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BIO ACTIVE COMPONENTS IN FRUITS AND VEGETABLES – POTENTIAL SOURCES FOR FOOD TO FOOD FORTIFICATION

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ABSTRACT

Fruits and Vegetables are an important part of a healthy diet, and variety is as important as quantity. By having a variety of types and colors of produce i.e., dark leafy green Vegetables, brightly colored red, yellow and orange vegetables and fruits in fresh or processed forms delivers the essential nutrients of the body which it needs. The bioactive components which are available only in fruits and vegetables are also equally exhibits antioxidant properties of micronutrients. A wide variety of processed food products has developed by the different food product innovators through applying different techniques in consideration of health view, minimizing food losses and extension of availability of food products in non-season also. Even though plenty of healthy food products are processing in now-a-days, still some non-nutritional factors i.e., inhibitors hinders the absorption of nutrients from the products. This is due to purely following of planning and preparation of unbalanced food combinations. One of the emerging and sustainable food based strategy is Food to Food fortification which consist of dietary modifications to either include in a meal that can promote the absorption of nutrient or to exclude foods that inhibit nutrient absorption. Fruits and Vegetables which are rich in bio active components are the potential sources for developing food based approaches such as Food to Food fortification to mitigate nutritional deficiencies.

KEY WORDS

Fruits and Vegetables, Bio active constituents, Processed food products and Food to Food Fortification.

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INTRODUCTION

Fruits and vegetables constitute together with other groups of food should be promoted as favorable in all periods of life. Both fruits and vegetables are an important part of our diet and the benefits they exert on health become more evident every day. When determining the dietary importance of a foodstuff, nutrients often are the only elements considered, whereas in actual fact there are other known food components called 'non-nutrients' that are of

enormous interest with regard to health. In some cases they have important physiologic properties and are therefore considered bioactive substances. These substances are named "phytochemicals" when they are found in plants. Among these phytochemicals some stand out because, in addition to having beneficial properties, they give fruits and vegetables their colour.

Plant pigments in Fruits and Plants

Chlorophylls (Glucosinolates)

The compounds that give green vegetables their colour are called glucosinolates. Glucosinolates are a large group of sulphur-containing amino acid derivatives. Certain glucosinolates and their breakdown products have been linked to a reduction in the prevalence of certain types of cancer. The anticarcinogenic effect of glucosinolates is explained by the activation of enzymes involved in the detoxification of carcinogens, inhibition of enzymes modifying steroid hormone metabolism, and protection against oxidative damage (Hounsome, N. *et al*.).Glucosinolates are found in broccoli, cauliflower, Brussels sprouts and cabbage (Heber, D. *et al*.).Green leafy vegetables also contain high amounts of iron and folic acid, and the ascorbic acid or vitamin C present in them facilitates iron absorption.

Carotenoids

The phytochemicals responsible for orange colour in fruits and vegetables such as carrot, mango, or pumpkin are the carotenoids α- y β-carotene. Carotenoids belong to the class of isoprenoid lipids and derive their colour from conjugated carbon-carbon double bonds in the chemical structure. Between 40 and 50 carotenoids are present in our diets that can be absorbed, metabolized, or used by our organism. In particular, α and β-carotene are very important in the diet because they are vitamin A precursors, which are also called provitamin A. Vitamin A is involved in hormone synthesis, regulation of cell growth and differentiation, and immune responses (Hounsome, N. *et al*.).

Lycopenes and Anthocyanins

The red colour of fruits and vegetables such as tomato, watermelon, or grapefruit, is due to the compound lycopene (also belonging to the carotenoids, like α- and β-carotene), and the red-purple colour of grapes, berries, raspberries and cranberries is caused by anthocyanins (Heber, D. et al.). Lycopene has a very strong antioxidant capacity, plays a role in cell communication, and there is experimental evidence that it protects against prostate cancer, cardiovascular disease.

Anthocyanins have antioxidant properties that have been demonstrated in both *in vitro* and *in vivo* experiments. It has also been suggested that anthocyanins are very important in preventing carcinogenesis and mutagenesis (Lazzè, M. C., *et al*.).

Xanthins

The flavonoids which are the largest group of phenolic compounds, together with β-cryptoxanthin are responsible for the light orange to yellow colour of fruits such as peach, papaya or orange (Heber, D. *et al*.).

Dietary flavonoids possess antiviral, anti-inflammatory, antihistamine and antioxidant properties. They have been reported to inhibit lipid peroxidation, scavenge free radicals, chelate iron and copper ions, and to modulate cell signalling pathways. Production of peroxides and free radicals has been linked to cancer, aging, ischemic injury, and neurodegenerative diseases such as Parkinson's and Alzheimer's disease. Flavonoids protect low-density lipoprotein cholesterol from being oxidized, thus preventing the formation of atherosclerotic plaques in the arterial wall.

β-cryptoxanthin like β-carotene or lycopene is a carotenoid, and as such has an important function as biologic antioxidant, protecting cells and tissues from oxidative damage (Hounsome. N. *et al*.).

Xanthophylls

These colours in vegetables are due to zeaxanthin and lutein, both pigments that belong to a group called xanthophylls, which in turn are a member of the carotenoid family. They bring about yellowish colours, even though many times they are hidden by the green colour of chlorophyll, e.g. in spinach or avocado. The list of various bioactive food components, common food sources, and its functions are tabulated in Table No.1.

Antioxidant potentiality of phytochemicals

A great number of research activities in the field of health related dietary aspects have demonstrated a significant link between the regular intake of phytochemicals (e.g. polyphenols, carotenoids, phytosterols), and the prevention of life-style related diseases, such as cancer, obesity, diabetes and cardiovascular complications (Greselea, 2011).

As a natural source of these phytochemicals, especially the consumption of whole foods (e.g. coloured fruits and vegetables), has been suggested to be of health benefit (Liu, 2003). Research studies have shown that a polyphenol mixture including anthocyanins, proanthocyanidins and flavonols, naturally occurring in certain red and blue berry fruits, had a stronger activity against cancer cells than purified polyphenols (Herring and Albrecht, 2005). Similar to this finding, the consumption of purified lycopene resulted in a minimal protection against prostate cancer in rats, whereas the consumption of tomatoes lowered this risk more successfully by 26% (Boileau *et al*., 2003).

The potent antioxidant and anticancer activities can be assumed to be due to the additive and synergistic effects of phytochemicals and nutrients, when occurring in a complex mixture in fruits and vegetables (Liu, 2004). This may also explain why no single antioxidant can replace natural compounds in fruits and vegetables to achieve similar health benefits.

There is also increasing evidence that consumption of whole foods is better than isolated food components such as dietary supplements and nutraceuticals. For example, increased consumption of carotenoid -rich fruits and vegetables was more effective than carotenoid dietary supplements in increasing LDL oxidation resistance, lowering DNA damage, and inducing higher repair activity in human volunteers who participated in a study conducted in France, Italy, The Netherlands, and Spain (Southon 2000).

In another study, adding antioxidant (vitamins A, C, and E) dietary supplements into the diet of cancer treatment patients who were eating a balanced diet of fruits and vegetables negatively affected their radiotherapy and chemotherapy (Seifried *et al*. 2003). High consumption of tomatoes and tomato products has been linked to reduced carcinogenesis, particularly prostate cancer, and has been thought to be due to the presence of lycopene, which gives red tomatoes their color (Giovannucci 2002). However, use of tomato powder effectively reduced prostate carcinogenesis in rats, while lycopene supplements, considered the primary active ingredient of tomatoes, had no effect (Boileau *et al*. 2003).

A primary mechanism for immune-modulation is the multiple antioxidant capability of polyphenols, tocopherols, carotenoids, isothiocyanates, and allyl sulfides. Together these compounds are able to reduce the deleterious effects of reactive oxygen species and free radicals, which cause premature death of immune cells (Brennan *et al*.).

Bioactive food components have also been shown to stimulate the phagocytic action of macrophages and synthesis of several immune cell types, which increases the protection against infection. Among the foods that have been shown to have beneficial immuno-modulatory effects are broccoli, garlic, onions, vegetable oils and almonds.

GOOD SOURCES OF ANTIOXIDANTS

Many foods are good sources of antioxidants. There is a huge range of antioxidant systems, and scientists haven't yet determined exactly how all the different systems work together in our bodies to protect us from free-radical damage. No one antioxidant can provide the protection offered by the many antioxidants working together. Some vitamins are antioxidants, such as vitamins C and E. Some minerals are antioxidants, such as selenium and manganese, and there are plant compounds that act as antioxidants such as beta carotene and lycopene, terms you may have heard before or seen in ads for vitamin supplements.

The best way to get a variety of antioxidants in the diet is to eat foods that represent all the colors of the rainbow. Each color provides its own unique antioxidant effects. Bright orange, deep yellow fruits and vegetables like carrots, sweet potatoes, and apricots provide one type of antioxidant. Red foods like tomatoes, provide another. Green vegetables, such as broccoli and cabbage, and blue or purple

foods, like blueberries and eggplant, each have their own antioxidant packages. Different types of antioxidants, their possible effects, and food sources are presented in the Table No.2.

Application in Food Based Approaches

Because of a wide range of positive health benefits of fruits and vegetables and evidences indicating that people has showing more interest on consumption of whole foods than dietary supplements, there is a need to develop several approaches to retain the active principles in fruits and vegetables as well promote various food technologies incorporating them. A number of food based approaches are currently in practice to address the nutritional deficiencies. One such approach is Food-to-Food Fortification.

In food fortification technology, chemical or extracted forms of nutrients have been adding to the vehicles to recover the loss of nutrients whereas, in Food to Food Fortification, select food combinations are using to enhance the bio availability of nutrients. It can apply at home level also. This process empowers households to take ultimate responsibility over the quality of their diet through own production of nutrient rich foods. Daily inclusion of such seasonal fresh and unseasonal processed food products may reduce the susceptibility of micronutrient deficiencies.

Table No.1: List of various bioactive food components, common food sources, and its functions

S.No	Bioactive component	Food source	Function
1	Glucosinolates, diallyl sulfides, isothiocyanates	Broccoli, cauliflower, brussels sprouts, garlic, onions	Induction of detoxifying enzyme systems, antimicrobial, immunomodulator, anticancer
2	Tocopherols and tocotrienols	Vegetable oil, nuts, seeds	Antioxidant, immunomodulator
3	Isoflavonoids and polyphenols	Grapes, red wine, tea, fresh fruit, and vegetables	Antioxidant, lipid- lowering, immunomodulator, antiosteoporotic, anticancer
4	Phytoestrogens (genistein, daidzein)	Soybean and other soy-based products, flaxseed, cabbage, legumes, tea	Antiestrogen, anti- osteoporotic, antiproliferative
5	Phytosterols	Vegetable oils, nuts	Lipid-lowering
6	Dietary fiber	Whole grains, oats, fresh fruit with skin	Lipid-lowering
7	γ-linolenic acid, α-linolenic acid, and omega-3 fatty acids	Evening primrose or borage oil, walnuts, rapeseed, flaxseed, fish, microalgae	Anti-inflammatory, lipid- lowering
8	Lutein	Green leafy vegetables	Reduction in age- related macular degeneration
9	Carotenoids	Carrots, corn, squash, green leafy vegetables, oranges, papaya, red palm oil	Antioxidant immunomodulators
10	Lycopene	Tomatoes	Antiproliferative, anticancer

Table No.2: Different types of antioxidants, their possible effects and food sources

Chemical Name	Possible Effects	Food Sources
Carotenoids (beta-carotene, alpha-carotene, gamma-carotene, lycopene, beta-crpytoxanthin, zeaxanthin, and astaxanthin, lutein, and many other related compounds)	Neutralizes free radicals which may damage cells; bolsters cellular antioxidant defenses; possible potential anti-cancer and ant-aging compounds; may enhance the function of the immune system and reduce the risk of many diseases.	Deeply pigmented fruits and vegetables (carrots, sweet potatoes, spinach, kale, collard greens, tomatoes)
Flavonoids (include quercetin, rutin, hesperidin, apigenin and luteolin)	Bolster cellular antioxidant defenses; may contribute to maintenance of brain function; may contribute to heart health and boost immune defenses; may contribute to vision and urinary tract health.	Apples, apricots, blueberries, pears, raspberries, strawberries, black beans, cabbage, onions, parsley, pinto beans, black tea, celery, citrus fruits, green tea, olives, oregano, purple grapes, purple grape juice, soybeans and soy products, vegetables, whole wheat, wine
Isothiocyanates	May enhance detoxification of undesirable compounds and bolster cellular antioxidant defenses by deactivating carcinogens, counteracting the effects of carcinogens that have been activated, and speeding up their removal from the body; may reduce risk of breast cancer, prostate cancer	Cruciferous or "cabbage family" vegetables such as broccoli, cauliflower, kale, turnips, collards, Brussels sprouts, cabbage, Chinese cabbage, bok choy, radish, and watercress
Resveratrol	May protect the lining of blood vessels in the heart; may prevent inflammation, reduce LDL cholesterol, and prevent blood clots.	Red wine, red and purple grapes and juice, peanuts, blueberries, cranberries
Tannins	May decrease the risk of cancer, potential antiviral, antibacterial and antiparasitic effects.	Pomegranates, persimmons, nuts, lentils, red and white wine, green tea

CONCLUSION

Bio active food components will play an important role in health maintenance. They are the non-essential bio molecules that are present in foods; exhibit the capacity to modulate one or more metabolic processes, which results in the promotion of better health. In combination of these molecules with the nutrient constituents which are available plentiful in food serves multiple functions to the body and strongly aids in the correction of nutritional deficiencies. Consumption of seasonal fresh produce and preparation of high produce into processed ones through food to food fortification increases the bio availability of nutrients thereby reduces the micronutrient deficiencies. Appropriate utility of locally available foods and inclusion of well-planned food combinations improves the standards of healthy living.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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