

## Fruits: Nature's Health Capsules: by Dr. J. S. Pai

Fruits have been enjoyed since times immemorial with references in ancient scriptures. Even the health benefits were known for long. Fruits along with vegetables have now regained its prime position in healthy diet due to essential vitamins and minerals and also due to the various nutraceuticals and phytochemicals they contain providing all kinds of health benefits against many modern ailments like cardiovascular diseases, cancer, etc.

India has always been ahead in fruit and vegetable production and traditional Indian diet had prominent position for various food preparations made of fruits and vegetables including jams, preserves, chutneys, curries, garnishes, etc. as well as many sweets and desserts, condiments, savouries etc. India has been leading in fruit and vegetable production with over 51 million tonnes of fruit out of a total world production of 500 million tonnes and over 72 million tonnes of vegetables out of 890 million tonnes world production, standing second only to China in both. Various fruits produced in India in the year 2007 are given in the table with their production figures.

Mango is considered the king of fruits in India and has been leading revenue earner both domestically and for exports. However, banana is the leading fruit produced in India with 21.77 million tonnes being produced in 2007 forming over 24% of world production. Mango production, although much smaller than banana, is commercially most important. India produces over 12.5 million tonnes of mangoes being almost 40% of the world production. Andhra Pradesh (3.2 million tonnes) and Uttar Pradesh (2.7 million tonnes) are leading in production. In 2006-07, India exported over 2 million tonnes of fresh fruits and vegetables worth US \$ 547 million of which mango accounts for just about 80,000 tonnes but valued at about US \$ 30 million.

Grape export is very sizeable and fetches over US \$ 60 million from around 86,000 tonnes. Grape Net, the traceability system set up for grapes has enabled rapid increase in the grape exports. Some of the other important fruits produced (with production in million tonnes) in India include apple (20), orange (4), lemons (2), grapes (1.7), guava (1.8), litchi (0.4), papaya (2.3), sapota (1.1) etc.

Although there is a great potential for processed fruits and vegetables since over 25 to 40% of fruits spoil because of lack of proper post-harvest handling and processing to various products. Just about 2-3% of fruits are processed into various products like pulp, juice, concentrates, jams, jellies, marmalades, syrups, squash, and used in a variety of other preparations like ice cream, cakes, yoghurt, muffins, cookies etc. Even the export potential is there as presently only 850,000 tonnes of processed fruits and vegetables are exported worth around US \$ 550 million.

India is the second largest producer of vegetables in the world (ranks next to China). The current production level is over 73 million MT. In case of vegetables, potato, tomato, onion, cabbage and cauliflower account for around 60% of the total vegetable production in the country. Vegetables are typically grown in India in field conditions; the concept is opposed to the cultivation of vegetables in green houses as practiced in developed countries for high yields.

India produced in 2006 almost 60 million tonnes of fruits and almost 110 million tonnes of vegetables, thus ranking among the first two in the world along with China. Highest contributions in fruits came from southern states like Andhra Pradesh, Tamil Nadu and Kerala with Maharashtra topping with almost 12 million tonnes of fruits. Highest vegetable producer was West Bengal with almost 19 million tonnes followed by Uttar Pradesh, Bihar and Orissa. Although mango is known as the king of fruits in India, banana leads the production with almost 19 million tonnes produced in 2006. China's fruit production was 95 million tonnes and vegetables 450 million tonnes. The table gives production of different fruits compared to world production.

### Production in million tonnes in 2007

| Fruits                       | India | World |
|------------------------------|-------|-------|
| Apples                       | 2.00  | 64.26 |
| Apricots                     | 0.01  | 3.07  |
| Bananas                      | 21.77 | 81.26 |
| Cherries                     | 0.01  | 2.00  |
| Figs                         | 0.01  | 1.06  |
| Grapefruit                   | 0.18  | 5.06  |
| Grapes                       | 1.67  | 66.27 |
| Lemons and limes             | 2.06  | 13.03 |
| Mangoes, mangosteens, guavas | 13.50 | 33.45 |
| Oranges                      | 3.90  | 63.91 |

|                                  |       |       |
|----------------------------------|-------|-------|
| Other melons (incl. cantaloupes) | 0.65  | 26.10 |
| Papayas                          | 0.70  | 6.94  |
| Peaches and nectarines           | 0.15  | 17.46 |
| Pears                            | 0.20  | 20.11 |
| Pineapples                       | 1.31  | 18.87 |
| Plums and sloes                  | 0.08  | 9.72  |
| Watermelons                      | 0.26  | 93.17 |
| Total                            | 51.40 | 500   |

FAO Statistics 2009

### Chemical Composition and Nutritional Value of Fruits

Fruits contain very little fat and proteins but are rich in carbohydrates including sugars and dietary fibre. There are exceptions like avocado and olives that are rich in oil. Fruits are sweet and also slightly sour as they contain good amounts of sugars and organic acids. Only a couple of fruits like banana and pineapple may contain sucrose as the major sugar but most fruits contain glucose, fructose and sucrose. Some fruits like grapes, gooseberry and lemons contain very little or no sucrose. The sourness of fruits is because of the organic acids present. Most fruits contain citric and/or malic acids as major acids. Most fruits also contain smaller amounts of other acids like tartaric, oxalic, pyruvic, fumaric, succinic, shikimic, quinic etc.

#### Sugar Contents (%) of Some Fruits

| Fruit          | Glucose | Fructose | Sucrose |
|----------------|---------|----------|---------|
| Apple          | 1.7     | 6.08     | 3.62    |
| Banana         | 5.82    | 3.78     | 6.58    |
| Gooseberry     | 4.40    | 4.10     | 0.71    |
| Grapes (black) | 8.2     | 7.28     | 0       |
| Grapes (green) | 8.1     | 8.01     | 0       |
| Grapefruit     | 1.95    | 1.24     | 2.14    |
| Lemon          | 0.52    | 0.92     | 0.18    |
| Musk Melon     | 1.16    | 0.83     | 3.26    |
| Orange         | 2.36    | 2.38     | 4.70    |
| Pineapple      | 2.32    | 1.17     | 0       |

From: Fruits by Gopalan & Mohanram, NIN, 2000

Fruits are good sources of nutrients including vitamins, minerals and dietary fibre.

#### Nutrient Contents of Common Indian Fruits (per 100 g edible portion)

| Fruit      | Moisture g | Crude fibre g | Carbohydrates g | Calcium mg | Iron mg | Carotene µg | Vit C mg | B <sub>1</sub> mg | B <sub>2</sub> mg | Niacin mg |
|------------|------------|---------------|-----------------|------------|---------|-------------|----------|-------------------|-------------------|-----------|
| Amla       | 81.8       | 3.4           | 13.7            | 50         | 1.2     | 9           | 600      | 0.03              | 0.01              | 0.2       |
| Apple      | 84.6       | 1.0           | 13.4            | 10         | 0.66    | 0           | 1        | -                 | -                 | 0         |
| Banana     | 70.1       | 0.4           | 27.2            | 17         | 0.36    | 78          | 7        | 0.05              | 0.08              | 0.5       |
| Cherry     | 83.4       | 0.4           | 13.8            | 24         | 0.57    | 0           | 7        | 0.08              | 0.08              | 0.3       |
| Grapes     | 79.2       | 2.9           | 16.5            | 20         | 0.52    | 0           | 1        | -                 | -                 | 0         |
| Guava      | 81.7       | 5.2           | 11.2            | 10         | 0.27    | 0           | 212      | 0.03              | 0.03              | 0.4       |
| Lemon      | 85.0       | 1.7           | 11.1            | 70         | 0.26    | 0           | 39       | 0.02              | 0.01              | 0.1       |
| Mango      | 81.0       | 0.7           | 16.9            | 14         | 1.3     | 2743        | 16       | 0.08              | 0.09              | 0.9       |
| Orange     | 87.6       | 0.3           | 10.9            | 26         | 0.32    | 1104        | 30       | -                 | -                 | -         |
| Papaya     | 90.8       | 0.8           | 7.2             | 17         | 0.5     | 666         | 57       | 0.04              | 0.25              | 0.2       |
| Pear       | 86.0       | 1.0           | 11.9            | 8          | 0.5     | 28          | 0        | 0.06              | 0.03              | 0.2       |
| Sapota     | 73.7       | 2.6           | 21.4            | 28         | 1.25    | 97          | 6        | 0.02              | 0.03              | 0.2       |
| Strawberry | 87.8       | 1.1           | 9.8             | 30         | 1.8     | 18          | 52       | 0.03              | 0.02              | 0.2       |

From: Nutritive Value of Indian Foods by Gopalan & others, NIN, 2004 (1 µg Retinol = 4 µg β-carotene)

Fruits are generally high in fibre, water, vitamin C and some also have good amounts of vitamin A and iron. Fruits also contain various phytochemicals including antioxidants, which have been indicated by various researchers are necessary for long-term health and disease prevention. Regular consumption of fruits and vegetables is associated with reduced risks of cancer, cardiovascular disease, stroke, Alzheimer disease, cataract and some of the age-related ailments. Since fruits and vegetables are rich in potassium it may also help reduce risk of developing kidney stones and decrease bone loss. Fruits being low in calories per volume, and having high in fibre, help lower caloric intake. Many fruits are also rich in folate that helps body form red blood cells.

### **Importance of Fruits in Diet**

Normal diet should include fruits and vegetables as these are rich sources of micronutrients and also provide health providing factors like fibre, antioxidants etc. Most fruits are rich sources of vitamins, minerals and fibre. They contain good amounts of iron, vitamin C, folic acid, carotenoids etc.

Vitamin A is necessary for clear vision and for maintaining integrity of epithelial tissues and its deficiency may result in blindness in children. It also helps maintain resistance of body to common infections. They are plentiful in yellow and orange fruits like orange, mango, papaya, apricot, figs, jackfruit, muskmelon etc. in the form of carotenes, the precursors of vitamin A.

Iron is essential for formation of haemoglobin present in red blood cells playing important role in transport of oxygen to tissues. Deficiency of iron leads to reduction in haemoglobin causing anaemia characterised by fatigue and susceptibility to infections. Iron is available in many vegetables in large quantities but some fruits like black currants, dates, watermelon, raisins, seetaphal (custard apple) etc. while most fruits have fair quantities of iron.

Vitamin C is needed for healthy teeth and bones. It also promotes iron absorption. Its deficiency causes weakness, bleeding gums and defective bone growth. It is abundant in amla, citrus fruits, guava, papaya, litchi, muskmelon, pineapple, seetaphal and strawberries but all fruits have good quantities of it.

Folic acid is essential for healthy red blood cells and its deficiency leads to megaloblastic anaemia and its intake during pregnancy is essential to prevent certain congenital defects including spina bifida. Although green leafy vegetables and legumes are better sources of it, fresh fruits when consumed will provide significant quantities of it as it is degraded easily. Oranges, melons and strawberries are good sources.

Dietary fibre is important for proper bowel function, reduce chronic constipation, diverticular disease and haemorrhoids. It has protective role against colon cancer. Most fruits and vegetables are good sources of it but particular examples are amla, dates, figs, grapes, guava, pomegranate, sapota and seetaphal.

Fruits and vegetables are also good sources of antioxidants which restrict damage by free radicals to cells protecting them from various diseases including cardiovascular diseases, cancer, joint diseases, asthma, diabetes etc. Vitamin C and E, carotenoids, anthocyanins etc. are some of the antioxidants present in fruits. Anthocyanins are red and blue pigments in fruits like strawberries, dark grapes, blueberries, pomegranate, jamun etc.

Some of the fruits have medicinal properties and have been recommended in certain diseases. Amla (Indian gooseberry) is one of the richest sources of vitamin C and is used in many ayurvedic preparations. It is claimed to be useful in haemorrhage, diarrhoea and dysentery. In combination with iron it is used in treatments of anaemia, jaundice, and dyspepsia. Pomegranate is another fruit with medicinal properties. It is useful in indigestion and dyspepsia. It is also a mild laxative. It has been shown more recently to lower cholesterol. Even its bark, rind and seeds have useful properties. Kokum (*Garcinia indica*) and similar fruits have weight-reduction properties. Bael fruit also has certain medicinal properties useful in gut-health.

### **Harvesting & Processing**

Fruits grow on plants and continually undergo change in chemical composition and hence nutritional value even after harvest. When the fruits are not fully developed, they have starch, many ligno-cellulosic substances, high acidity among other things. As they become mature and start ripening the sensory as well as nutritional value begins to improve. Sugars start forming at the expense of starch and many vitamins and other important phytochemicals begin to accumulate some like carotenoids and anthocyanins will make visual changes. Many flavour substances also start forming and also acidity and astringency decreasing thereby making the fruits most desirable. The fruits will then continue to become overripe and will not only start losing sensory appeal but many nutrients like vitamin C will also start reducing in amounts.

Fruits may be most desirable to consume and also most nutritious, when they are at the peak of their ripeness. However, since most markets are in urban areas and fruit are commonly grown in rural areas, the distances are large and getting even larger, so if harvested while ripe, there is extensive loss due to damage and overripening during transport and storage of fruits. So normally fruits are harvested while they are still unripe so they are harder and can easily be handled without any losses and once they reach the markets the ripening takes place so they could be sold while they reach the peak of their quality. Similarly the fruits for industrial processing also is harvested while somewhat unripe and then after they reach the processing unit, ripening is completed and then processed. Although fruits will attain the maximum sensory attributes when they are ripened on the plant itself but if not eaten immediately after harvest they rapidly lose the quality and may even become spoiled, so they are always harvested slightly before ripening.

Temperature and humidity conditions during storage and transport of fruits affect the quality of fruits as they affect the changes taking place after harvest. At higher temperatures, changes are rapid and losses in many vitamins and other phytochemicals are substantial so most fruits are kept at low temperature. Some fruits are sensitive to chilling injury e.g. mango, banana etc. so they need cooler conditions but not refrigeration. Humidity prevents loss of moisture from the fruit but at extreme humidity fungal growth occurs. Some fruits can be kept at low oxygen and higher CO<sub>2</sub> conditions to slow down respiration and changes accompanying and the post-harvest life of banana and apples are prolonged. Gamma radiation also is useful in extension of shelf life of mangoes and bananas.

Since fruits are highly perishable and most are also seasonal, they are processed and preserved making various products out of them so they can be enjoyed year round. Earlier jams, jellies and preserves were made using sugar or were dried to prevent microbial spoilage. There are all kinds of products including canned, bottled and dehydrated products available. The processes like high temperature short time and aseptic technology, vacuum dehydration, freeze drying, IQF freezing, high pressure processing, ohmic heating etc. among others that strive to improve the product quality with respect to colour, flavour, appearance etc. but also the nutritional value.

### **Quality of Fruits**

The best quality of fruits will normally go to fresh market where it fetches premium prices unless fruit is grown specially for processing. The better quality is usually used for bigger piece products like IQF or whole while lower quality goes for purees and juice. Also the products having larger pieces like pie fillings, jams with whole fruit etc. require higher grades. Higher grades command higher prices and will be used in more expensive products. Quality is measured by characteristics like colour, size, blemishes, flavour, firmness and presence of extraneous matter including skin, stem, pits and leaves.

Quality may be specified in terms of Brix or moisture content, pH or titratable acidity, microbial specs, colour, haze, size, viscosity, texture, flavour/aroma and defects. Chemical tests are done to detect contamination, adulteration or treatments. Some other characteristics specially for juice include pectin and starch levels, pulp or solid content.

Brix indicates soluble solids, primarily sugar in fruit juice and macerated products and is measured by a refractometer specially designed for this. The pH indicates amount of acid present which affects both flavour and microbial quality. Most fruits have pH below 4.5 but banana, figs and papaya have higher pH. Some high acid fruits like apples and berries have pH lower than 3.7.

Colour should be consistent and typical of the fruit in its ripened state. Colour not only depends on variety and ripeness but also if it was treated to prevent browning and the effectiveness of treatment. Some fruit juices need to be clear, free from haze that is present if pectin, starch, particulate matter etc. are not removed by enzyme or filtering. In citrus juices cloudiness is desirable indicating wholesomeness. Haze, cloud or clarity can be measured by transmittance.

Viscosity, flavour and defects are some of the other measures of quality and can be measured by instruments or sensory analysis. Chemical analysis can also measure sugar and acid content which have an impact on quality.

### **Preservation Methods**

Fruit is seldom used fresh in most processed products like juice, jams, jellies, concentrates etc. It usually preserved by freezing, heating or dehydration after seeds, skin removal and size reduction and extraction. As fruits have high moisture content, refrigeration may only prolong shelf life by limited period. For long term storage of fruit pieces or pulp or concentrate, freezing may be necessary. Sugar, syrup and/or juice may be added sometimes to prevent damage to fruit pieces due to ice crystal formation but IQF may not need any addition.

Preservation of fruit for processing industry is usually thermally processed using canning, aseptic processing or pasteurisation. Fruit pieces are packed in liquids like sugar syrup, juice or water facilitating heat transfer. Heat may affect colour, flavour, texture and nutritional value depending on time and severity of heat process. Heat has benefit of deactivating undesirable enzymes.

Drying is another common preservation method used traditionally for dried fruits like raisins, dates, prunes, figs, apricots and apple. Excepting certain fruits with fragile structure like berries or citrus fruits, most fruits can be successfully dried using various methods

from traditional sun drying to mechanical dehydration using controlled temperature, air, relative humidity and increasing surface area to facilitate rapid drying to prevent microbial and enzymatic deterioration. Chemicals like sulphur dioxide or sulphites are used to protect from enzymatic browning and reducing losses in carotene and vitamin C.

Freezing may keep the fruit from spoilage for several months but as the ice crystals may damage the texture, sugar may be added to fruit to prevent ice formation. Sometimes fruits may be infused with sugar or fruit juice concentrate replacing water in fruit. Infused fruit become soft or chewy and may also alter flavour and colour.

Besides straight or sweetened packs of fruit, some fruit ingredients may receive additional processing and may be used in baking, confectionery and dairy industries. Jellies and preserves are just a few examples of large number of such products that may contain besides fruit, sweeteners, stabilisers, acidulants, colours and flavours. Gums, starches and pectin are some stabilisers used depending on the process, storage and final product characteristics like pH, particle suspension etc. The most widely used acidulant is citric acid, though others are used to impart particular flavour. Acid lowers pH as required by stabiliser, gives antimicrobial action and contributes flavour.

## **Benefits of Fruit-containing Ingredients**

Fruit-based ingredients can add value to the food products as consumers like products containing fruits but many fruits can offer functional benefits. Use of whole fruit is not possible with all fruit products and a variety of fruit-based ingredients may be used like concentrates, purees, pastes, fruit essences etc. Purees may contain added sugar or may be concentrated to 42°Brix. Puree is made by washing, cooking and sometimes depectinising fruit and passing through finisher to remove seeds and stems. Sweetened, concentrated puree is sometimes referred to as paste but some pastes are prepared by chopping and grinding dried fruits. Sometimes single strength puree may be dried to yield fruit powder.

Puree's primary function is to add fruit solids to the product as some designers use them just to get fruit in ingredients list rather than its flavour or colour contribution since there is a lot of loss during concentration and economically it is cheaper to add essence or colour. Purees however can provide extra mouthfeel especially with tropical fruits. Fruit purees naturally contain hydrocolloids and humectants contributing to the product texture. In baked products they soften the crumb. They can be used to some extent as fat replacers.

Fruit juice concentrates are made by concentrating pressed juice by vacuum evaporation and can provide functional properties like sweetness, flavour and colour as well as fruit identity. As fruit colours are pH dependent, product pH may be important for colour identity to be retained. Many beverage products use concentrates but it must be remembered that concentrates not only interact with each other affecting pH and buffering systems, they can also interact with other ingredients like sugars, gums, starch etc. affecting the final beverage characteristics.

Fruit ingredients tend to be fairly stable in confections due to high levels of sugar and low water activities slowing most reactions. Fruits are also useful ingredients in dressings and sauces but its effect on stabiliser system especially one containing starch need to be verified when using heating which might also affect fruit colour.

Fruit essences are natural fruit flavours created during concentrating juices or purees by condensing volatile flavour components that are flashed off. They are used not just for ingredient statement but for actual flavour contribution. As they are very volatile they are sensitive to heat and have a tendency to be lost easily.

As fat has become a big issue with consumers and fruit fillings are very low in fat, fruit fillings in various products is one way of reducing overall fat content of the product. In many dairy products like ice cream, yoghurt, shakes, soft swirls etc. adding fruit not only adds colour and flavour but helps reduce fat.

Many fruit preparations are also used in bakery foods. Some are thermally stable and can survive baking process while others may be used after baking by cold filling.

While some fruit product manufacturers use fresh fruit, there will be problems of limited shelf life. Individually quick frozen (IQF), straight pack frozen fruits and fruit purees are used by the industry that allows them to plan processing schedule without much loss in quality. From these preserves, jams, juices, concentrates etc. may be prepared. Dried fruits are commonly used in cereals, baked goods etc.

Air-dried, sun-dried and freeze-dried fruit products normally the only thing removed is water. Here most of the fibre is retained. However, to prepare beverages there is problem since fibres are not fully soluble unless one needs cloudy or pulpy beverage like orange. Purees contain some fibre but less than whole fruit as some fibre is removed as it causes settling. Purees are hence more soluble than air-dried fruits but sometimes they may contain carriers like maltodextrin, starch etc. Spray dried juice powder is completely soluble but it may have the least fibre. Flavour-wise, the powders made from juice concentrates have more flavour than air-dried with purees in between.

Sometimes one can even replace part of the sugar using fruit juice concentrate. This will not only lower the rank of sugar in ingredients list but also presence of fruit will give health significance along with the concomitant vitamins, minerals and antioxidants. Some may add colour to the product or if not desirable apple or green grape juice concentrate could be used. Some dried fruits like plum may be able to replace part of fat in bakery and confectionery products.

Although Asians have been enjoying them, western consumers are now slowly coming around to exotic tastes of tropical fruits like guava, mango and papaya along with pineapple, passion fruit etc. Pomegranate is becoming quite popular in Europe for its medicinal properties. Fruits will thus regain its important position in daily diet as people realise its nutritional and health benefits.

\*\*\*