Vegetables are necessary for sound health. But the nutrients they contain may depend on a number of factors and may also vary depending on the predominance or lack of certain conditions or factors. Nutrients are chemical substances needed for growth and maintenance of normal cells in the human body.

For instance, genetic make up of the plant may decide its nutrient availability. Cultivars may vary in their nutrient content even though these are grown under the same soil and environmental conditions. The nutrient content in a particular genetic material can be increased by breeding and selecting genetic material superior in nutrients.

Conditions under which the crop is raised may also decide its nutrient content. These could be:

- **Environmental components** such as temperature, light (intensity, duration and quality), wind velocity and relative humidity
- **Atmospheric composition**
- **Soil factors** such as soil texture, soil structure, soil pH, soil fertility status, soil organic matter content and soil moisture and
- **Cultural practices** such as fertilization, attack of insect-pests and diseases, and maturity stage.

Leafy vegetables alone may never be enough to meet out the entire body requirement for different nutrients. They have very high water content and conversely very low dry matter. Thus, for the entire demand of various nutrients, more quantity of leafy vegetables has to be ingested.

For instance, carrot is a good source of carotene but not of protein so a small quantity of carrot can supply the minimal daily requirement of vitamin A, but to satisfy the daily requirement of proteins, a large quantity of carrots has to be consumed. The protein demand can be achieved by ingesting a small quantity of food from those plant sources that are rich in protein.

Hence, a balance of all the nutrients can be obtained from different plant sources rich in particular nutrients. However, there is very little awareness about which plant source is rich in which nutrient and how a balance could be struck. Vegetables can be categorized into different groups according to their contents of nutrients.

**High in minerals:** All root crops and most of the leafy vegetables, particularly of the cruciferous group.

**High in carotene (vitamin A):** Green leafy vegetables, carrot (yellow or orange colour), sweet potato (yellow or orange fleshed), cucurbits (yellow or orange fleshed), yellow sweet pepper, green beans, green peas and tomato especially yellow types.

**High in ascorbic acid (vitamin C):** Cruciferous group vegetables, pepper, tomato, beans (immature seeds), bean sprouts, melons, most leafy vegetables and freshly harvested potato.

**High in proteins:** All peas and beans, sweet corn, all leafy vegetables and cruciferous group vegetables.

**Factors Affecting Nutrients**

**Harvesting methods:** Losses of nutrients vary with the kind of harvesting method employed. Some vegetables are susceptible to bruising but others are resistant to abrasion. Mechanical harvesting causes more damage to the produce as well as crop than manual harvesting. Injury to the fruits during either harvesting or transition leads to great loss. Hand harvesting is always better over mechanical harvesting.

**Holding produce prior to consumption:** Losses depend on duration between harvesting from the field and reaching to the consumer end, and temperature at which the produce is held during this period.

**High in carbohydrates:** Potato, sweet potato, sweet corn, cassava, dry-beans, taro, yam and arum.

**High in oils:** Soybean, mature vegetable seeds particularly of the crucifereae family and cucurbits.

Get The Best Out Of Your Vegetables

How you grow, store and even cook your vegetables could determine how much nutrients your vegetables supply you.
Washing: In some vegetables, washing is essential to remove field heat, soil particles adhering to the vegetable and to improve appearance. This process hardly affects loss of nutrients from the fruit body. Water used for washing if recycled continuously for long time warms up, and if strong detergents are used, the water-soluble substances are leached out.

Peeling: Peeling leads to a great loss of nutrients. The extent of loss depends on peeling intensity and method or instruments used for peeling. Most nutrients are present just below the skin, thus, peeling by any means will certainly remove the nutrients. Ascorbic acid has been reported to be present below the peel of the tomato fruit.

Chopping, dicing, grating, mashing, mincing, or slicing: Any process that breaks vegetable cells is likely to be responsible for significant losses of certain vitamins. The longer the broken process of vegetables are held, the greater is the loss of vitamins. Therefore, vitamins may be conserved by i) cutting/slicing just prior to serving, and ii) using a plastic knife for slicing, because metals speed up the destruction of vitamin C. Nutrients are removed more if washing after peeling and chopping from the cut pieces, and the loss will be more if shreds are made very small. Vegetables should always be chopped in big size pieces to minimize these losses. Vitamins like vitamin C and minerals like iron are oxidized when the shreds come in direct contact with oxygen. However, addition of acetic acid in shreds of the vegetables to be cooked prevents oxidation and loss of vitamin C.

Blanching: Enzymatic browning occurs when vegetables are chopped. Enzymes are heat labile and can be made inactive by either steam or hot water. It inactivates the enzymes, which produce undesirable effect on the colour of the produce. Some water-soluble vitamins and minerals are lost due to leaching when hot water is used for blanching. This process is done to stop enzyme action in vegetables prior to canning, drying, and freezing.

Preservation: Vegetables are generally preserved by freezing, canning, fermenting, pickling and dehydration. The extent or degree of nutrient loss depends on the type of processing. The greatest loss takes place when the foodstuffs are processed at higher temperature, and also when the duration of processing is longer. High temperature treatment for a short time causes lesser loss of vitamins.

Freezing: Most losses of vitamins in frozen vegetables occur during blanching since freezing itself is responsible for only small losses. The vitamin losses during frozen storage may be considerably greater when blanching is done prior to freezing.

Canning: Blanching plus strong heat treatments applied to non-acid vegetables appears to be responsible for the large vitamin losses in canning.

Fermenting/pickling: Vitamin losses in these products may vary widely as a result of factors such as heat developed during fermentation, volume of pickling solution and temperature under which pickles are canned and stored.

Dehydration: Moderate amounts of carotene and vitamin C may be destroyed in this process, unless the vegetables are sulfured before drying. However, sulfuring destroys most of the thiamin content. Vitamin losses are greater during slow processes such as sun drying than they are for more rapid processes like freeze-drying.

Packing: Packing affects nutrient retention. High quality/class packing material can keep the vegetables for longer time and helps in the retention of minerals and vitamins.

Storage prior to processing: Storage temperature, humidity, composition of gases and duration affect the nutrient stability in the produce. Low temperature, high humidity, low oxygen, high carbon dioxide, nitrogen, carbon monoxide, vacuum and darkness are the best conditions for long-term retention of nutrients. Dehydrated food articles can be held safely at low storage moisture. The quality deteriorates with increase in temperature and storage duration.

Conventional Processing

Vegetables are generally cooked before they are consumed. Cooking methods vary from region to region. The methods include boiling with or without water, pressure-cooking, backing, frying, French-frying, steam, and microwave cooking. Some vegetables are cooked with or without peel.

In some vegetables, peeling is an important traditional process generally employed prior to consumption. The method of peeling significantly influences the percent loss through peeling. The average loss in weight has been accounted from 5 to 24%, varying with the method employed for peeling. Some vegetables such as potato, colocasia etc. should be peeled after but not before boiling to reduce the losses that take place due to peeling. The loss of nutrients through peeling removed after boiling will always be lower in all cases than that from which peel is removed before boiling, whatever the method of peeling employed.
Peeled vegetables during boiling lose more nitrogen than unpeeled, and amino acids loss is observed negligible.

Some important minerals, trace elements, and vitamins are present in fruit body just below the rind. Hence, peeling results in the loss of some minerals, trace elements, vitamins, amino acids and crude fibers.

Cooking Methods

Baking: Baking is very common in sweet potato. The sweet potato tubers are generally baked with their skin. The fried products retain more ascorbic acid than the baked ones. The cooking method used has a significant influence on the retention of vitamin C. Losses of vitamins are maximum when vegetables are baked because in baking the external temperature goes very high and most of the nutrients remain present just below the rind, so they are volatilized due to the extreme high temperature near the rind. During baking, minerals like potassium, phosphorus and iron start moving toward the interior.

Frying: A large number of fried products are being served in hotels and restaurants today. These products are prepared for serving by finish frying in deep fat. French fries are always prepared from good quality produce. The French fries preparation includes washing, peeling, trimming, sorting, cutting, blanching, frying, defatting, cooling, freezing and packaging.

Vegetables are first boiled or blanched before converting them into small pieces, and then fried in shallow oil. Frying decreases the moisture content and makes the nutrients concentrated. Vitamin losses during the frying of vegetables vary greatly as a result of factors such as i) time and temperature of frying, ii) type of frying (shallow fat, deep fat or stir frying ), and iii) fat or oil that is used (those which break down during frying due to high temperature may increase the rate of vitamin destruction).

Fried vegetables retain more vitamin C than that in boiled ones. However, ascorbic acid is oxidized to dehydro ascorbic acid more rapidly by boiling than by frying but hydrolysis of dehydroascorbic acid is slowed down by the dehydration of the product during frying. Frying decreases mineral content.

Boiling: Boiling is the most common and traditional method of cooking vegetables domestically worldwide. Peeling before boiling results in a higher loss of nutrients. If the loss of nutrients is compared in cooking of vegetables with or without water, it has been shown that the loss will be more if cooking of vegetables is done by boiling with or without water than without water. The cooking of vegetables by boiling increases the digestibility of the starch. Peeled vegetables during boiling lose more nitrogen than unpeeled, and amino acids loss is observed negligible.

Significant losses in ascorbic acid have also been noticed due to boiling of both peeled and unpeeled vegetables. Vitamin B is water-soluble and so is lost during boiling. Nutrient losses are found less in boiling method than steam cooking. The losses of minerals and water-soluble vitamins increase as the amount of cooking water increases. Hence, greater mineral and vitamin retention results in steaming and cooking without water.

Pressure-cooking: This method of cooking vegetables results in a greater retention of minerals and vitamins than boiling in a saucepan. However, best results are obtained when the vegetables are placed on a rack above the water so that they are cooked only by steam.

Microwave cooking: In conventional cooking, the heat is applied to the outside of the food body by conduction and then conducted to the interior of the food. Heat generated from within the food by a series of molecular vibrations is the basis for microwave cooking. The advantages of microwave cooking are higher energy efficiency, greater time saving, convenience and easy cleaning. The vitamin losses during this procedure are small and are comparable to those that occur when vegetables are cooked with little or no water. The disadvantage is less palatability of food.

Steaming: Vegetables cooked with steam but not in contact with water have better nutrient retention than those cooked in boiling water.

Holding on a dining table: Losses of vitamin C, thiamin and riboflavin appear to increase with the length of the time that vegetables are kept warm on a dining table.

Sulfuring: This process, which consists of either exposing vegetables to fumes from burning sulfur or dipping them in a sulphate solution, is used to prevent discolouration and spoilage. It is generally utilized before the vegetables are dried. Sulfuring helps to prevent the losses of both carotene and vitamin C but destroys thiamin. Fortunately, vegetables are utilized more as a source of the first two vitamins than as a source of thiamin.

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