td>
<td>1.0</td>
<td>0</td>
<td>3.04 ± 0.32</td>
</tr>
<tr>
<td>Buckton et al. (2001)</td>
<td>RDB PC II</td>
<td>USA</td>
<td>16</td>
<td>Normocholesterolaemic adults with TC 3.0 ± 0.4 mmol/L</td>
<td>3.96 ± 0.44</td>
<td>Sphered</td>
<td>0.9</td>
<td>0</td>
<td>3.66 ± 0.30</td>
</tr>
<tr>
<td>Cogal et al. (1998)</td>
<td>RDB PC II</td>
<td>India</td>
<td>50</td>
<td>Healthy middle-aged male and female subjects, with TC &lt; 6.0 mmol/L</td>
<td>3.39 ± 0.25</td>
<td>Sphered</td>
<td>1.0</td>
<td>0</td>
<td>3.04 ± 0.32</td>
</tr>
<tr>
<td>Cater et al. (2003)</td>
<td>RDB PC II</td>
<td>The Netherlands</td>
<td>39</td>
<td>Adults with non-normolcholesterolaemic and mild hypercholesterolaemia with TC 6.0–7.5 mmol/L</td>
<td>4.48 ± 0.75</td>
<td>Sphered &amp; shortening</td>
<td>1.9</td>
<td>0</td>
<td>4.25 ± 0.61</td>
</tr>
<tr>
<td>Choueuse &amp; Marreille (2007)</td>
<td>RDB PC II</td>
<td>USA</td>
<td>30</td>
<td>Healthy middle-aged male and female subjects, with TC 4.0 ± 0.4 mmol/L</td>
<td>3.96 ± 0.44</td>
<td>Sphered</td>
<td>0.9</td>
<td>0</td>
<td>3.66 ± 0.30</td>
</tr>
</tbody>
</table>

Key:
- **RDB PC II** – Randomised double blind placebo controlled parallel design study
- **RDB PC XO** – Randomised double blind placebo controlled cross over design study
- **TC** – Total Cholesterol
- **DNI** – Data not included in paper

**Notes:**
- *Overall change in LDL concentration calculated using March 2018 LDL concentration.
- *Overall % change calculated using 2013 LDL concentration.
- *As reported

**Studies 18-29:** Overall change and overall % reduction calculated using:

- **Intervention group:** Change in LDL concentration (mmol/L) of Intervention group – Change in LDL concentration (mmol/L) of Control group

- **Control group:** Change in LDL concentration (mmol/L) of Control group

**Average % reduction in LDL concentration:**

- **Overall:** 9.0% ± 2.0% (95% CI 7.0% to 11.0%)

**Average % reduction in LDL concentration of intervention group:**

- **Overall:** 10.3% ± 2.5% (95% CI 8.3% to 12.3%)

**Average % reduction in LDL concentration of Control group:**

- **Overall:** 0.7% ± 1.0% (95% CI -0.2% to 2.5%)
Foods with added plant stanol esters were launched in the UK and Ireland in 1999, following a successful launch in Finland in 1995. A range of dairy products containing plant stanol esters are now on the market, including yogurts, yogurt drinks, spreads and cream cheese style spreads. Millions of Europeans are regular consumers. The body of available evidence demonstrates that the cholesterol lowering effects are most beneficial at an intake of at least 2g per day, eaten with a meal (Law 2000).

Foods with added plant stanol esters have been approved for use by many regulatory agencies, including the Scientific Committee on Foods of the European Union (EC 2000) and the US Food and Drug Administration (FDA 2000). Evidence of the safety and efficacy of plant stanol esters has come from extensive animal and human research.

Initial concerns about the safety of plant stanol and sterol esters centred on their possible interference with the absorption of nutrients (particularly fat-soluble vitamins) and therapeutic drugs, as well as the possible effects of unabsorbed cholesterol and plant stanols and sterols and their metabolites in the large intestine.

It has been suggested that the absorption of other substances, including fat-soluble vitamins, might be reduced by plant stanol and sterol esters (Plat & Mensink 2005). However, studies have found the absorption of the fat-soluble vitamins A, D and K to be largely unaffected by plant stanol ester intake (Katan et al. 2003). Some studies have shown a slight reduction in plasma levels of beta-carotene, although levels always remained within normal limits (Katan et al. 2003). Indeed, the slight deficit in beta-carotene can easily be compensated by the regular consumption of fruit and vegetables, important components of a heart-healthy diet (Noakes et al. 2002).

Information about the effect of plant stanol esters on the absorption of therapeutic drugs is limited. However, one eight-week study of 318 hypercholesterolaemic subjects reported no adverse effects on the absorption of therapeutic drugs when plant stanol esters were consumed (Nguyen et al. 1999).

As plant stanol esters inhibit the absorption of cholesterol, they consequently result in an increased faecal excretion of cholesterol and its metabolites. These substances therefore enter the large intestine in larger quantities than would normally occur in the absence of foods with added plant stanol and sterol esters. Although many studies have been conducted investigating gut health and potential cancer risk (for example Drasar & Hill 1972; Awad & Fink 2000), at present there are no convincing data to suggest that plant stanol esters have any effect on colon cancer risk (Katan et al. 2003).

The evidence published to date on the safety of plant stanol esters demonstrates that an intake of 2g per day effectively lowers LDL concentration, produces no adverse effects, and poses no health risks. However, intakes above 3g per day are not recommended, as higher levels have little additional effect on LDL levels (Katan et al. 2003).

The safety of foods containing plant stanol esters is continually being monitored to ensure their safety. For example, a prospective longitudinal study in Finland is currently investigating long-term health effects of consumption of stanol spreads (Attolainen et al. 2001).
Claims approved and recommendations made by regulatory and medical bodies around the world

Products enriched with plant stanol esters sometimes carry claims about the health promoting effects associated with the ingredients they contain. A number of regulatory and medical bodies around the world have issued position statements, recommendations or regulatory frameworks, to ensure that any claims made are underpinned with robust scientific evidence, in order to protect consumers. By following these recommendations and by adopting labelling rules that regulate the information about the health benefits of foods and their nutritional value, it is hoped that consumers will be able to make informed and meaningful choices.

All foods sold in Europe with added plant stanols or sterols must include the statement: ‘foods with added plant stanol/sterol esters may not be nutritionally appropriate for pregnant and breast feeding women, and children under 5 years. If you take cholesterol lowering medication seek you doctor’s advice. Eat no more than 3g of plant stanol per day. Eating more does not provide additional cholesterol lowering benefit’. This is to ensure that consumers are provided with information to help them to set the potential health benefits of the product in context, as well as advice on how to incorporate such products into a healthy, balanced diet.

Claims approved by national bodies

The Table below sets out the detail of claims that have been approved for use in the USA, Netherlands, Japan and Sweden. As evident from the detail of the claims, the regulatory bodies have made sure that any beneficial health effects of the product are matched with clear conditions of use, including recommended amounts (see table 2).

A new European Commission (EC) regulation on nutrition and health claims (1924/2006/EC) came into force in July 2007. The regulation provides a legal framework for nutrition and health claims that applies across the European Union (EU). In due course a list of approved claims will be published that can be used on foods, provided the product in question contains enough of the nutrient to have a health benefit and its nutrient profile is deemed healthy enough to support a claim.

Health claims, which refer to a health benefit from a food or food constituent, are divided into two types. One category comprises claims that refer specifically to reduction of disease risk or to children’s health. The other category excludes these types of claims and instead comprises health claims that are supported by generally accepted scientific evidence and concern the function of the food or its components (e.g. in relation to growth, development, function or behaviour). It is not yet certain into which category claims relating to the cholesterol lowering potential of plant stanol esters will fall, but it is thought likely that they will be considered to be disease risk reduction claims. Manufacturers wishing to make such a claim will need to submit a detailed dossier describing the scientific evidence for the claim to the EC. For more information see Aisbitt 2007.

Recommendations regarding plant stanol esters

Due to the potential of foods with added plant stanol esters to have a beneficial effect on blood cholesterol concentrations, a number of medical authorities have described their value in the treatment and management of elevated cholesterol. Table 3 outlines recommendations from around the world.

<table>
<thead>
<tr>
<th>National Body</th>
<th>Food</th>
<th>Claim</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Food and Drug Administration (FDA) September 2000 and February 2003</td>
<td>Diets that include plant stanol esters</td>
<td>Foods containing at least 1.7g per serving of plant stanol esters, eaten twice a day with meals for a total daily intake of at least 3.4g, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. A serving of [product name] supplies [x] grams of plant stanol esters. In 2003, FDA stated it will leverage its enforcement discretion on products that contain 0.8g of plant stanols/plant sterols.</td>
</tr>
<tr>
<td>Netherlands Nutrition Centre May 2001</td>
<td>Spread or yogurt drink</td>
<td>Two to three servings of [product name] daily lower serum total and low-density lipoprotein cholesterol concentrations and may consequently reduce the risk of coronary heart disease.</td>
</tr>
<tr>
<td>Ministry of Health, Labor and Welfare, Japan February 2002</td>
<td>Spread</td>
<td>This product contains plant stanol ester which restrains the body of absorption of blood cholesterol and lowers blood cholesterol level, especially LDL cholesterol (bad cholesterol). We recommend the product for people who tend toward a high level of cholesterol.</td>
</tr>
<tr>
<td>Swedish Nutrition Foundation December 2006</td>
<td>Spread or yogurt drink</td>
<td>[Product name] effectively reduces blood cholesterol. [Product name] has a sustained blood cholesterol lowering effect. [Product name] effectively reduces blood cholesterol.</td>
</tr>
</tbody>
</table>
The evidence for the cholesterol lowering effects of Plant Stanol Esters

Table 3: Recommendations regarding plant stanol esters

<table>
<thead>
<tr>
<th>Medical Body</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Cholesterol Education Programme</td>
<td>In the third report on the detection, evaluation and treatment of high blood cholesterol, published in 2002, the authors include a statement on plant stanol esters. They recommend that plant stanol esters are a therapeutic option to enhance serum cholesterol lowering; daily intakes of 2-3g of plant sterols or stanols will reduce serum LDL cholesterol by 6-15% (NCEP 2002).</td>
</tr>
<tr>
<td>Joint European Societies</td>
<td>The third Joint Task Force Report of European and other societies on cardiovascular disease prevention provides general recommendations regarding fat in the diet. In the case of dyslipidemia specifically, the importance of lowering serum LDL cholesterol by dietary means is stressed and the fact that plant sterols can help to achieve this is mentioned (De Backer et al. 2003).</td>
</tr>
<tr>
<td>Joint British Societies</td>
<td>The Task Force reports that consumption of 2g plant sterols or stanols per day by individuals with established cardiovascular disease would be expected to lower serum LDL cholesterol by approximately 0.5mmol/L and reduce the risk of cardiovascular disease by 25% over a 2 year period (Wood et al. 2005).</td>
</tr>
<tr>
<td>American Heart Association</td>
<td>The American Heart Association recommends that all patients with coronary or other forms of atherosclerotic vascular disease should add 2g daily of plant stanols or sterols to a low saturated fat, low cholesterol diet, to lower LDL cholesterol further (Lichtenstein et al. 2006).</td>
</tr>
<tr>
<td>World Health Organization</td>
<td>The World Health Organization recognises the cholesterol lowering ability of plant sterol and stanol esters and indicates that there is the probability that plant sterol and stanol esters may lower the risk of cardiovascular disease, in its report on diet, nutrition and the prevention of chronic diseases (WHO/FAO 2003).</td>
</tr>
<tr>
<td>International Atherosclerosis Society</td>
<td>After reviewing numerous recent studies, a report published by the International Atherosclerosis Society indicates that plant sterols and stanols lower cholesterol concentrations beyond what can be achieved by reducing dietary saturated fatty acids and cholesterol alone (IAS 2003).</td>
</tr>
<tr>
<td>Finnish Internal Medicine Society</td>
<td>The treatment guidelines of the Finnish Internal Medicine Society state that if regular dietary treatment is not enough to lower cholesterol in patients with dyslipidemia, products containing plant sterol or plant stanol esters can be added (FIMS 1996).</td>
</tr>
<tr>
<td>Australian Heart Foundation</td>
<td>In their recent position statement, the Australian Heart Foundation recommends that adult Australians with high absolute risk of CVD would benefit from the cholesterol-lowering effects of consuming plant sterol and stanol esters naturally occurring in plant foods and food products enriched with plant sterol and stanol esters (2-3g of plant stanols or sterols per day) (AHF 2007).</td>
</tr>
</tbody>
</table>

Conclusions

Foods and drinks with added plant stanol or sterol esters reduce blood cholesterol and are a promising addition to interventions aimed at lowering heart disease risk. Maximum effects are observed at intakes of approximately 2-3g per day. The reduction in LDL cholesterol concentration ranges between 6-15%. Therefore, individuals wishing to reduce their blood cholesterol level may benefit from inclusion of foods with added plant stanol esters (e.g. spreads, mini drinks and yogurts) in a healthy, varied and balanced diet.
with a strict lipid-lowering diet. Andersson A, Karlstrom B, Mohsen R et al.


