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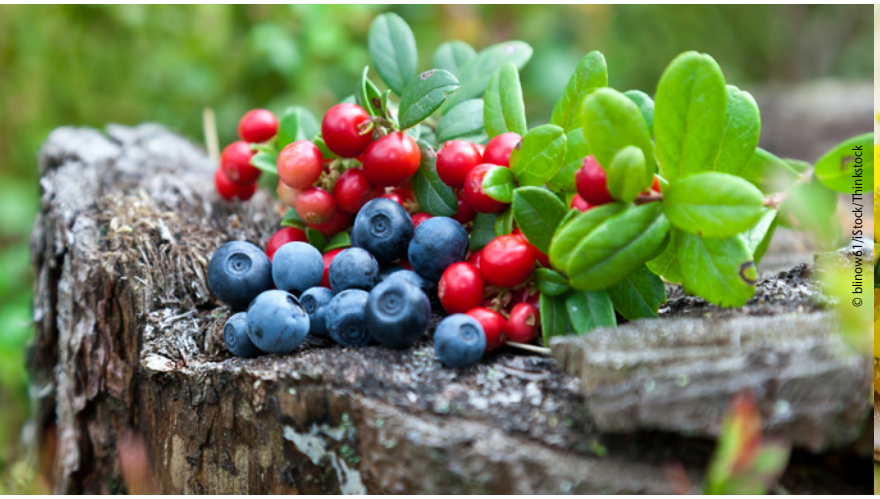

The Nordic Diet[1]

Towards the North by inspiration from the South

Marjukka Kolehmainen

There is a strong on-going interest regarding a "new" diet, which is sometimes called Nordic Diet, Healthy Nordic Diet, New Nordic Diet or Baltic Sea Diet. This interest is evoked by emerging evidence of potential health benefits with Nordic-based foods and related dietary patterns. With this short review, the composition of such a "Nordic Diet" is shown and the currently available evidence of health effects associated with a Nordic Diet is presented.

Summary

The concept of a Nordic diet has gained great research interest recently. Before studying the whole dietary pattern, many separate food items belonging to a Nordic Diet concept such as whole grain rye, barley and oat, various Nordic berries and fruits, cabbage, roots and tubers, native fish and wild (and pasture-fed) land-based animals as well as rapeseed oil have been the target of many nutritional studies, especially in the Nordic countries. Thus, the knowledge and understanding on these foods and more recently on the whole healthy Nordic dietary pattern has been increasing, and proving that it may be as healthy as the traditional Mediterranean diet when composed of healthy, mainly local foods. In fact, the background of the current Healthy Nordic Diet lies in the knowledge of the health effects of a Mediterranean Diet, and the idea that the diet would be easier to follow and more sustainable by using local and familiar products in northern countries. This article summarizes the current state of art knowledge on the health benefits of the Healthy Nordic Diet.

Keywords: Nordic Diet, Mediterranean Diet, cardiovascular disease, dietary patterns, sustainability, regionality

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Concept and composition of the Nordic Diet

Some decades ago, the Nordic diet, especially the Finnish version of it, was associated with high chronic disease morbidity. The Seven Countries Study [1] (www.sevencountriesstudy.com) showed striking differences in the intake of saturated fat across Europe, and alongside that the direct relation between saturated fat intake and the incidence of coronary heart disease (CHD). Eastern Finland had the highest intakes of saturated fat and coronary heart incidence among the countries that were compared in the study [1]. After that the North Karelia intervention in Eastern Finland showed marked decrease in the incidence of and mortality due to CHD by a healthy lifestyle intervention. The decrease has been 82% in men and 84% in women over the 40-year period [2], and dietary changes had great impact on the improvement of risk factors, such as serum cholesterol [3].

Mediterranean Diet	Healthy Nordic Diet
Olive oil	Rapeseed oil
Vegetables, legumes	Local vegetables in focus: roots, cabbage, legumes
Fruits	Berries, especially wild growing varieties, local fruits, such as apples or pears
Whole grain wheat	Whole grain rye, oats, barley
Nuts	Nuts
Fish and sea food	Sea and lake fish
Meat, poultry in moderation	Game, low fat meat, poultry in moderation
Wine in moderation	No recommendation or counterpart, wine in moderation
Cheese	Low fat varieties of milk products and cheese

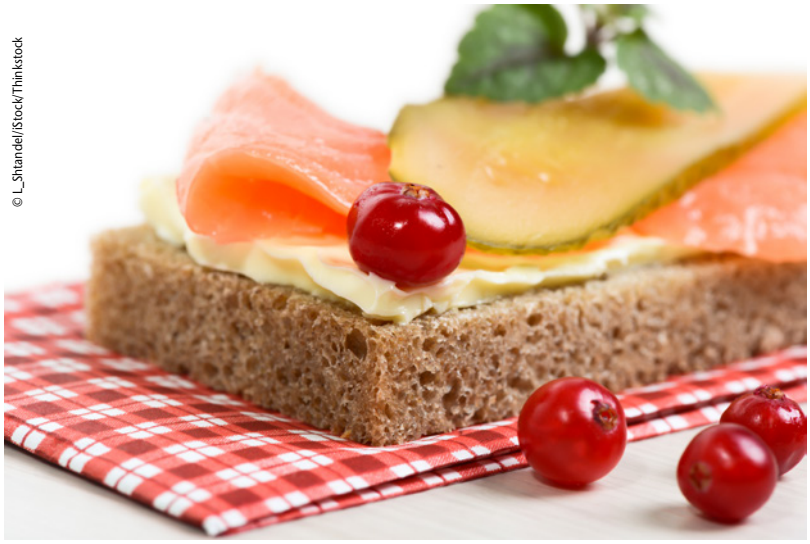
Tab. 1: **Comparison of Mediterranean Diet and Healthy Nordic Diet**

The Seven Countries Study also included the Mediterranean Diet, which in contrast showed then and continuously after many health benefits [4, 5]. For example Sofi et al. [4] showed that a 2-point increase in the adherence score of the Mediterranean Diet was associated with a reduction by 8% in overall mortality and by a 10% lower risk for cardiovascular disease (CVD). Quite early, also in Finland there were interventions showing marked benefits if adhering to the Mediterranean Diet regarding CHD risk markers: the diet was associated with a 20% decrease in total and LDL cholesterol, apolipoprotein B (Apo B), and a significant blood pressure lowering effect [6, 7]. However, the acceptance of the Mediterranean Diet among the local population has not been as successful as expected, probably due to the difficulties in changing dietary patterns, cultural differences in taste and limited accessibility to various foods [8, 9].

More recently, the research interest towards the Nordic food items, such as rye, oats, berries and local fruits and fish, has been increasing. Rye bread, commonly consumed as whole grain within Nordic countries, has been shown to deliver many health benefits including the improvement in glucose metabolism in healthy individuals as well as in

Nordic countries are a geographical and cultural region in Northern Europe and the North Atlantic including Denmark, Finland, Iceland, Norway and Sweden. Especially in English, the term Scandinavia is sometimes used as a synonym for the Nordic countries.

[1] This article is a short review based on the presentation given at VFED Conference in Aachen/Germany in September 2015.



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According to Bere and Brug, a Nordic Diet should include six food groups since they are healthier and sustainable choices within Nordic countries: native (i.e. wild) berries, cabbage, native fish and other seafood, wild (and pasture-fed) land-based animals, rapeseed oil and oat/barley/rye [25].

individuals at risk of chronic diseases in several dietary interventions [10–15]. Furthermore, consumption of berries has been associated with the improvement of low grade inflammation and improvement of glucose metabolism postprandially [16–22]. Both rye and berries are rich in polyphenolic compounds which were shown to have a beneficial impact on glucose metabolism [23] and are among the dietary factors related to improvement of low grade inflammation [24]. In addition, both lean and fatty fish have been linked to health benefits. These dietary components have been traditionally and again currently consumed widely throughout the Nordic countries.

Upon composing a Healthy Nordic Diet Bere and Brug [25] have suggested that it should include healthy choices of foods which

- are varieties that are produced locally over large areas within the Nordic countries without usage of external energy
- are traditionally or common food sources within the Nordic countries
- possess a better potential for health-enhancing effects compared to similar foods within the same food group,
- are eaten as foods (excluding e.g. spices).

Taking into account these considerations, they suggest six ingredients that are healthier and sustainable choices within Nordic countries: native (i.e. wild) berries, cabbage, native fish and other seafood, wild (and pasture-fed) land-based animals, rapeseed oil and oat/barley/rye [25].

However, only recently the Healthy Nordic Diet as a dietary pattern has increased the research interest, and many simultaneous efforts were launched to investigate the health effects of the Healthy Nordic Diet. As a Nordic collaborative effort the SYSDIET study, a controlled intervention study, was conducted [26]. The main aim of this study was to apply a modified Mediterranean Diet by replacing the known health related food items by the Nordic counterparts (♦ Table 1).

This diet has a quite similar nutrient composition compared to the Mediterranean Diet. Thus, the question remained whether it is possible to produce similar health benefits by offering local foods as part of a healthy diet based on the knowledge taken from the Mediterranean Diet. The objective was to increase the adherence to the diet by consuming familiar food items.

Indices to evaluate the Nordic Diet

In order to evaluate the health effects of adhering to a Nordic Diet, the "Healthy Nordic Food Index" (HNFI) has been developed [27]. Several cohort studies conducted in the Nordic countries which included dietary assessments, offer the opportunity to apply the HNFI. One of these is the Danish Diet, Cancer and Health Study, in which the HNFI was used in a modulated version [27]. The use of fish, cabbages, rye bread, oatmeal, apples and pears, and root vegetables were included as the components of the HNFI. It was shown that the higher the HNFI, the lower the overall mortality [27], the association was more consistent in men. It was also demonstrated that the higher the HNFI, the lower the incidence of colorectal cancer [28].

Within the Swedish Women's Lifestyle and Health Cohort, the HFNI was used to analyze the associations of the Healthy Nordic Diet with the risk of cardiovascular disease (CVD) [29]. The authors did not find associations between adherence to the HNFI and the risk of CVD, although they found an interaction between the HNFI and CVD with a beneficial effect among the group of former smokers [29].

Another score to evaluate the Nordic Diet is the "Baltic Sea Diet Score" (BSDS), consisting of nine variables: six food groups including Nordic fruits and berries, vegetables, cereals such as rye, oats and barley, low-fat milk, fish and meat products as well as total fat of the diet ex-

pressed as a percentage of total energy intake, a ratio of polyunsaturated fatty acids to saturated fatty acids (PUFA:SFA), trans-fatty acids to illustrate dietary fat and alcohol [30]. The BSDS was applied in the prospective cohort "Dietary Lifestyle and Genetic Determinants on the Development of Obesity and Metabolic Syndrome Study" (DILGOM Study) to study the effects of the Nordic Diet. A greater adherence to the Baltic Sea diet was found to be associated with lower waist circumference independently of body mass index (BMI) [30]. The study group also showed that a higher BSDS was associated with improved low grade inflammation, where high intake of Nordic fruits and cereals, low intake of red and processed meat, and moderate intake of alcohol contributed to the association [30]. However, in the same analysis it was found that high adherence to the BSDS may set women at a higher risk of lower HDL-cholesterol concentration [30], which underlines the necessity of controlled intervention studies to investigate causal relation with reduced risk of bias and confounding.

Health effects associated with the Healthy Nordic Diet

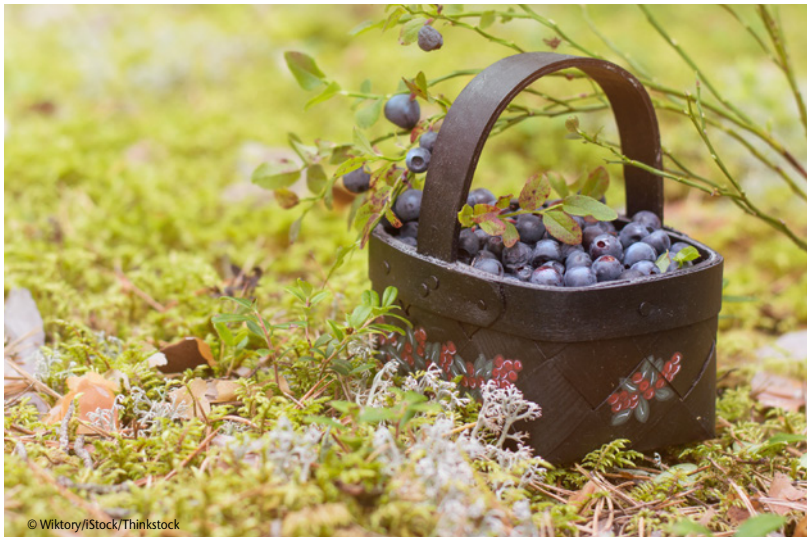
The aforementioned SYSDIET-Study, a reasonably large dietary intervention study with 200 individuals starting the study and 166 individuals completing the whole intervention, was conducted in four Nordic countries, namely in Finland, Sweden, Denmark and Iceland [26]. The participants of the study were randomized to either the Healthy Nordic Diet group based on Nordic nutrition recommendations or to the control diet group based on the average Nordic diet according to the national intake data in the Nordic countries at the time the study was planned. In the Healthy Nordic Diet, the main emphasis was placed on consumption of whole-grain products, abundant use of berries, fruit and vegetables, rapeseed oil, three fish meals per week, low-fat dairy products and avoidance of sugar-sweetened products. The key food items were provided to the participants. While the two diets were isocaloric, the main differences in nutrient intake between the two intervention diets were the amount of dietary fiber and salt, and the quality of dietary fat [26]. The intervention lasted 18–24 weeks and the dietary intake was investigated using the 4-day food records that volunteers kept several times during the intervention. The compliance for both the intervention diets was also analyzed by determining the objective biomarkers after the intervention [31, 32].

Main clinical findings within the SYSDIET study were that the consumption of the Healthy Nordic Diet decreased non-HDL-cholesterol, and there was also a non-significant trend towards to a decrease in LDL-cholesterol and Apo B, and increase in HDL-cholesterol was also detected [26]. Interestingly, interleukin 1 receptor antagonist (IL-1Ra), a marker of low grade inflammation, was found to be increased in the control diet group compared to the Healthy Nordic Diet group causing a difference in the impact of diets on inflammation. Moreover, it was found that especially the intake of saturated fat and magnesium were associated with the IL-1Ra concentration [26]. In a smaller sub-study of SYSDIET, diastolic ambulatory blood pressure and mean arterial pressure were found to be decreased after consuming the Healthy Nordic Diet [33].

Food	Biomarker(s)
Rapeseed oil	serum phospholipid α-linolenic acid
Fatty fish	eicosapentaenoic acid (EPA) docosahexaenoic acid (DHA)
Vegetables	plasma β-carotene
Whole grains (rye/wheat)	plasma alkylresorcinols
High-fat dairy	serum pentadecanoic acid

Tab. 2: **Biomarkers of the Healthy Nordic Diet in the SYSDIET Study [32]**

The study effects were also studied regarding the dietary compliance [32]. Based on the used biomarkers of the food consumption, a biomarker score was formulated (♦ Table 2). It was found that those individuals with a higher score had greater cardiometabolic benefits, such as lower concentration of LDL-cholesterol and lower ratio of total cholesterol to HDL-cholesterol compared to those with a lower score [32]. One of the used biomarkers, alkylresorcinols (AR), markers of whole grain wheat and rye consumption, was investigated with respect to its association with insulin sensitivity. The ratio of AR isoforms, AR C17:0/C21:0 ratio, an indicator of relative whole-grain rye intake, was associated with increased insulin sensitivity describing the benefits of whole grain rye consumption on glucose metabolism [34].
Within the SYSDIET Study, also global gene expression and lipidomic profiling has been conducted. Kolehmainen et al. [35] published analyses of global gene expression in adipose tissue. It was shown that the expression of genes related to inflammation was down-regulated by consuming the Healthy Nordic Diet. Moreover, the Healthy Nordic Diet down-regulated the expression of genes involved in inflammation and lipid metabolism in peripheral mononuclear cells after the acute glucose tolerance test compared to the control diet [36]. These two studies confirm anti-inflammatory effects of the Healthy Nordic Diet. Furthermore, based on a global circulating lipid profile analysis, it was detected that the Healthy Nordic Diet modified the plasma lipidomic profile by increasing the concentrations of



The Nordic Diet, when composed of healthy, mainly local foods, produces similar health effects as the Mediterranean Diet, can be locally modified and should thus be easily acceptable and a more sustainable diet in northern countries.

antioxidative plasmalogens and by decreasing insulin resistance-inducing ceramides [37].

In another study, the "Nordiet Study", the Nordic Diet included fruits (e.g. apples and pears), and berries (e.g. lingonberries and blueberry jam), vegetables, legumes, low-fat dairy products, fatty fish (e.g. salmon, herring and mackerel), and oats, barley, soy protein, almonds and psyllium seeds [38]. All food items were provided to the participants. The control group continued eating their habitual diet. In this study, total cholesterol, LDL-cholesterol, plasma insulin, systolic blood pressure and body weight were decreased. Part of the effects might have been caused by the weight reduction due to high fiber content in the Nordic Diet [38].

In Denmark a large dietary intervention program, OPUS (Optimal well-being, development and health for Danish children through a healthy New Nordic Diet) produced a modification of the Nordic Diet as the so called New Nordic Diet concept [39]. The program addressed both children and adults. The OPUS-program differs from the aforementioned studies, both observational and interventional studies, since it also proposes new food items and new cuisine to be added in the Nordic Diet. The main ideology of this New Nordic Diet is based on the principles of health, gastronomic potential, Nordic identity and sustainability [39]. Poulsen et al. [40] showed that ad libitum use of the New Nordic Diet resulted in weight loss and blood pressure reduction in centrally obese individuals. The weight loss and associated improvement in insulin sensitivity were found to be associated with metabolites originating from increased consumption of fish, vegetables, fruit and whole grain [41]. Among the children within the OPUS study, increase in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in circulation were positively associated with 'school performance', indicating that fish consumption may partly explain the increase in reading performance and attention during the school day [42].

Limitations

Producing scoring indices and their use have limitations, such as selection of food groups and nutrients are made subjectively, although in the case of HNFI and BSDS the choices were made on a typical Nordic/Baltic Diet, respectively. However, both the scores were predetermined prior to the analyses of associations, but may naturally include some confounding. In addition, applying these scores might be problematic in other populations since they include food items, such as Nordic berries or a specified source of whole grain that might not be specified in the data from other populations.

Regarding dietary interventions, most often volunteers are recruited. They are often more health conscious than other individuals. Thus, the populations might not be totally representable for the average populations. This fact induces also another limitation, since there may be more drop-outs in the control groups, such in the case of SYSDIET study. This naturally may have an effect on the study results.

Conclusions

So far, it can be said that the Nordic Diet, when composed of healthy, mainly local components and foods, produces similar health effects as the Mediterranean Diet. Moreover, as a local modification of the Mediterranean Diet it should be easily acceptable to the population in the Nordic countries. It has also been shown that by consuming local Nordic food in healthier composition, the global warming potential is reduced, which further supports the use of local healthy choices [43].

Conflict of Interest
The author declares no conflict of interest.

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