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RESEARCH ARTICLE

THE ROLE OF PHYTOCHEMICALS IN PREVENTION AND CONTROL OF CHRONIC DISEASES

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ABSTRACT

Background: Overproduction of oxidants (reactive oxygen and nitrogen species) in human body can cause an imbalance and lead to oxidative damage to large biomolecules such as proteins, lipids and DNA (Deoxyribonucleic acid) which is responsible for the development of chronic diseases. Metabolic diseases are associated to our daily lifestyle, mostly unbalanced energy-rich diet lacking fiber and bioactive compounds such as micronutrients and phytochemicals. Scavenging of these oxidants is thought to be an effective measure to depress the level of oxidative stress. Adequate dietary intake of fruits and vegetables may have protective effects against a number of diseases due to the biological protective effects of phytochemicals in these foods.

Methodology: The reviewed article was obtained by using search tools to search for studies done within the year 2013 to 2017. Key words such as phytochemicals, antioxidants, polyphenols, bioavailability and health were used in the searching. Studies were searched in journals such as PUBMED, Science direct and Mendeley desktop used in the writing and referencing of the article.

Results: Antioxidants found in popularly consumed vegetables, including red beans, have been found to prevent diabetic complications. Healthy eating practices that emphasizes consumption of plant based foods plays vital roles in the prevention of chronic diseases such as cancer, Alzheimer, cataract, heart diseases, age related function decline and stroke.

Conclusion: Health practitioners should emphasize consumption of plant based foods as per the recommendations since they play a big role in the prevention and control of chronic diseases that are of high prevalence now and affected people all over the world.

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INTRODUCTION

Phytochemicals are bioactive non-nutrient compounds in fruits, vegetables, grains and other plants. So far, about 10,000 phytochemicals have been identified (Zhang *et al*., 2015). The main two antioxidant phytochemicals are polyphenol and carotenoids. Natural polyphenol are the most abundant antioxidants in human diets and their radical scavenging activities are related to substitution of hydroxyl group in the aromatic rings of the phenols.

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Fruits with high phenolic content possess stronger antioxidant activity (Zhang *et al*., 2015). Phytochemicals including resveratrol, curcumin and anthocyanin can reduce inflammation via inhibition of prostaglandins production and nuclear factor kB-activity, enzyme inhibition as well as cytokine production. Lycopene present in tomatoes improve endothelial function of people with cardiovascular disease. Lycopene and β-carotene inhibit cell proliferation, arrest cell cycle, and increase apoptosis in human breast cancer cells (Zhang *et al*., 2015), angiogenesis/ neovascularization which is the development of new capillaries from existing and/or from preexisting vascular network and plays role in repair of system. Angiogenesis is a an important step in wound healing and some botanicals compounds have been found to modulate angiogenesis and increase the rate of wound healing (Sharad, 2016). Fruits, vegetables and other plant based foods are active

in bioactive phytochemicals that may provide desirable health benefits towards reduction of chronic diseases (Liu, 2013). Dietary phytochemicals or antioxidants have been shown to have a role in the reduction of platelets aggregation, modulation of cholesterol synthesis and absorption and lipid profiles, reduction of blood pressure and anti-inflammation (Yin *et al*., 2016). Phytochemicals plays anticancer, anti-inflammatory and antioxidant roles by regulating specific signalling pathways and molecular markers to inhibit the occurrence of cancer (Yin *et al*., 2016). Phytochemicals protect the skin by reducing inflammation and quenching free radicals through the inhibition of NF-kB (nuclear factor kappa B). They also affect other signaling pathways including; transformation growth factor beta (TGF-β). Poor bioavailability of phytochemicals may be due to their high intrinsic activity, absorption, rapid metabolism and rapid elimination and clearance from the body (Sharad, 2016). Fruits, vegetables and beverages rich in carotenoids, isoflavones, phytosterols and phytoestrogen delay the onset of atherosclerosis or act as a chemoprotective agent by interacting the underlying pathomechanisms. Phytochemicals exert their beneficial effects by reducing circulating level of cholesterol or by inhibiting lipid oxidation and others exhibit anti-inflammatory and antiplatelet (Upadhyay, 2015). The systematic review was aimed to find out what research has found out concerning the role of phytochemicals on health. The idea of the research was generated after the high burden of non-communicable diseases while focusing on the 2025 Global targets.

METHODS

The reviewed article was obtained by using search tools to search for studies done within the year 2013 to 2017. Key words such as phytochemicals, antioxidants, polyphenols, bioavailability and health were used in the searching. Studies were searched in journals such as PUBMED, Science direct and Mendeley desktop used in the writing and referencing of the article.

RESULTS

Disease development and phytochemicals

Phytochemicals from fruits, vegetables, spices and herbs to some extent have immunomodulatory and anti-inflammatory activities in the context of brain injury (Corbi *et al*., 2016). Epidemiological studies have shown that frequent consumption of vegetables, fruits which contain abundant phytochemicals, lowers the onset of some diseases (Murakami, 2013). Flavonoids have notable anti-oxidant activity which plays a major role in protection against UV light-induced oxidative damage as well as antimicrobial and antifungal activities (Murakami, 2013). Flavonoids possess properties such as anti-mutagenic activity, reducing the risk of cardiovascular diseases, anti-proliferative action on tumour cells, atherosclerosis protection, radio-protective action, hormonal repository in natural menopause women and antimicrobial activity (Pace *et al*., 2014). Flavonoids possess antioxidant, hypocholestrolemic, anti-inflammatory effects as well as ability to modulate cell signaling and gene expression related to disease development (Thilakarathna, 2013). Green tea polyphenol epigallocatechin-3-gallate (EGCg) has exhibited anti-oxidative, anti-inflammatory and chemopreventive properties in many experimental studies (Murakami, 2013).

Polyphenol provide health benefit by elimination of free radicals, protection and generation of dietary antioxidants such as vitamin E, and chelation of pro-oxidant metals (Pace *et al*., 2014). Chronic, low-grade inflammation is one of the major risk factors for brain aging. Phytochemicals present in vegetables, fruits, herbs and spices have shown relevant immunomodulatory and anti-inflammatory in the context of brain aging (Corbi *et al*., 2016). Whole grains has been shown to play a vital role in health. The specific effect of food structure (increased satiety, glycemic response and reduced transit time), antioxidant and anti-carcinogenic properties of numerous bioactive compounds especially those in germ and bran (minerals, trace elements, vitamins, carotenoids, polyphenols) all of which play part in prevention of pathogenesis (Fardet, 2010) Metabolic diseases are associated to our daily lifestyle, mostly unbalanced energy-rich diet lacking fibre and bioactive compounds such as micronutrients and phytochemicals (Fardet, 2010).

Scavenging of these oxidants is thought to be an effective measure to depress the level of oxidative stress (Zhang *et al*., 2015). Chronic inflammation is another contributing factor to development of chronic diseases cancer, cardiovascular diseases and diabetes mellitus. Adequate dietary intake of fruits and vegetables may have protective effects against coleretal cancer due to the biological protective effects of phytochemicals in these foods (Yin *et al*., 2016). Phytochemicals possess antioxidants and free radical scavenging abilities as well as anti-inflammatory activities which are basis for health benefits such as anti-aging, anticancer and protection against diabetes mellitus, cardiovascular diseases, neurodegenerative diseases and obesity (Zhang *et al*., 2015). Healthy eating practices that emphasizes consumption of plant based foods plays vital roles in the prevention of chronic diseases such as cancer, Alzheimer, cataract, heart diseases, age related function decline and stroke (Liu, 2013).

Phytochemicals health benefits

Curcumin

It's a hydrophobic polyphenol derived from turmeric. Research shows it has a potential in suppressing inflammation and inhibiting the growth of neoplastic cells (11). Curcumin down regulate the expression of survivin and (Insulin growth factor) IGF-1 by activating the expression of p53 and reducing tumor necrosis factorα (TNFα) levels leading to activation of apoptotic signals (Li, 2015). Curcumin protects the skin by quenching free radicals and reducing inflammation through NF-Kb inhibition. Curcumin also act as pro-angiogenic agent during wound healing and wound repair by regulating TGF-β(2). This phytochemical has been reported to show low or no toxicity. Curcumin has biological and physiological activities such as anti-neurodegenerative, anti-inflammatory, anti-Alzheimer disease, anti-cancer, anti-oxidative, anti-HIV activities and anti-obesity (Murakami, 2013).

Allicin

A thiosulphinate present in crushed garlic (*Allium sativum* L.) bulbs .An antioxidant organosulfur compound from garlic acid, was found to prevent the cardiovascular system by inducing vasorelaxation and alleviating cardiac hypertrophy, angiogenesis, platelets aggregation, hyperlipidemia and hyperglycemia (Zhang *et al*., 2015).

Table 1. Examples of Phytochemicals, food sources and their role in health

S/N	Phytochemical	Sources	Health benefit	Author
1.	Quercetin		• Induces apoptosis of prostate cancer cells • Exhibit antioxidant activities	(Murakami, 2013)
2.	Curcumin	Turmeric	• Enhance wound healing by activating the anti-inflammatory and reactive oxygen species	(Sharad, 2013)
3.	Sulforaphane	Cruciferous vegetables	• Interfere with early cancer development and progression	(Yin *et al*., 2016)
4.	Resveratrol	Pines, berries and nuts	• Inhibit lipid peroxidation, thrombocyte aggregation, thus playing anti-oxidation, anti-inflammatory and vasodilation roles	(Yin *et al*., 2016)

Food sources of quercetin are; apples, peppers, tomatoes, black and blue berries, citrus fruits, spinach, kale and cruciferous vegetables

Allicin is produced upon tissue breakdown from the non-proteinogenic amino acid alliin(S-allylcysteine sulfoxide) in a reaction catalyzed by enzyme alliinase. Being a thiosulphinate, allicin is a reactive sulfur species (RSS) which undergoes a redox reaction with thiol groups in glutathione and proteins that is thought to be essential for its biological activity (Borlinghaus et al., 2014). Allicin is physiologically active in microbial, plant and mammalian cells. In cancer cells, allicin induces cell death and inhibit cell proliferation. Garlic has health promoting benefits by reduction of triacylglycerol total and low density lipoprotein cholesterol concentration without altering the HDL (High Density Lipoprotein) cholesterol levels (Borlinghaus *et al*., 2014). Allicin and other thiosulphinates are known to react with cysteine to enhance antimicrobial activity (Wallock-richards *et al*., 2014). Allicin has a variety of health promoting properties, for example, blood pressure lowering and cholesterol lowering all of which have a positive effect in the cardiovascular system (Borlinghaus *et al*., 2014). The compounds formed from the decomposition of alliin play an important role in the antioxidant, protecting against some degenerative diseases and acting as antibacterial against positive and negative gram bacteria (Prati et al., 2014). Compounds of garlic prevent cholesterol from attaching on the walls of the blood vessels and thus prevention of cardiovascular diseases.

Resveratrol

Resveratrol (trans-3, 4', 5- trihydroxystilbene) belong to the stibene family of phenolic compounds that is found in pine, nuts, berries especially in the skin of red berry. Resveratrol can inhibit thrombocyte aggregation, lipid peroxidation thus vasodilation, anti-inflammatory and anti-oxidation roles (Yin et al., 2016). Resveratrol shows chemopreventive mechanism in inhibition of the three stages of cancer development; tumor initiation, promotion and progression (Murakami, 2013).

DISCUSSION

Polyphenols provide health benefits of several mechanisms, including the elimination of free radicals, protection and regeneration of other antioxidants and the chelation of pro-oxidant metals, antibacterial, anticancer and immune modulatory actions.Antioxidant activities of polyphenols like flavonoids is by scavenging of oxidizing species, superoxide union, hydroxyl radical and Peroxyl radical (Pace *et al*., 2014). Frequent consumption of vegetables and fruits with abundant phytochemicals lowers the risk of the onset of some diseases. Phytochemicals has created significant effects in the prevention of chronic diseases such as cancer, metabolic disorders and cardiovascular impairment. Polyphenol alone or in combination with other nutrients are believed to have health benefits and has proved to have pivotal role in metabolic abnormalities such as dyslipidemia, hypertension, insulin resistance, systemic inflammation, glucose intolerance and oxidative stress.

Studies have shown that fruits, vegetables and beverages with carotenoids, isoflavones, phytosterols and phytoestrogens delay the onset of atherosclerosis or act as a chemoprotective agent by interacting with underlying pathomechanisms. Phytochemicals either exert their health benefits by reducing the circulating levels of cholesterol or by limiting lipid oxidation while others exhibit antiplatelet and anti-inflammatory activities. They also neonatal thickening by inhibiting proliferation of smooth muscles (Upadhyay, 2015). Other phytochemicals such as Ferulic acidwhich is commonly found in fruits and vegetables such as tomatoes and rice corn. It decreases the level of inflammatory mediators (TNF-α, prostaglandin E2) (Corbi *et al*., 2016).

Conclusion

Poor dietary practices has contributed a big percentage in the development of chronic diseases including diabetes, hypertension, cancer, and cardiovascular diseases. Various aldehyde produced in the oxidation of PUFAs (Poly unsaturated fatty acids) and sugars are known to initiate several diseases including, diabetes, asthma, inflammation, endothelial dysfunction and atherosclerosis (Lawrence, 2013). Nutritionists, therefore, have a task of educating the communities on the health benefits of phytochemicals. Community members also need to know the foods rich in these phytochemicals and the preparation methods for enhance the bioavailability of different phytochemicals. Policies should emphasize on the different food regulations to the manufacturers to minimize malpractices of indicating availability of certain nutrients in products of which the nutrients mentioned are not presences.

List of abbreviations

DNA: Deoxyribonucleic acid
EGCg: Epigallocatechin-3-galate
HDL: High Density Lipoprotein
IGF: Insulin growth factor
PUFA: Poly Unsaturated Fatty Acids
RSS: Reactive sulfur species
TNF: Tumor Necrosis factor

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