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SELECTED PLANT-DERIVED POLYPHENOLS IN THE PREVENTION OF CIVILIZATION DISEASES: IMPLICATIONS FOR HEALTH AND NUTRITION EDUCATION

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ABSTRACT

Civilization diseases — including obesity, type 2 diabetes, cardiovascular disease, osteoporosis, and selected cancers — are non-communicable conditions closely tied to modern lifestyle patterns, and they account for a substantial share of premature mortality worldwide. A growing body of evidence indicates that dietary polyphenols, a broad group of plant secondary metabolites, may play a meaningful role in the prevention of these conditions. This article presents a narrative review of the literature on the classification, dietary sources, and physiological activity of the main polyphenol subgroups — flavonoids, phenolic acids, stilbenes, and lignans — and synthesizes evidence on their preventive potential in diabetes, cardiovascular disease, osteoporosis, and cancer. Amaranth is discussed as an illustrative example of a polyphenol-rich functional food. The review further considers the practical implications of this evidence for nutrition and health education, arguing that translating polyphenol research into accessible dietary guidance is an important, and currently underused, tool of non-communicable disease prevention. The findings support the inclusion of plant-based, polyphenol-rich dietary patterns in public health and patient education programs, while noting that most available evidence remains observational or preclinical and that further controlled clinical research is warranted.

KEYWORDS

Polyphenols, Flavonoids, Civilization Diseases, Non-communicable Disease Prevention, Nutrition Education, Functional Food

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Introduction

Civilization diseases — sometimes called lifestyle or social diseases — are non-communicable health conditions that nevertheless spread across whole populations as living conditions industrialize. According to Kitajewska et al. (2014), this pattern is closely tied to urban living: more sedentary jobs, faster daily routines, low physical activity, poor diet, and greater exposure to noise and pollution all combine to raise the disease burden. The same authors report that these conditions now account for more than 80% of premature deaths worldwide, that obesity rates have risen by roughly half in recent decades, and that close to 40% of adults get no regular exercise. Poland's own figures point in the same direction: Urych (2005) found that only 8–20% of families engage in leisure-time physical activity, that around a third of the population lives with a diet-related illness, and that cardiovascular disease remains the country's leading cause of premature death.

Bulska (2008) and Kitajewska et al. (2014) group these conditions into three broad domains — physical, psychological/social, and disease linked to environmental exposure — spanning cardiovascular disease, cancer, diabetes, obesity, digestive and skeletal disorders, food intolerances, and respiratory illness tied to air pollution and tobacco smoke. Siemiński (2009) draws a further distinction between direct causes — chiefly low physical activity, poor diet, and tobacco use — and indirect ones, such as industrialization, noise, urbanization, and chronic stress. Within diet specifically, Siemiński (2009) singles out an imbalanced, monotonous pattern, heavy in processed foods, salt, sugar, and animal fat and light on fiber, minerals, and vitamins, as one of the most consistently modifiable risk factors in this literature.

Because dietary behavior is modifiable and educable, nutrition and health education represent one of the most cost-effective avenues for non-communicable disease prevention. Understanding which specific plant-derived compounds contribute to disease prevention, and through which mechanisms, is a prerequisite for translating this knowledge into curricula, patient counselling, and public health messaging. This article focuses on polyphenols — a large family of bioactive plant compounds — and reviews evidence for their role in preventing selected civilization diseases, before discussing the implications of this evidence for nutrition and health education practice.

Materials and Methods

This article is a narrative review. It draws on literature collected and analyzed during the author's undergraduate thesis research on the role of selected plants in the prevention of civilization diseases (Medical University of Gdańsk, Faculty of Health Sciences, 2022), reorganized, condensed, and reframed here around the theme of nutrition and health education. Sources include Polish- and English-language peer-reviewed articles, book chapters, and institutional reports on polyphenols, flavonoids, and the prevention of civilization diseases. As a narrative review, this article does not follow a systematic search protocol and should be read as a synthesis of the literature consulted rather than an exhaustive or quality-graded appraisal of all available evidence on this topic.

Polyphenols: Classification and Dietary Sources

Polyphenols are plant-derived compounds built around one or more phenolic ring structures. Majewska and Cieczot (2009) describe their principal role within the plant itself as a defense against bacterial and fungal attack, while also pointing to the broader biological activity these compounds display once consumed. Because the human body cannot build these molecules on its own, they reach the diet only through plant foods — legumes, whole grains, fruit, vegetables, nuts, cocoa, tea, and coffee among them (Lutomski & Mścisz, 2003). Building on the number and arrangement of their aromatic rings, Lutomski and Mścisz (2003) and Majewska and Cieczot (2009) sort polyphenols into four families: flavonoids, phenolic acids, stilbenes, and lignans.

Of these four groups, flavonoids are both the largest and the most thoroughly studied. Majewska and Cieczot (2009) and Grajek (2007) break the group down further by structure: catechins, supplied mainly by green tea, apricots, cocoa, cherries, and red wine; anthocyanins, concentrated in cranberries, red wine, berries, grapes, and cereal grains; flavones, present in cereal grains, celery, and parsley; flavanols, drawn chiefly from onion and tea; isoflavones, associated almost exclusively with soybean; and flavanones, sourced from peach kernels and the white pith of citrus fruit. The remaining three families are smaller but still dietarily relevant: phenolic acids occur widely in tea, raspberries, onion, blackcurrants, and strawberries; stilbenes — resveratrol being the best known, valued for its antioxidant activity — are found in fruit, wine, and grape seeds; and lignans come from coffee, flaxseed, and cereal grains (Grajek, 2007).

Table 1 summarizes representative sources of each polyphenol subgroup discussed in this review.

Table 1. Representative dietary sources of major polyphenol classes.

Polyphenol class	Representative compounds	Common dietary sources
Flavonoids — catechins	Catechin, epicatechin	Green tea, cocoa, apricots, cherries, red wine
Flavonoids — anthocyanins	Cyanidin, procyanidins	Chokeberry, cranberries, berries, grapes
Flavonoids — isoflavones	Genistein, daidzein	Soybean and soy products
Phenolic acids	Chlorogenic, caffeic acid	Tea, raspberries, onion, blackcurrants
Stilbenes	Resveratrol	Grape skin/seeds, red wine
Lignans	Secoisolariciresinol	Flaxseed, cereal grains, coffee

Source: compiled by the author based on (Grajek, 2007; Lutomski & Mścisz, 2003; Majewska & Cieczot, 2009).

Preventive Role of Polyphenols in Selected Civilization Diseases

This section reviews evidence for the preventive role of polyphenols across the civilization diseases introduced above, followed by a case example illustrating how these compounds combine in a single functional food.

Diabetes mellitus

Rosołowska-Huszcz (2007) reviews evidence that dietary polyphenols support glycemic control in type 2 diabetes, largely through improved insulin sensitivity and reduced oxidative stress in glucose metabolism; flavonoid-family compounds and grape-seed procyanidins are among those most consistently linked to this effect. Koszowska et al. (2013) similarly place diabetes among the civilization diseases for which polyphenol-rich diets show the clearest preventive signal in the literature they reviewed. Taken together, these findings

support regular consumption of polyphenol-rich foods as a plausible, low-risk complement to standard type 2 diabetes prevention — though, as both sets of authors note, human dose-response data remain limited, and these compounds should be understood as a supporting dietary habit rather than a substitute for established medical management.

Cardiovascular disease

Of all the conditions reviewed here, cardiovascular disease has the most extensively documented polyphenol evidence base. Koszowska et al. (2013) and Biegańska-Hensoldt and Rosołowska-Huszcz (2017) describe several converging mechanisms: polyphenols with phytoestrogen-like activity appear to influence how the body synthesizes and oxidizes cholesterol, to support vasodilation and vascular elasticity, and to help lower blood pressure — effects that together point toward reduced atherosclerosis and ischemic heart disease risk. Working from a different angle, Budryn and Nebesny (2006) and Ryszawa et al. (2006) focus on anthocyanins, abundant in chokeberry and other dark-colored fruit, and report benefits for capillary permeability and elasticity along with reduced platelet hyperreactivity — changes that plausibly support healthy vascular function even if the exact clinical magnitude is still being established. Resveratrol, present in red wine and grapes, is often discussed in connection with the so-called “French paradox,” the comparatively low rate of coronary disease seen in populations with relatively high saturated-fat intake but regular red wine consumption (Biegańska-Hensoldt & Rosołowska-Huszcz, 2017); this association remains a widely cited hypothesis rather than settled causal evidence.

Osteoporosis

Estrogen deficiency is a well-established risk factor for osteoporosis, which makes postmenopausal women a particular focus of this literature. Kwiatkowska (2007) reports that isoflavones, acting as phytoestrogens, help preserve bone density in women and influence bone metabolism, in part through interaction with vitamin D–related pathways. Across the studies Kwiatkowska (2007) reviews, diets richer in phytoestrogens are associated with fewer fractures via higher bone mineral density, though — as with the diabetes evidence above — most of this work is observational rather than interventional.

Cancer

Cancer prevention research in this area has centered on lignans and isoflavones, which Koszowska et al. (2013) describe as capable of slowing the growth of estrogen-dependent tumors by suppressing enzymes involved in steroid hormone synthesis. Laskowski (2007), writing specifically on soy phytoestrogens, adds that genistein can reduce expression of matrix metalloproteinases involved in tumor angiogenesis while boosting the tissue inhibitors that counteract them. More broadly, Cierniak and Kapiszewska (2007) summarize a wider set of mechanisms across the polyphenol literature: upregulation of the body’s own antioxidant enzymes (catalase, glutathione reductase, superoxide dismutase, glutathione peroxidase), altered prostaglandin and leukotriene synthesis, inhibition of tyrosine kinases, promotion of apoptosis in malignant cells, and increased sex hormone–binding globulin. Not all of these mechanisms carry equal weight in the clinical literature, and Cierniak and Kapiszewska (2007) themselves note that much of the supporting evidence comes from cell and animal models rather than human trials.

Flavonoids have also been studied as a possible complement to chemotherapy rather than solely as a preventive agent. Chinery et al. (1997) found, in cell-based work, that selected polyphenols could protect healthy cells from chemotherapy-related oxidative damage while increasing the cytotoxic effect on malignant cells and reducing inflammation linked to myelosuppression and rapid tumor cell turnover; Cierniak and Kapiszewska (2007) reach similar conclusions in their broader review. Fruit rich in anthocyanins, chokeberry among them, has been associated in some animal studies with altered mutagen activity, changes to the cell cycle, and fewer tumors, and polyphenol-rich diets more generally have been linked to lower colorectal cancer risk (Budryn & Nebesny, 2006) — though this remains an association rather than demonstrated causation. The clinical evidence is comparatively stronger for pomegranate: Jacob and Klippel (2008) report some of the most consistent trial data supporting its use alongside standard treatment in prostate cancer, alongside favorable effects on cardiovascular markers, and propose pomegranate juice as a candidate for chemoprevention and adjuvant nutritional therapy.

Additional applications: inflammation, gut health, and neuroprotection

A wider body of evidence points to anti-inflammatory activity across multiple polyphenol classes, including chrysin, curcumin, apigenin, kaempferol, and anthocyanins, several of which downregulate pro-inflammatory mediators such as NF- κ B, COX-2, and inducible nitric oxide synthase (Owczarek et al., 2017). Polyphenol-rich foods and extracts have also shown benefit in inflammatory bowel disease and in reducing gastrointestinal disease associated with *Helicobacter pylori* infection, in some cases complementing antibiotic therapy (Krzyżek, 2017). In the context of neurodegenerative disease, oxidative stress and mitochondrial dysfunction are recognized contributors to disease onset and progression; polyphenols, through free-radical scavenging and support of mitochondrial function, have been proposed as a dietary strategy for delaying onset or progression of these conditions (Gutowska & Sierocka, 2022). Green tea catechins in particular have demonstrated anti-inflammatory, antioxidant, antithrombotic, and anti-atherosclerotic activity, alongside evidence for anticancer and weight-management effects (Całka et al., 2008).

Amaranth as a case example of a polyphenol-rich functional food

Amaranth (*Amaranthus* spp.) offers a concrete illustration of how a single polyphenol-rich plant can fit into a prevention-oriented diet; roughly 60 cultivated varieties exist worldwide. Kaźmierczak et al. (2011) and Kłoczko (2008), comparing amaranth's nutrient profile with wheat, oats, maize, and rice, report that it has the highest protein content of the group (about 18%) along with the highest fiber, mineral, and iron content; its gluten-free status further makes it a practical option for patients with celiac disease. Kaźmierczak et al. (2011) also link amaranth consumption to lower blood glucose levels, suggesting a possible role in glycemic support for people with diabetes, and to reduced cholesterol — an effect the authors connect, cautiously, to lower cardiovascular risk.

Implications for Nutrition and Health Education

The evidence reviewed above has direct relevance for educational practice in health and nutrition contexts. First, because polyphenols cannot be synthesized endogenously and their preventive effect depends on regular dietary intake, bioavailability, and the diversity of sources consumed (Biegańska-Hensoldt & Rosołowska-Huszcz, 2017), effective education must go beyond naming "healthy foods" and instead convey practical, repeatable dietary patterns — for example, encouraging habitual inclusion of berries, legumes, whole grains, tea, and unrefined plant oils rather than isolated supplementation.

Second, the evidence base is strongest for prevention rather than treatment, and educators, dietitians, and clinicians should be careful to communicate polyphenol-rich diets as a complementary, risk-reducing behavior rather than a substitute for medical therapy — a distinction that is particularly important in contexts such as oncology and chronic disease management, where patients may be receptive to dietary claims that overstate current evidence.

Third, because civilization diseases disproportionately affect populations with limited access to health information, embedding polyphenol-related nutrition content into public health campaigns, school curricula, and primary-care patient education may be a comparatively low-cost, high-reach intervention. Practical educational tools — food-source charts such as Table 1, simple visual comparisons (for example, contrasting amaranth with common cereals), and short, condition-specific guidance (for diabetes, cardiovascular disease, osteoporosis, and cancer prevention) — may improve the translation of phytochemical research into everyday dietary choices.

Finally, given that most of the evidence reviewed here derives from in vitro, animal, or observational human studies, health educators should avoid overstating certainty and should frame polyphenol-rich diets within the broader, well-established framework of physical activity, balanced nutrition, and avoidance of tobacco and excessive stress as the core pillars of civilization disease prevention (Siemiński, 2009).

Conclusions

Civilization diseases remain a leading cause of disability and premature death, and diet is among their most modifiable risk factors. This review indicates that dietary polyphenols — flavonoids, phenolic acids, stilbenes, and lignans — are associated with measurable preventive potential across diabetes, cardiovascular disease, osteoporosis, and cancer, acting through antioxidant, anti-inflammatory, and hormone-modulating mechanisms. Amaranth was presented as an illustrative functional food combining several of these properties. Translating this evidence into accessible nutrition and health education — through clear, practical, and appropriately cautious messaging — represents an important and currently underused strategy for civilization disease prevention. Future research should prioritize controlled clinical trials to clarify effective intake levels and to strengthen the evidence base available for educational and clinical use.

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