Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 03 (MAY-JUNE, 2024)
Available online at http://www.agriarticles.com

Exploring the Nutritional Benefits of Fruits and Vegetables

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Abstract
The study presents a comparison of some nutritional values of juices made from organic and conventional apple, pear, blackcurrant, carrot, beetroot and celery. Fruits and vegetables are considered essential for well-balanced diet since they supply minerals, protein, vitamins, fibers, and phytochemicals. Some of the phytochemicals of vegetables are strong in antioxidant and are thought to reduce the risk of chronic disease. The chapters include the nutritive value and health benefits of fruits and vegetables and the amount of nutrition we get per 100 grams of vegetables and fruits.

Keywords: Nutritive value, minerals, vitamins, phytochemicals, consumption.

Introduction
Fruits and vegetable play important role in our day-to-day life. India is the second largest producer of fruits and vegetable after china. India accounts 13.59% of fruit production and 14.04% of total vegetable production in the world. Fruits and vegetables are the good source of vitamins and minerals. According to WHO, a person has to consume 400 gm of fruits and vegetables per day to maintain a healthy lifestyle as well as for prevention and alleviation of several micronutrients' deficiencies, potatos, sweet potatos, cassava and other starchy roots are not classified as fruits and vegetables.

Epidemiological studies have shown the importance of diet rich in fruits and vegetables in the prevention of illness such as heart disease cancer, metabolic disorder, nutritional anemia etc., low plasma level of micronutrient with antioxidant property, often found in fruits and vegetable are associated with increased risk for this disease. In this chapter, we describe the main nutritional components and non-nutritional antioxidants present in fruits and vegetables, with special reference to the latest advancements. The influence of species, cultivar, maturity stage and postharvest storage conditions on these components is discussed.

Benefits of Fruits and Vegetables
- Provide vitamins and minerals including folate and vitamin C and potassium.
- Provide dietary fiber which helps to maintain a healthy gut and prevent constipation and other digestion problems.
- It is an inexpensive source for alternative for micronutrients.
- It is essentials for maintaining for wide variety of metabolic functions critical for health.
- It is a good source of acid (citric acid, tartaric acid and malic acid).
- Vitamin A keeps eyes and skin healthy and helps to protect against infections. Excellent fruit and vegetable sources of vitamin A are sweet potatoes, pumpkin, carrots, spinach,

turnip greens, mustard greens, kale, collard greens, winter squash, cantaloupe and red peppers.

- Vitamin C helps to heal cuts and wounds, keeps teeth and gums healthy. Excellent fruit and vegetable sources of vitamin C are red and green peppers, kiwi, strawberries, sweet potatoes, kale, cantaloupe, broccoli, pineapple, Brussels sprouts, oranges and mangoes.
- Vegetables and fruits (with the exception of olive, avocado and coconut) are naturally low in fat. Substituting vegetables and fruits for higher calorie foods should be a part of any weight loss program and healthy diet.

Pigments Present in Fruits and Vegetables

Vegetables and fruits are appealing because of their bright and variable colours which are due to pigments present in the plastids of plant cells. The chief pigments of vegetables and fruits can be classified as water soluble and fat soluble.

FAT SOLUBLE/LIPOPHILIC PIGMENT	WATER SOLUBLE/LIPOPHOBIC PIGMENT
Chlorophyll	Anthocyanin(red ,blue ,purple)
Carotenoids (red, orange and yellow)	Flavones & flavonols (yellow) and flavanals etc.

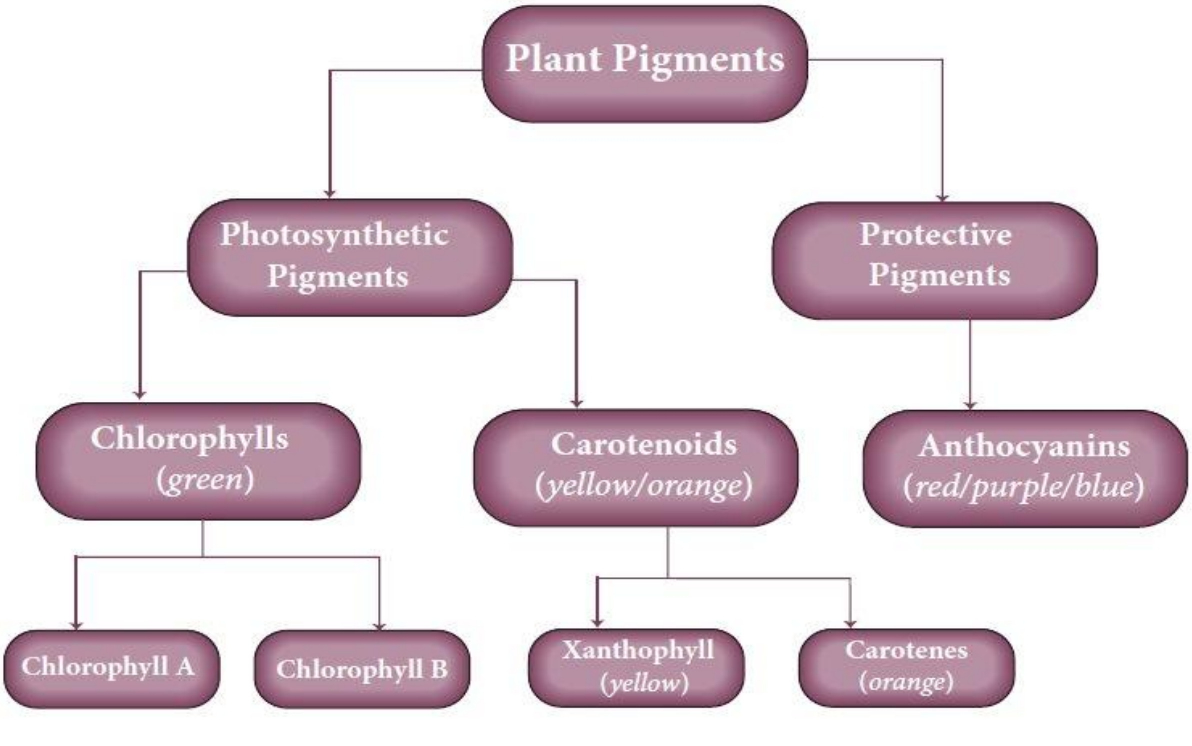

Fig 3.2: Classification of pigments in vegetables and fruits

Nutritive Value for Fruits

- Fruits contains high amount of moisture hence they are highly perishable. They are also good source of fiber. Apples, pears, cherries, grapes, and citrus fruits contains flavonoids which acts as antioxidant.
- Gooseberry is the high source of vitamin C but fruits are poor source of fat and protein except avocado.
- Yellow coloured fruits like banana, papaya are the rich source for beta carotene.
- Banana is good source of carbohydrate and energy.

Table- Nutritive value of fruits per 100 grams

Name of fruits (nutritional value/100g)	protein	iron	potassium	phosphorus	calcium	sodium	Energy
Orange	0.7	0.32	9.5	20	26	4.5	48
Mango, ripe	0.6	1.3	205	14	14	26	74
Banana, ripe	1.2	0.36	88	36	17	36.6	116
Sapota	0.7	1.25	269	27	81	5.9	98
Pineapple	0.4	2.42	37	9	20	34.7	46
Papaya, ripe	0.6	0.5	69	13	17	06	32
Guava	0.9	0.27	91	28	10	5.5	51
Apple	0.2	0.66	75	14	10	28	59
Grapes(pale green)	0.5	5.52	-	30	20	-	71
Pomegranate	1.6	1.79	133	70	10	0.9	65
Lemon	1	0.26	270	10	70	-	57
Coconut water	1.4	0.1	-	10	24	-	24
Jack fruit, ripe	1.72	0.2	160	21	24	-	95
Water melon	0.2	7.9	-	12	11	27.3	16
Custard apple	1.6	4.31	-	47	17	-	104
Strawberry	0.7	1.8	341	30	30	-	44
Muskmelon	0.3	0.21	225	20	32	104.6	17
Amla	0.5	1.2	490	20	50	5	58
Sweet lime	0.8	0.7	-	30	40	-	43

Nutritive value of vegetable

Nutritional value(per100g)	spinach	tomato	Onion	cucumber	lettuce	broccoli
Energy (kcal)	23	18	40	16	13	34
Carbohydrate (g)	3.6	3.9	9.34	3.63	2.23	6.64
Starch (g)	0.4	2.6	4.24	1.67	1.9	1.7
Dietary fiber (g)	2.2	1.2	1.7	0.5	1.1	2.6
Fat (g)	0.4	0.2	0.1	0.11	0.22	0.37
Protein (g)	2.9	0.9	1.1	0.65	1.35	2.82
Vitamins	.	.	.	.		.
Thiamine (B1) (mg)	0.08	0.042	0.046	0.027	0.057	0.032
Riboflavin (B2) (mg)	0.078	0.449	0.027	0.033	0.062	0.361
Niacin (B3) (mg)	0.724	0.123	0.116	0.098	0.15	0.071
Pantothenic acid (B5) (mg)	0.269	0.037	0.123	0.0259	0.082	0.117
Vitamin (B6) (mg)	0.195	0.594	0.12	0.04	0.184	0.639
Folate (B9)	194	80.0	19	7	73	175
Vitamin C (mg)	28	14	7.4	2.8	3.7	0.063
Vitamin E (mg)	2	0.57	.	.	0.18	89.2
Vitamin K (mg)	0.483	7.9	.	0.0164	0.1023	0.78
Minerals	.	-	.	.	-	.
Calcium (mg)	99	-	23	16	35	0.47
Iron (mg)	2.71	.	0.21	0.28	1.24	0.73
Zinc	0.53	.	0.17	0.2	0.27	33

Browning in Vegetable and Fruits

You might have seen apples, pears, potatoes and brinjal that turns brown in colour when peeled or cut open. Have you ever thought about it? What is the reason behind this colour change? That's because of a naturally occurring process called oxidation.

Enzymatic browning is an oxidative reaction responsible for browning in vegetable and fruits. When the skin of vegetable and fruits are either cut or broken, cell wall gets raptured and an enzyme called polyphenol oxidase is released and reacts with the oxygen in the air as a result vegetables and fruits turn brown or dark leading to change in flavour and nutritional values.

Measures to Prevent Enzyme Browning

There are the ways to prevents fruits and vegetable from getting oxidized with the following methods-

- Squeeze lime juice on fruits such as banana, apples, avocado, pears, and vegetable like potato, sweet potatos to prevent oxidative browning. The juice of other citrus fruits such as oranges and grapes fruits can also be used.
- Soak the cut fruits or vegetables in plain water which helps to slow down the oxidation process.
- Blanching fruits or vegetables also prevents browning.
- Wrapping in a cling wrap tightly is also a good way to prevent browning.
- Most important, do not use a rusty knife or any other iron metals because iron will increase the rate of reaction.

Factors influencing mineral content of fruits and vegetables

Species and cultivar: Mineral composition varies widely in raw fruits and vegetables. Leafy vegetables have higher concentrations of nutrients that are less mobile in the plant (e.g., calcium) and depend on direct water flow rather than recycling from older leaves. Tissues with higher transpiration rates generally have higher tissue calcium concentrations.

Mineral concentrations may vary widely among cultivars. For example, both "Dwarf Brazilian" bananas (Santa Catarina Prata, Musa sp. AAB) and "Williams" (Cavendish subgroup, Musa sp. AAA) are considered good sources of potassium. Nevertheless, "Dwarf Brazilian" bananas have more P, Ca, Mg, Mn and Zn than "Williams" bananas.

As a result of the distribution of vascular tissue, sink characteristics and metabolic rates, higher mineral concentrations are usually found in the skin and seeds than in the flesh of fruits. Tissues with higher metabolic rates (epicarp, core) may accumulate more nitrogen and phosphorus. Rapidly expanding or large-celled tissues are unlikely to have high calcium concentrations. In mature fruit, the calcium concentration is highest in the peel.

Preharvest factors: Orchard location has important effects on fruit and vegetable mineral concentrations. For example, potassium in bananas differs among locations/ microclimates in Hawaii. Similar fluctuations in potassium among growing areas is seen in "Rainbow" papaya fruits. Usually, fertilizers are applied directly to the soil to raise nutrient concentrations that are inadequate for successful crop growth, and to maintain soil fertility, which will decline if nutrient removal from the soil via crop uptake, leaching, volatilization, or denitrification exceeds nutrients added via weathering of minerals and mineralization of organic matter. Nitrogen is the most frequently deficient element and most commonly applied fertilizer in orchards, while phosphorus and potassium are added when soil test results, plant response or tissue analysis indicate a need. N-P-K addition with irrigation water has several advantages, including the ability to transport soluble nutrients directly to the root zone whenever water is applied to the plant. Thus, fertilizer amounts and timing can be precise and adjusted to coincide more closely with actual plant demand.

The mineral concentrations in some horticultural species are affected by intensive culture systems (glasshouse) or organic conditions. Tomato fruit contained more calcium and less potassium, magnesium and sodium when grown in an organic compost/soil mix than in hydroponic substrates. Organically cultivated apples, pears, potatoes and corn had higher mineral concentrations than conventionally cultivated ones. In contrast, found no differences in mineral concentrations between organically and conventionally cultivated vegetables. Organic cultivation did not affect strawberry mineral concentrations consistently.

Postharvest practices: Postharvest treatments with minerals, primarily calcium, can increase the storage life and quality of some fruits and vegetables. In the last decade, the industry has been encouraged to fortify food and beverages with calcium. Increasing the calcium concentration of horticultural crops gives consumers new ways to enhance calcium intake without supplements. In addition, phosphorous-free sources of calcium can help provide a good balance of dietary calcium and phosphorus.

There are two primary ways to apply postharvest calcium to horticultural crops: (1) dipping-washing, and (2) impregnation. Immersion treatments are used for fresh, sensitive products like leafy vegetables. The delicate texture of berries does not withstand vacuum infiltration, so dips in $CaCl_2$ solution are performed, followed by the removal of excess solution. Impregnation modifies the composition of food through partial water removal and replacement with solutes, without damaging integrity. The driving forces can be an osmotic gradient between sample and solution, application of vacuum followed by normal atmospheric pressure, or both. $CaCl_2$ is widely used as a firming agent and preservative for whole and fresh-cut fruits and vegetables. Mineral concentrations were similar in fresh, canned and frozen fruit and vegetable products; this is expected, since these nutrients are inert and thus not sensitive to degradation by the thermal processes used in food preservation.

Incidence of minerals on fruit and vegetable quality and consumer acceptance

Consumers buy certain products as good sources of specific minerals: potato and sweet potato for potassium, banana for magnesium and potassium, spinach for iron, potassium, magnesium and as a non-dairy source of calcium. Mineral analysis is performed by ashing and atomic absorption. Without such advanced analytical equipment, the consumers cannot detect differences in individual products at the point of purchase. Minerals are thus credence attributes because they cannot be detected by visual inspection or consumption. Thus, there is no incentive to measure minerals in a quality control program unless specific nutritional claims can be made.

To judge quality, consumers use purchase attributes (size, colour, firmness, aroma and absence of defects) and consumption attributes (flavour and mouth feel) (see also Chapter 3). Many of these qualities are affected by mineral concentrations and are part of many factors leading to fruit and vegetable acceptability. Acceptability, defined as “the level of continued purchase or consumption by a specific population”, determines the consumption of many essential nutrients: vitamins, antioxidants and fibre.

Thus, the effect of minerals on crop quality and consumer acceptance should be considered. The effect of minerals on colour, flavour, firmness and other attributes of specific horticultural commodities is described below.

Effect of minerals on colour: In apples and pears, both leaf and fruit nitrogen positively correlate with fruit green background colour, regardless of the rootstock. Manganese is also associated with green ground colour in apples. Excessive nitrogen inhibits background colour change from green to yellow, inhibits reddish blush development and decreases edibility in peaches. High nitrogen also decreases fruit colour in grapes. In Citrus, nitrogen retards endogenous chlorophyll catabolism and postharvest ethylene may be required to accelerate de-greening. In apples, correcting potassium deficiency can increase fruit red colour, but applications in excess of need have no effect. In tomato, potassium deficiency is associated with less lycopene and increased β-carotene.

Effect of minerals on flavour: Nitrogen status correlates negatively with soluble solids in apples and in pears. In contrast, soluble solids increase with increased nitrogen in tomatoes. Apple calcium and phosphorus both correlated negatively with fruit soluble solids at harvest and after six months of 0^0 C storage, while fruit K/Ca ratio correlated positively with titratable acidity. In mango, total soluble solids increased when zinc sulphate fertilizer was applied to the soil. Minerals also affect the production of several classes of volatile compounds in pome fruit. In fresh onions, increased sulphur availability enhances pungency and total sulphur flavour but decreases the concentrations of precursors for synthesis of volatiles, imparting "green" and "cabbage" notes.

Effect of minerals on firmness: Excess nitrogen can decrease tissue firmness. Also, low phosphorus decreases firmness in low-calcium fruits The relationship between calcium and fruit firmness has been extensively studied and reviewed. Higher firmness and/or slower softening after harvest/storage are associated with higher calcium concentrations or calcium applications in apples and pears, kiwifruit and strawberries. Calcium foliar sprays on peaches and nectarines increased calcium slightly. Calcium effects on fruit firmness are attributable to calcium's ability to cross-link with pectic polysaccharides by ionic association. Calcium binding may reduce the accessibility of cell wall degrading enzymes to their substrates.

Environmental factors: Radiation Modifications in the concentrations of phenolic compounds, ascorbic acid and carotenoids are associated with changes in sunlight exposure. Sun-exposed fruit sides have more phenolics and vitamin C than shaded regions. In leafy vegetables, there are 10 times more flavonols in surface leaves than in internal leaves. Total phenolics doubled in tomato plants exposed to more light. These plants also accumulated more carotenoids and ascorbic acid. Thus, radiation interception is important for producing commodities with increased antioxidants. However, the optimal irradiance to maximize accumulation of different antioxidants in fruits and vegetables is not established.

Cultural practices: Several works have analyzed the effect of cultural practices on antioxidants. Strawberries grown with plastic mulch had higher antioxidant capacity than fruits from uncovered beds. High nitrogen is associated with reduced ascorbic acid. Adding compost as a soil supplement significantly enhanced ascorbic acid. Vitamin C accumulation is inversely correlated with rainfall. Some studies found that organic products accumulated more antioxidants and vitamins than conventionally grown commodities. Some studies found that organic products accumulated more antioxidants and vitamins than conventionally grown commodities.

Maturity at harvest: Fruit developmental stage has a great impact on total antioxidant capacity These changes are highly dependent on the commodity. In tomato and pepper, total antioxidant capacity increases as carotenoids and vitamin C accumulate during ripening. Total anthocyanin increases during ripening in all berries. However, the antioxidant capacity peaks in other species early in development. During blueberry ripening, anthocyanins accumulate while phenolic acids decrease. The result is a net reduction of total antioxidant capacity. A similar pattern occurs in strawberry and blackberry. Carotenoids increase during development in pepper, tomato, mango and Prunus species. In products in which anthocyanins or chlorophylls dominate, carotenoids usually drop during development.

Wounding: Tissue damage greatly affects total antioxidant concentration. Cell disruption exacerbates the turnover of AsA and phenolic compounds. Eliminating cellular compartmentalization triggers the oxidation of pre-existing phenolics by PPOs and increases hydrogen peroxide, providing the co-substrate for POD-mediated degradation. Wounding also alters phenolic biosynthesis. In lettuce, cutting induced phenylalanine ammonia lyase and led to accumulation of chlorogenic acid. Carotenoid turnover is also accelerated by oxygen, but they are more stable than other AOX groups. Careful handling to minimize physical damage is recommended to reduce antioxidant losses.

Storage: Refrigeration slows the deterioration of vitamin C; in broccoli, losses after seven days storage were 0 at $0^{o}C$ but 56% at $20^{o}C$. Excluding broccoli and banana, most products lose visual quality before significant losses of antioxidant capacity occur Improper temperature management significantly reduces visual quality and thus, consumer acceptance. Ethylene induces accumulation of the bitter iso-coumarin 6- methoxymellein.

Other treatments: Biosynthesis of phenolics is triggered by elicitors like ultraviolet radiation or ozone. In grape, postharvest UV-C and ozone increased accumulation of resveratrol. Elicitation and accumulation of antioxidant compounds also occurs in other fruits. In blueberry cv. "Bluecrop", reduced UV-C radiation exposure (2 or 4 kJ/m2) increased the accumulation of anthocyanins and antioxidants. In strawberry, UV-C also increased phenolic compounds and antioxidants. Further studies are needed to determine the feasibility of increasing AOX capacity of fruits and vegetables through manipulation of the postharvest environment.

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