International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

IMPACT OF NUTRITION EDUCATION ON DIETARY PHYTOCHEMICAL INTAKE ON CHILDREN

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ABSTRACT

Medications may aid in the healing process of our body, but in chronic conditions such as diabetes, hypertension, and cardiovascular illnesses, nutrition plays a crucial role and no medication can replace it. Phytochemicals may be beneficial in treating such conditions and have the potential to enhance brain health and strengthen the immune system. This enhances the resilience of our body, which directly impacts our productivity. Studies indicate that phytochemicals significantly contribute to improving the health and nutritional well-being of youngsters. Veugelers P and Heller L (2008) discovered that the eating of fruits and vegetables significantly impacts the academic performance of youngsters. Optimal nutrition throughout infancy may establish enduring dietary patterns that enhance children's overall welfare and enable them to reach their maximum potential and maintain a state of good health. Teaching youngsters about proper nutrition fosters their ability to function well and sustain a healthy way of life throughout adulthood. Implementing an educational intervention focused on promoting healthy eating habits and physical exercise in schools has the potential to reduce the prevalence of childhood obesity.

KEYWORDS: Nutrition education, dietary, phytochemical intake, children, hypertension, and cardiovascular illnesses, nutritional well-being

INTRODUCTION

Healthy eating pattern in childhood and adolescence promotes optimal growth, intellectual development, prevent immediate health problems, such as iron deficiency anemia, obesity eating disorders and minimizes the risk of long term health problems such as coronary heart diseases, cancer and stroke. Assessment of nutritional status and food practices of children can be helpful in making nutrition education interventions which are needed to adopt long term healthy eating behaviour.

In present study, following recommendations had come out from obtained results and observations on the basis of assessment of anthropometric measurements, biochemical assessment, nutrient intake, health status, academic performance and knowledge, attitude and food practices in relation to phyto-intake (fruits and vegetables).These points should be thoroughly reviewed in making strategies for the promotion of health and nutrition of school going children in planning nutrition education guidelines for long term health benefits.

TYPES OF PHYTOCHEMICALS

i. Alkaloids:

Alkaloids are a diverse class of organic compounds that consist of nitrogen, carbon, hydrogen, and often oxygen. Alkaloids may impact the central nervous system (CNS), which includes the nerve cells in the brain and spinal cord that regulate many bodily processes and behavior. Additionally, they may impact the autonomic nervous system, which governs the control of internal organs, heart rate, blood flow, and respiration. Indole alkaloids are characterized by the presence of the indole carbon-nitrogen ring, which is also present in the fungal alkaloids ergine and psilocybin, as well as the psychoactive substance Lysergic acid diethylamide (LSD). These alkaloids have the potential to disrupt or vie with the activity of serotonin in the brain. The source cited is Dip R. and Gmuender, 2009. Vinpocetine is an alkaloid derived from Vinca minor and is a very strong vasodilator. Vinpocetine has been shown in clinical research to specifically improve blood flow and metabolism in the brain. This includes an increase in glucose absorption, which may help guard against the negative consequences of low oxygen levels (hypoxia) and reduced blood supply (ischemia).

ii. Flavanoids

Flavonoids are polyphenolic compounds that are soluble in water and consist of 15 carbon atoms. Flavonoids are classified as polyphenols. Flavonoids are present in the majority of plant matter. Key dietary sources include fruits, tea, and soybeans. Both green and black tea include around 25% flavonoids. Additional significant sources of flavonoids are apples (containing quercetin) and citrus fruits (containing rutin and hesperidin). Flavonoids possess several beneficial properties such as anti-allergic, anti-cancer, antioxidant, anti-inflammatory, and anti-

viral actions. Research has shown that flavonoids inhibit the oxidation of low-density lipoprotein, hence decreasing the likelihood of atherosclerosis. Red wine is rich in flavonoids, including quercetin and rutin. The French paradox may be attributed to the French population's elevated consumption of red wine, which is rich in flavonoids. This high intake maybe accounts for their lower incidence of coronary heart disease compared to other Europeans, despite their greater consumption of cholesterol-laden diets.

iii. Anthocyanins

Anthocyanins are hydrophilic phytochemicals that have a characteristic hue ranging from red to blue. They are present in plant tissues, such as leaves, stems, roots, flowers, and fruits. They mostly exist as glycosides of anthocyanidins, including cyanidin, delphinidin, peonidin, pelargonidin, petunidin, and malvidin. Anthocyanins are abundant in several plants, with particularly high concentrations reported in acai, blackcurrant, blueberry, bilberry, cherry, red grape, and purple maize. Among fruits, apples have a significant amount of quercetin. The phenolic compounds, specifically catechins and epicatechins, found in green tea have the ability to safeguard neurons against various oxidative and metabolic harm. This includes shielding dopaminergic neurons from harm caused by 6hydroxydopamine in a rat model of Parkinson's disease, protecting retinal neurons against injury from ischemia reperfusion, and decreasing the misfolding and neurotoxicity of mutant huntingtin in models of Huntington's disease.

iv. Carotenoids

The pigments, which exhibit a high concentration, manifest as hues of yellow, orange, and red, and may be found in many fruits and vegetables. Carotenoids consist of two distinct categories of chemicals, namely carotenes and xanthophylls. Carotenes have tissue-specific biological action, with betacarotene possessing vitamin A activity. Beta-carotene, lycopene, and lutein provide protection against uterine, prostate, breast, colorectal, and lung cancers. Additionally, they may provide protection against the chance of developing cancer in the digestive system. Xanthophyll carotenoids provide defense for other antioxidants and may provide protection that is particular to certain tissues. Zeaxanthin, cryoptoxanthin, and astaxanthin belong to the xanthophylls category.

Beta-carotene, a member of the terpenoid group, is the most prevalent kind of carotene. Beta-carotene in its pure form appears as an oil with a red to purple color. It lacks solubility in water. The solubility of beta-carotene in beverages is achieved by encapsulating it with either starch or gelatin.Beta-carotene is present in pigmented fruits and vegetables such as mango, apricot, sweet potatoes, carrots, kale, broccoli, spinach, turnip greens, winter squash, and collard greens.

v. Hydroxycinnamic Acids

Chicoric acid: Chicoric acid is a derivative of caffeic acid and is classified as a polyphenol compound. Chicoric acid has the highest level of activity among the compounds found in Echinacea pupurea. Chicoric acid has high stability under dry circumstances, but it undergoes enzymatic degradation in the presence of moisture, facilitated by the enzymes present in Echinacea.Chicoric acid is only present in Echinacea purpurea.

Coumarin: Coumarin is a plant-derived compound that has a flavor reminiscent to vanilla. Coumarin is an oxygen-containing heterocycle. Coumarin may exist in two forms: as a free compound or as a compound bound to the sugar glucose, known as coumarin glycoside.

Coumarin is present in several plants such as tonka beans, lavender, licorice, strawberries, apricots, cherries, cinnamon, and sweet clover.

Ferulic acid: Ferulic acid in its pure form is a powder with a yellowish color. It is classified as a member of the hydroxycinnamic acid family. Ferulic acid, a phytochemical, is present in the leaves and seeds of several plants, with a particularly high concentration in grains such brown rice, whole wheat, and oats. Coffee, apple, artichoke, peanut, orange, and pineapple also contain ferulic acid.

vi. Isoflavones

Populations in China, Japan, Taiwan, and Korea are believed to have a high intake of isoflavones. Women in these countries report fewer cases of osteoporosis and related health issues, such as hot flushes, cardiovascular diseases, and hormone-dependent breast and uterine cancer.

vii. Lignans

These compounds are very intriguing due to their estrogenic, anticarcinogenic, antiviral, antifungal, and antioxidant

properties (Cos P. et al., 2003). Flaxseed, asparagus, whole grains, veggies, and tea are rich sources of phytolignans. In humans, the ingestion of plants containing high levels of isoflavones and lignans leads to enzymatic metabolic transformations in the intestines, facilitated by microorganisms. As a result, the mammalian lignans are easily absorbed. (Prakash et al., 2011) The reference is from a paper by Cos P. and colleagues published in 2003. The reference is from a study conducted by Ikeda K. et al. in 2002.

viii. Monophenols

Hydroxytyrosol: Hydroxytyrosol is considered to have the greatest potential for scavenging free radicals among antioxidants, being twice as effective as quercetin and more than three times as effective as epicatechin. The waste fluids produced during olive processing include significant concentrations of hydroxytyrosol, a compound that may be largely extracted to get hydroxytyrosol extracts. Hydroxytyrosol is the primary polyphenolic compound present in olives.

ix. Monoterpenes

Geraniol: Geraniol is a kind of acyclic monoterpene alcohol. Geraniol in its pure form is a transparent viscous liquid, with a pleasant aroma reminiscent of roses. Geraniol undergoes oxidation to become either geranial or citral. The following ingredients are included: bergamot, carrot, coriander, lavender, lemon, lime, nutmeg, orange, rose, blueberry, and blackberry.

x. Organosulphides

Allicin: Allicin serves as garlic's means of protection against insect invasions. When the garlic plant is subjected to an assault or sustains an injury, it generates allicin via an enzyme process. Alliinase, an enzyme, transforms the compound alliin into allicin, a substance that is harmful to insects and bacteria. Cavallito discovered the antibacterial properties of allicin in 1944. Commercial distribution of purified allicin is not feasible due to its inherent instability and unpleasant odor. The allicin obtained from garlic undergoes a loss of its advantageous characteristics within a few hours and transforms into other molecules that include sulphur. Diallyl trisulfide, a chemically synthesized compound related to allicin, exhibits stability and is used for the therapeutic management of bacterial, fungal, and parasite illnesses. Allicin is the most abundant thiosulfinate compound found in garlic (Allium sativum). Allicin is the compound accountable for the

characteristic and unpleasant smell of garlic.

***Glutathione*:** Glutathione is a sulfur-containing tripeptide consisting of cysteine, glutamic acid, and glycine. Glutathione is mostly found in animal products, but it is also present in several plants such as avocado, asparagus, broccoli, grapefruit, potato, strawberries, orange, tomato, peach, and spinach.

xi. Phenolic acid

Capsaicin: The substance known as pure capsaicin is a powder that has a crystalline structure and appears white in color. Capsaicin is a member of the alkaloid family and is classified as a capsaicinoid. It has remarkable thermal stability and retains its functionality even when subjected to cooking. Capsaicin has limited solubility in water, while displaying high solubility in ethanol and vegetable oil. Capsaicin is the specific phytochemical found in chili peppers that is responsible for the characteristic sensation of heat.

***Ellagic Acid*:** Ellagic acid is a polyphenol consisting of four fused rings. The cream to light yellow crystalline solid is composed solely of ellagic acid. Ellagic acid is found in several red fruits and berries such as raspberries, strawberries, blackberries, cranberries, pomegranates, as well as some nuts like pecans and walnuts. Raspberries have the greatest concentrations of ellagic acid. Ellagic acid in plants exists as ellagitannin, a compound formed by the binding of ellagic acid to a sugar molecule.

Gallic acid: Pure gallic acid is a colourless crystalline organic powder. Gallic acid occurs as a free molecule or as part of a tannin molecule. Gallic acid is found in almost all plants. Plants known for their high gallic acid content include gallnuts, grapes, tea, hops and oak bark.

Rosmarinic acid: Pure rosmarinic acid is a cream coloured powder. Rosmarinic acid belongs to the group of polyphenols. Rosmarinic acid is found in big quantities in oregano, lemon balm, sage, marjoram, rosemary.

Tannic Acid: Tannic acid is odourless but has a very astringent taste. Pure tannic acid is a light yellowish and amorphous powder.Tea, nettle, wood, berries, Chinese galls. Oak wood is very rich in tannic acid. When wine is kept in oak kegs some tannic acid will migrate into the wine. High levels of tannic acid are found in some plant galls. These are formed by plants when they are infected by certain insects. These insects

pierce the plant leaves and when the egg hatches out into a larva the plant produces a gall which surrounds the larva.

xii. Phytosterols

Beta-Sitosterol: Beta-sitosterol is a phytosterols or plant sterol. The structure of beta-sitosterol is similar to that of cholesterol. Beta-sitosterol differs from cholesterol by the presence of an extra ethyl group. There are many plant sources of betasitosterol, but the most important are wheat germ, rice bran, flax seeds, peanuts, soybeans, pumpkin seeds and corn oil.

xiii. Triterpenoids

Ursolic acid: Ursolic acid is a is a pentacyclic triterpenoid.Ursolic acid is present in many plants, including apples, bilberries, cranberries, elder flower, peppermint, lavender, oregano, thyme, hawthorn, prunes.

xiv. Xanthophylls

Astaxanthin: Astaxanthin is a red carotenoid pigment. Astaxanthin is similar in structure than beta-carotene. The small differences in structure cause large differences in the chemical properties. Astaxanthin is produced by microscopic small plants: the micro-alga Haematococcus pluvialis. Haematococcus algae can contain up to 30 gm of astaxanthin per kg dried algae.

Beta-Cryptoxanthin: Beta-cryptoxanthin belongs to the class of carotenoids, more specifically the xanthophylls. In the human body, beta-cryptoxanthin is converted to vitamin A (retinol) and is therefore considered as a pro-vitamin. The phytochemical beta-cryptoxanthin can be found in many vegetables and fruits, mainly in papaya, mango, peaches, oranges, tangerines, bell peppers, corn and watermelon. Betacryptoxanthin is also found in some yellow coloured animal products such as egg yolk and butter. **xv. Stylbenes**

Pterostilbene: Pterostilbene is a stilbenoid phytochemical with structure similar to that of resveratrol (pterostilbene contains two extra methyl groups). Pterostilbene is more stable than resveratrol and has a higher bioavailability. It is found in foods such as peanuts, blueberries and grapes. Plants produce it to fight infections.

Resveratrol: Ellagic acid is a polyphenol composed of four fused rings. The cream to light yellow crystalline solid is composed solely of ellagic acid. Ellagic acid is found in several red fruits and berries such as

raspberries, strawberries, blackberries, cranberries, pomegranate, as well as some nuts including pecans and walnuts. Raspberries provide the most abundant amounts of ellagic acid. Ellagic acid in plants exists as ellagitannin, a compound formed by the binding of ellagic acid to a sugar molecule resveratrol are found *(Cornwell T., Cohick W. and Raskin I., 2004)*

xvi. Other Phytochemicals

Damnacanthal: Damnacanthal is an anthraquineone. Pure damnacanthal is a orangeyellow solid. Damnacanthal is found in noni fruit.

Digoxin: Digoxin is a glycoside composed of 3 sugars and a cardenolide. Pure digoxin is an odourless white crystal. Digoxin is not soluble in water. Digoxin is mainly found and extracted from the leaves of foxglove (digitalis) plant**.**

***Phytic acid*:** In plants phytic acid is the principal store of phosphate. Phytic acid is a natural plant antioxidant. Phytic acid can be found in most grains, seeds and beans. Rich sources of phytic acid are wheat bran and flaxseed (3 % phytic acid).

***Catechins*:** Catechins are polyphenols exhibiting neuroprotective activities that are mediated, in part, by activation of protein kinase C (PKC) and transcription factors that induce the expression of cell-survival genes. *(Prakash D. et al., 2011)* Catechins have been suggested to suppress the pathogenesis of Alzheimer's disease, and to protect neurons against the processes of Alzheimer's disease. Major sources of catechins are grapes, berries, cocoa and green tea. Tea contains considerable amounts of gallic acid esters, such as epicatechin, epicatechingallate and epigallocatechingallate (EGCG). Numerous studies have suggested that these components provide protective benefits by their free radical scavenging ability and their inhibition of eicosanoid synthesis and platelet aggregation. *(Nichenametla S.N. 2006) (K.P. Ko, 2010)*

Coumestans: The main dietary sources of coumestans are sprouted legumes such as soy, and alfalfa; however low levels have been reported in brussel sprouts and spinach. Clover and soybean sprouts are reported to have its highest concentration.

Lignan: Lignan refers to a varied group of phenylpropanoid dimers and oligomers. Secoisolariciresinol and metaraminol are a pair of lignan dimers. These compounds are very intriguing due to their estrogenic, anticarcinogenic, antiviral, antifungal, and

antioxidant properties (Cos P. et al., 2003). Flaxseed, asparagus, whole grains, veggies, and tea are rich sources of Phyto lignans. In humans, the ingestion of plants containing high levels of isoflavones and lignans leads to enzymatic metabolic changes in the intestines, facilitated by microorganisms.

THE POTENTIAL HEALTH BENEFITS FROM SOME PHYTOCHEMICAL COMPOUNDS

Table1

Foods	P h y t o chemicals	Possible Benefits
Soy Beans, Soy Milk, and Tofu	Isoflavones Genistein and Daidzein	A reduction in blood pressure and increased vessel dilation
Strawberries ,Red Wine, Blueberries	Anthocyanins	Improveme nt of vision, inhibition of nitricoxide production, induction of apoptosis, decreased platelet aggregation, and neuro protective effects
Red Wine, Grape Juice, Grape Extracts, Cocoa	Proanthocyan idins and flavan-3-ols	Inhibition of LDL oxidation, inhibition of cellular oxygenases, and inhibition of proinflamm atory responses in the arterial wall
Garlic, onions, leeks, olives, scallions	Sulfides, thiols	Decrease in LDL cholesterol
Carrots, tomatoes, and tomato products, and various types of fruits and vegetables	Carotenoids such as lycopene, beta-carotenes	Neutralizati on of free radicals that cause cell damage
Broccoli and other cruciferous vegetables such as kale, horseradish	Isothiocyanat es (sulforaphane)	Neutralizati on of free radicals that cause cell damage and protection against some cancers

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THE NUTRITION RAINBOW

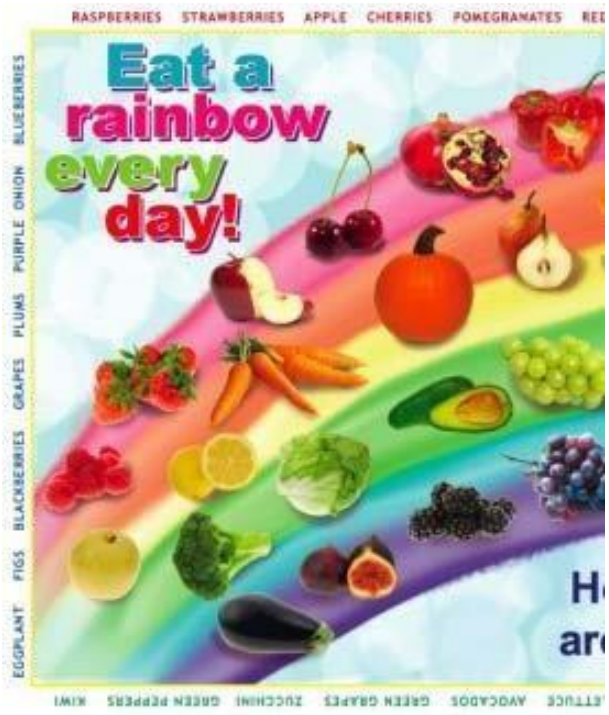

Figure 1 Source: www.worldpress.com

Various fruits exhibit distinct hues based on the specific phytochemicals they contain. It organizes colors into 5 distinct groupings. Figure 2 To get maximum benefits from fruits and vegetables, it is crucial to consume a diverse range of colorful produce from each color group.

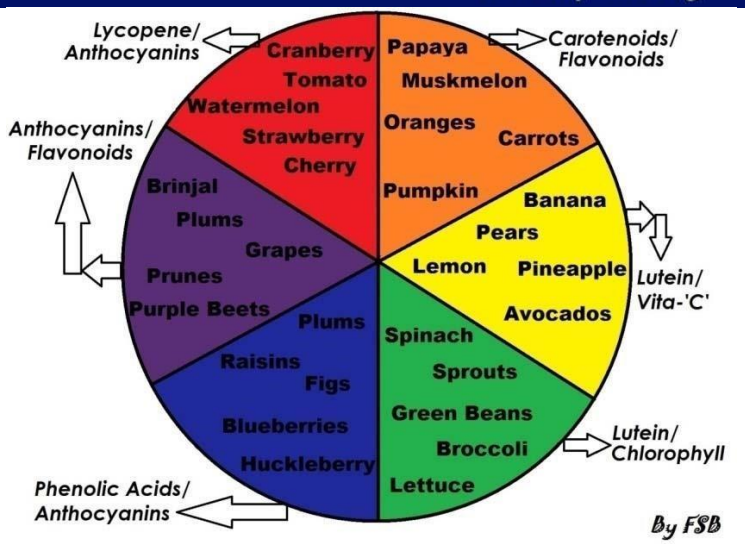

Figure 2 Deep Oranges and Bright Yellows:

Carrots, pumpkins, mangoes, peaches, oranges, and grapefruit contain Beta-carotene is an antioxidant that enhances the functioning of the immune system. Flavonoids has the ability to inhibit the proliferation of cancer cells and may be found abundantly in many fruits such as oranges, lemons, grapefruit, and peaches.

Deep Greens: Green vegetables such as spinach, lettuce, broccoli Green peas, are excellent sources of lutein. Broccoli, cauliflower, cabbage, and Brussels sprouts all contain indoles.

Deep red and bright pink: Watermelons, pink grapefruits, and tomatoes are all good sources of lycopene. Tomato-based products, such as tomato sauce, tomato

soup, and tomato juice have the most concentrated source of lycopene. Cooked tomato sauces are associated with greater health benefits, compared to uncooked, because of the heating.

Blues and purple: Blueberries, blackberries, grapes, plums, raisins and eggplant all contain the disease-fighting phytochemicals anthocyanin and polyphenols. These powerful antioxidants help reduce the risk of several diseases including cancer, heart disease and Alzheimer's, and may even slow down the aging process.

Whites: Garlic, onions and leeks may be lacking color, but they are bursting with powerful phytochemicals, including Allicin. Phytochemicals such as allyl sulfides and quercetin exhibit antioxidant effects and support the immune system from foods such as garlic, onions.

CONCLUSION

The impact of nutrition on health is significant at every stage of life, and it is most effective to initiate preventive measures at an early stage. Early in childhood, habits are established and they significantly influence dietary preferences in the future. The study has been designed to investigate the correlation between phytochemicals present in commonly consumed fruits and vegetables among school-going children and various variables such as weight, haemoglobin levels, nutrient intake, frequency of infections, and academic performance. The aim is to establish a strong foundation for a healthy body from early childhood, leading to a healthy adulthood and elderly life, through nutrition education.

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