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## 1 HISTORY

Fruit juices have been consumed by man for a long time with earliest references being found in the 16th century. Throughout history sailors had the juice from limes or lemons during their long voyages to provide vitamin C to prevent scurvy,

although at the time they were unaware of the true source of their protection.

During the 1930s methods of concentrating fruit juices were being researched in order to save expense in packaging and transport costs. Until the 1950s the methods of concentration used in the main citrus processing areas were satisfactory for producing concentrates for use in soft drinks, but when reconstituted the taste was not as successful as the original fruit juice flavour.

The first major supply of fruit juice to the UK started during the Second World War. The then Ministry of Food became concerned at the lack of fresh fruit and vegetables available and the resultant lack of vitamin C in the diets of babies and children. In order to improve this they started to import a concentrated orange juice and introduced the welfare orange juice scheme in the 1950s.



Further developments took place which resulted in modern processing plants. These improvements enabled fruit juices to be pasteurised and canned to extend shelf-life. These new processes resulted in the development of a wider variety of juices (long life, short life) allowing more opportunities for purchase.

## 2 A DEFINITION

Fruit juices are specifically defined in The Fruit Juices and Fruit Nectars Regulations 2003 in which they are described as being 100% pure fruit juice without preservatives, made from fresh fruit or concentrated fruit juice. In the case of citrus juices only the flesh of the fruit can be used, no pith, seeds or peel. With other varieties the whole fruit may be used. It is permissible within the regulations to add some sugar (up to 15 grams per litre) to regulate the sweetness of fruit juices (this is

# Fruit Juice

known as technical correction). However, if higher levels are added the product has been sweetened and must be described as sweetened juice. In either case the product can no longer be labelled as pure juice and the addition of sugar must be indicated on the label.

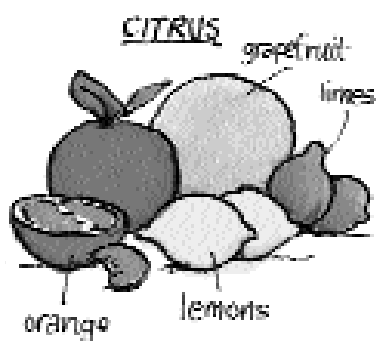
Fruit juices remain one of the growth areas in world foodstuffs. Fruit juices are completely natural and high in vitamins, containing only natural fruit sugar. These drinks have increased in sales due to a gradual worldwide shift away from alcoholic drinks and hot beverages.

Fruit juices are solutions of natural sugars (sucrose, glucose and fructose), proteins, pectins, minerals, pigments, essences, vitamins and essential oils. These minority ingredients contribute unique qualities of flavour, aroma and appearance to the individual juice.

## 3 ORIGINS OF FRUIT AND VEGETABLE PRODUCTS

### 3.1 Citrus fruits

The modern citrus fruits are East Asian in origin, and probably arose from just ten or twelve wild species. Over the centuries these species have been selected, crossed, improved and re-crossed.



With the development of modern storage and transport methods after World War II, a network of trade routes spread outwards.

**Oranges.** The principal sources of orange juice are the USA and Brazil which together supply the bulk of world demand. There are many other smaller sources, however, including Australia, Belize, Cuba, Israel, Mexico, Morocco and South Africa.

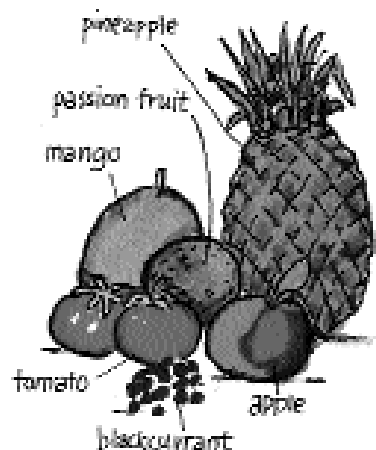
**Grapefruit.** The major origins of grapefruit juice are the USA, followed by Argentina, Cuba, Latin America and Israel. The future for grapefruit juice consumption is somewhat limited, partly due to its bitter taste. Consumption of red/pink grapefruit has increased following significant promotion in the USA. It is slightly sweeter than its yellow sister.

**Lemon.** Major processing countries of lemon juice are Argentina, Italy and the the USA. Both clarified and cloudy lemon juice concentrates are produced and these are used as ingredients in soft drinks and in other foodstuffs where the addition of natural acidity is required.

**Lime.** Lime juice holds a special place in the history of soft drinks having been consumed as early as the 18th century by British sailors. Two kinds of lime are known and processed, the dominant variety being the small fruited West Indian lime. There is also a large fruit variety more akin to the lemon. This juice is extracted by crushing the whole fruit. The resulting extraction is allowed to settle which enables a reaction of the oil and juice to take place giving the characteristic flavour of lime juice cordial. Lime juice is not consumed as a fruit juice but used to produce lime cordial. Limes are sourced from Mexico and Peru.

### 3.2 Non-citrus fruits

**Apple.** Apple has been included in many drinks both alcoholic and non-alcoholic for many years. It is also available in cloudy or clear forms. In the past, owing to the fact that apple juice has been plentiful and low in price, it has been included in many mixed fruit blends, used as a 'filler' in other juice drinks, has been produced as a soft drink in its own right or used as a natural sweetener. The



juice yield is high, up to 90%, and is obtained by pressing the whole fruit.

The USA is the most important processed apple market in the world. Europe, Argentina, Chile, South Africa and New Zealand also produce apples commercially for the drinks industry and China is rapidly developing. Different varieties of apples have different tastes ranging from tart (sharp) to very sweet. The European juice industry uses apples from all over Europe, from Poland and Lithuania in the north, to Italy and Turkey in the south and from France across to southern Russia. Apples grown in northern areas of Europe have higher acidity levels than those grown further south. Apple juice concentrates are usually blended to obtain the desired acidity level.

**Pineapple.** Pineapple has the largest market of all tropical fruits. The largest growing areas are the Philippines, Brazil and Thailand. Other supplies come from Kenya, the USA, South Africa, Costa Rica and Sri Lanka. Juice yield is around 50%.

Pineapples should be processed within 10 days of harvesting. The pineapples are washed and size graded into two sizes. Each fruit is fed into a Ginaca machine which cuts off the top and bottom and removes the outer skin. The central core is cut out to leave a cylinder of pineapple. The skin passes to a machine to remove the flesh from the inside and this material plus the cores are used for juice extraction. The cylinder of pineapple is inspected, cut into slices, inspected and hand filled into cans. Any broken pieces, off-cuts or other trimmed material not suitable for canning are added to the cores and other juice material. This is then passed through a disintegrator and then a press to extract the juice. The juice is heated, centrifuged to remove some of the pulp and then evaporated to produce the concentrate. Juice is usually a by-product of the canned fruit processes.

**Passion fruit.** There are two types of passion fruit – purple and yellow. The yellow gives a higher quantity of juice but the purple fruit has a stronger flavour. The fruit consists of sacs containing juice and black seeds. The fruit is squeezed by machinery to burst the skin and disgorge the contents. The seeds and fibrous material are separated from the juice by a paddle type machine. Warming of the pulp will increase the juice yield which can be between 30 and 50%. Yellow passion fruit comes from Australia and Hawaii. Purple passion fruit are sourced from India.

**Mango.** Mango is low in acid and high in vitamin C, with a pronounced flavour, a distinctive taste and an attractive yellow colour. The fruit is processed with skins and stone in place, steamed for a few minutes, cooled if necessary and then broken up. Stones and skin parts are removed. The end result is usually a puree. The yield is 60–75%. Products are usually sold at single strength and packed into drums and frozen. The puree can also be dried. Mangoes are supplied from the Caribbean, India, Mexico and South Africa.

**Blackcurrant.** The juice yield from processing is 75–80%. The primary use of this juice is to produce drinks that are diluted with water. Blackcurrants are a very good source of vitamin C.

### 3.3 Vegetables

#### Tomato.

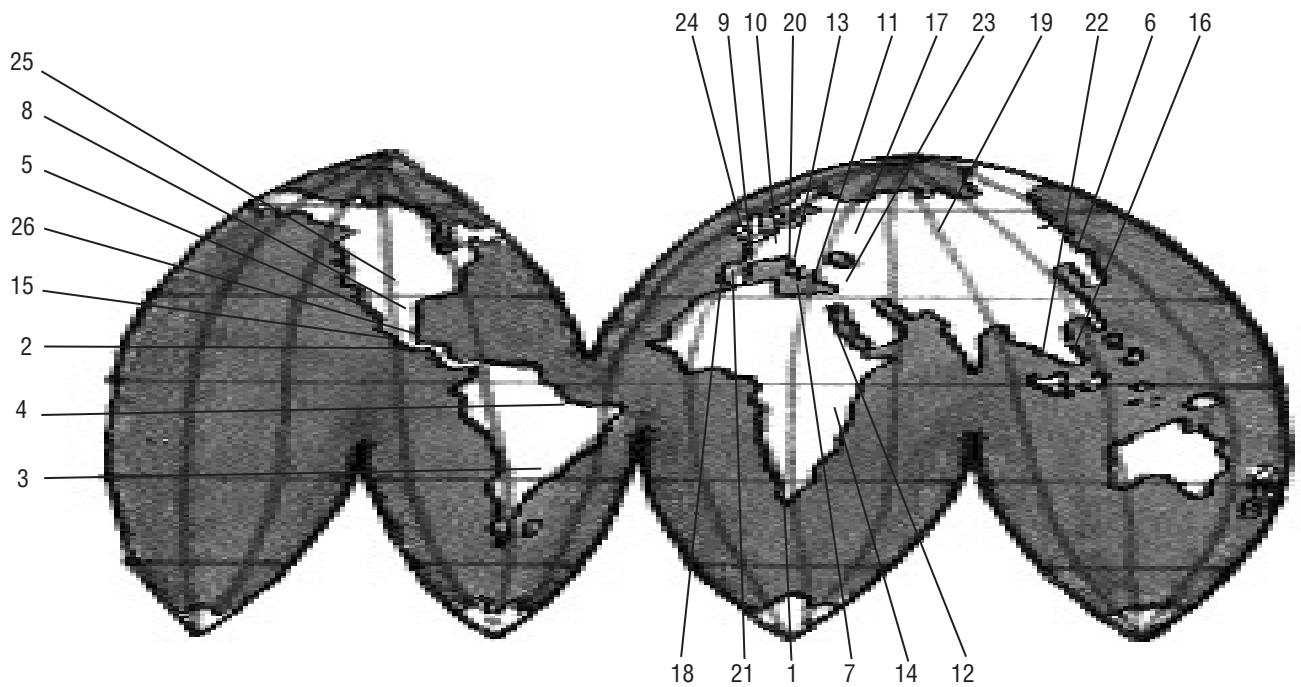
Tomatoes are of considerable importance world wide. In the USA, since 1959, the production of tomato juice has been higher than that of canned, peeled tomatoes. Nowadays tomato juice is mainly produced from



tomato concentrate which is a major trading commodity in the food industry. Acidity is quite low and pH high at 4–4.5. Tomatoes can be grouped in two main varieties – the round type and the long plum Italian type. The fruit is washed and the juice extracted by pulping equipment. The juice is heated to 121°C for 42 seconds to ensure it is safe. Some tomatoes are processed using high temperatures so that a thicker juice is achieved. This is used in the production of tomato ketchups and when canning some fish products.

**Carrot.** Carrot juice is another popular vegetable juice but is not as popular as tomato juice in the UK. Carrots are a good source of beta-carotene, a major nature identical colour which gives carrots their orange colour. It is one of a group of antioxidants which are believed to have beneficial effects in preventing cancer and cardiovascular diseases.

# Fruit Juice



1. S. Africa	O G P	14. Kenya	P
2. C. America	G	15. Mexico	Li
3. Argentina	L G	16. Philippines	P
4. Brazil	O Li P	17. Poland	A
5. California	T	18. Portugal	T
6. China	A	19. Russia	A
7. Cyprus	G	20. Sicily	L
8. Florida	O Li G	21. Spain	O L
9. France	A	22. Thailand	P
10. Germany	A	23. Turkey	T
11. Greece	T	24. UK	A
12. Israel	O L T	25. USA	A
13. Italy	O A	26. W. Indies	Li

KEY: O-Orange G-Grapefruit P-Pineapple L-Lemon  
Li-Lime T-Tomato A-Apple

## 4 JUICE PROCESSING

### 4.1 Extraction and concentration: citrus juices

The processes used to produce citrus fruit juices are:

#### 1. Fruit handling

In addition to fruit grown specifically for processing, fruit that is surplus to the fresh market due to oversupply, size or blemishes is also used. Oranges should be processed within 48 hours of harvesting. Each batch is checked for yield, acidity and sorted into size. Fruit is brush washed with water. This is often 'distilled' water from evaporators which are used for concentrating juice.

#### 2. Extraction

Juice yield is approximately 45–65%. The largest plants (in Brazil) can process up to 10,000 tonnes of fruit per day.

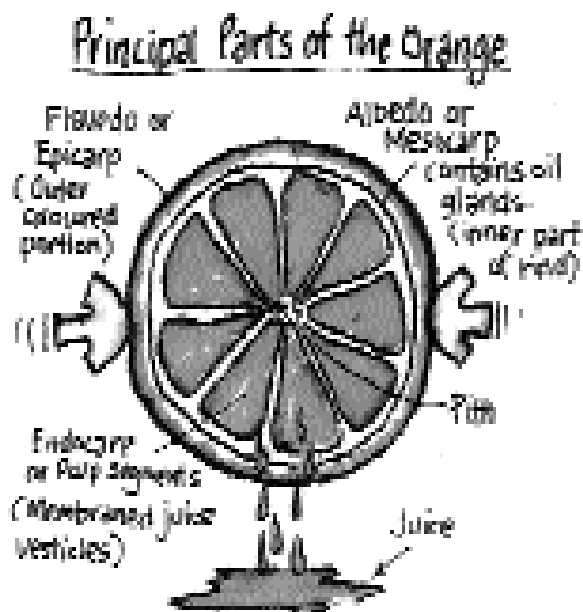
#### 3. Processing

Juice is sieved to remove pips and other unwanted solids. Single strength juice is de-aerated (removal of some oxygen to prevent destruction of vitamin C), centrifuged to remove surplus oil, and pasteurised (to prevent growth of bacteria, yeasts and moulds and to prevent cloudy appearance being destroyed). Juice must be pasteurised within 60 minutes if cloudy appearance is to be retained. HTST (High Temperature Short Time) pasteurisation avoids undesirable changes in flavour.

Pasteurisation conditions depend upon product, required shelf life and storage conditions.

#### 4. Concentration

Citrus juices are concentrated to approximately six times their original strength. The size of 'pieces' in the juice should be no more than 0.5 mm to prevent blocking the machinery. Brix is a measurement of the soluble solids content – mainly natural sugars – of a juice. 1°Brix = 1% sugar w/w. The range of extracted orange juice and grapefruit juice is 9 – 12° and for lemon and lime juice is 7°Brix. Juice producers, however, adhere to a strict international code of practice which sets



out recognised Brix levels for juices produced from various fruit in order to ensure that juices sold are of equal high standards. The code standard for orange juice is 11.2°Brix.

The acidity of citrus juice is usually expressed as citric acid, but malic acid and small amounts of oxalic acid are also present. The soluble solids to acid ratio is the best criterion of citrus quality, e.g. an orange of 11.5°Brix having 0.76% acid content would have a Brix: acid ratio of 15. The ratio alters according to the growing regions and the effect of early and late season fruit. The ratio is often called the Maturity Index.

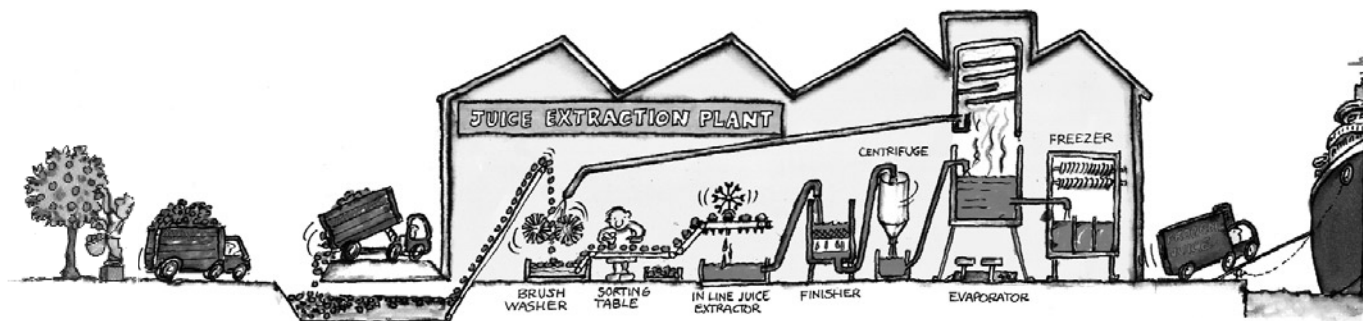
#### 5. Essence recovery

Essence oils which are present in citrus fruits are vital to the overall aroma and flavour. They are removed in the processing techniques but are recovered and blended back into the concentrated juice to obtain the best results.

### 4.2 Reconstitution: citrus juices

Water is added to the concentrate to bring the juice back to its natural level.

# Fruit Juice



## 4.3 Extraction and concentration: non-citrus juices

The juice yield for apples is high (up to 90%) and contains a large proportion of whole fruit. Apples grown in warm sunny conditions are usually higher in sugar and lower in acids than those grown elsewhere. There are two main types of pure apple juice on the market:

- clarified (clear), still
- cloudy, still

Apple juice can also sometimes be carbonated.

Clarified (clear) juices are the most popular and are usually produced from concentrates. Cloudy juices are usually produced directly from freshly pressed apples.

The processes used in producing non-citrus juices are:

### 1. Harvest, storage, handling

Apples can be stored for up to 12 months in gas-filled refrigerated rooms. The atmosphere is modified by reducing the oxygen level and increasing carbon dioxide to reduce further maturing activity. Fruit is transported from storage to processing by water flumes. It is hand sorted and washed thoroughly to remove all dirt, rotten fruit, debris and traces of pesticides.

### 2. Pressing and extraction

Apples are milled and ground to a mash and juice is pressed out. The crushed fruit passes through a

screen to control the particle size. Juice is pressed out of 'mash'. A fabric prevents solids passing into juice. Several pressings can be achieved.

### 3. Juice processing

Apple juice must be processed immediately after pressing to prevent changes to flavour by oxygen and microbiological spoilage. Cloudy apple juice is pasteurised and packaged. Clear juice is clarified and filtered to remove all particles.

### 4. Concentration

More than 50% of water is removed to produce concentrated apple juice.

### 4.4 Reconstitution: non-citrus juices

As in the case of citrus fruits, water is added to restore the juice to its natural level.

## 5 TYPES OF JUICE

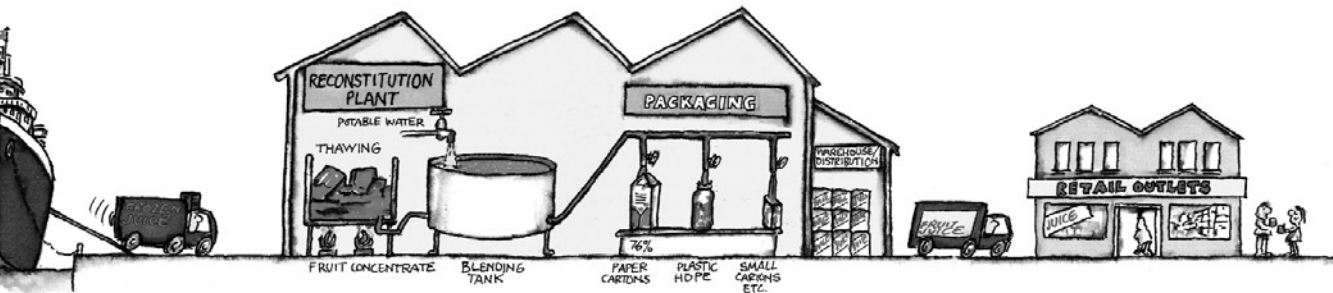
There are three main marketing styles:

1. Long-life juices – usually made from concentrate
2. Short-life juices – may be from concentrate or single strength juice, or a mixture
3. Unpasteurised/freshly squeezed juices

### 5.1 Juice from concentrate

Fruit is picked and squeezed and the juice concentrated in continuous evaporators. The concentrated juice is then frozen and shipped to the country of use for packing. It is then reconstituted with water to bring it back to its original strength.

# Fruit Juice



## 5.2 Freshly squeezed juice

a) Fruit is squeezed in the country of origin and then lightly pasteurised and frozen or aseptically packed for shipment to the country of use. The juice may be stored in this form and enables juice from a particular source, e.g. Florida, to be supplied throughout the year. This is usually known as 'not from concentrate' or pure squeezed.

b) Fruit is shipped to the country of use and squeezed there for immediate use. It may be unpasteurised or lightly pasteurised. Since fruits are seasonal the source material varies throughout the year. This method is usually known as 'freshly squeezed'. Such juices have a shelf-life of 14 days or less.

## 5.3 Long-life juices

These juices are sterilised using a high temperature short time process (typically 90–95°C for 10–20 seconds), filled into pre-sterilised containers and hermetically sealed. The product will remain sterile and life is limited only by the natural ageing process. Shelf-life is usually 6–9 months.

## 5.4 Short-life juices

These juices are usually lightly pasteurised and filled into cartons or bottles. The life is limited due to possible risk of spoilage and the products must therefore be kept chilled. Short-life juices may be made from concentrate, or from single strength juice or a blend of the two which is usually termed 'premium blend'. Shelf-life is normally 3–6 weeks depending on the method of packing. Some freshly squeezed juices are not pasteurised and the life of these is limited to a few days.

## 6 NUTRITION AND THE IMPORTANCE OF FLUID

### 6.1 The importance of fluid

Water is essential for the functioning of almost all the body's living cells. Human blood is 95% water, bones are 22% water and even 75% of the human brain is water. Without food humans can live for 14 days or more, but without water the body can only survive a few days. In total our bodies are about two-thirds water. An average man has 40 litres of water in his body.

Water is the principal constituent of cells and tissues and is the means of transport of essential nutrients around the body. [The digestive system breaks down solid foods into smaller units that the bloodstream can carry to the liver and other organs where they are converted into body substances for use by the cells as building materials. New materials are carried to the cells and waste products are removed by the flow of blood and glandular secretions.] Without water to moisten the lungs there could be no intake of oxygen and no expulsion of carbon dioxide.

Water also plays a vital role in controlling body temperature. Normally maintained at about 37°C, whether the outside temperature be arctic, temperate or tropical, the body temperature is controlled by a process called 'homeostasis', which includes the evaporation of water through the skin. In warm conditions or in a hot dry atmosphere heat loss is increased by perspiration and in extreme conditions can exceed one litre an hour. However, at low temperatures water is transferred from the blood into the tissues, so that less of it is brought to the surface of the skin and heat is conserved. During periods of intense physical effort, body heat also rises and needs to be regulated.

# Fruit Juice

However, we lose about 2 litres of water each day through urine, breathing and sweating. In hot weather an average adult will lose approximately 0.5 litres of fluid every hour without realising it. To make up these losses we get some water from foods but most from beverages.

*The British Dietetic Association states that an average adult should consume 2.5 litres of water a day, of which 1.8 litres (or 5 x 330 ml cans; 7 x 250 ml glasses) must be in fluid form, the remainder being obtained from foods.*

The body gets its water from three sources:

- water itself or the water in beverages;
- water in solid foods, which contains wide ranging amounts, from 5% or so in biscuits, 60% in steak, to 90% in the juiciest fruits;
- and water produced in the body as a byproduct of chemical changes that convert food into cell material.

By ensuring that we consume enough fluid we help to keep our bodies hydrated, replacing the fluid lost through normal bodily functions, preventing dehydration.



The two human organs that contain the most water in our body are the brain (75% water) and the skin (70%). They are the first to suffer from the effects of dehydration, such as headaches. Thirst is not always a good indicator of need. According to experts, we need to drink regularly, not just when we are thirsty. Being thirsty is a sign that a person is significantly dehydrated. Dehydration, caused by consuming too little fluid, can cause symptoms such as headaches, tiredness and loss of concentration. Severe dehydration, e.g. after

vigorous sport or on a hot day, can be dangerous. Soft drinks, fruit juices, water (bottled or tap), tea, coffee, milk and other non-alcoholic beverages are good sources of fluids. With water as their major ingredient they can quickly replace lost fluids into the body. Studies have also shown that the inclusion of sweet carbohydrates in drinks increases palatability and hence fluid intake.

## 6.2 Vitamins

In general, the vitamins in fruit are expressed into fruit juice. The B group of vitamins (B<sub>1</sub>– thiamin, B<sub>2</sub>– riboflavin) are important for the release of energy from carbohydrates, protein and fat during metabolism. Niacin is also involved in this process. Unfortunately, the levels of thiamin, riboflavin and niacin are low in fruit juice. However, there are significant levels of folates present.

### 6.2.1 Folates

Folates (folic acid) aid the development of genetic material and are involved in red blood cell production. Low levels can cause gastrointestinal disorders, anaemia and cracking of the lips. Premature infants and pregnant women are susceptible to deficiencies.

### 6.2.2 Vitamin C

The level of vitamin C (l-ascorbic acid) in a fruit depends upon its maturity and the conditions in which it was grown. The amount of vitamin C contained in a juice depends upon the processing techniques the product receives.

Vitamin C is essential for the structure of bones, cartilage, muscle and blood vessels. It also helps to maintain capillaries and gums and aids in absorption of iron. A deficiency of vitamin C can lead to bone deformities in children and calcium loss from bones in adults. The recommended daily intake for males and females aged 11 – 14 years is 35 mg.

Vitamin C is very sensitive to oxygen and heat. In the older style fruit processes, losses of vitamin C were very high. However, as the flavour volatiles are sensitive to the same factors as vitamin C, conditions which are best for flavour retention are also good for vitamin C retention.

## Vitamin C in fruit and vegetable juices

Type of juice	Average quantity per 100 ml	Percentage of recommended daily intake (11–14 yrs)
Orange	39 mg	111%
Grapefruit	31 mg	89%
Lemon	45 mg	129%
Lime	29 mg	83%
Apple	14 mg	40%
Pineapple	11 mg	31%
Passion fruit		
– yellow	12 mg	34%
– purple	25 mg	71%
Blackcurrant	107 mg	305%
Tomato	16 mg	46%

Modern processing and packaging practices have therefore reduced the losses of vitamin C, although some losses do occur. Further losses occur during prolonged storage, particularly if the container is open to the atmosphere. It is worth noting that many fruit juices now come in resealable packaging (cartons/bottles) which prevent further loss of vitamin C.

Citrus fruits are particularly rich in vitamin C. Some other fruits used for juice production have lower initial quantities of vitamin C. Therefore, there are lower levels in the juices after processing. The production of apple juice can lead to virtually complete losses of any natural vitamins. Freshly pressed/unpasteurised juice usually has a similar concentration to that of the original fruit.

The nutrition content of a typical orange juice is detailed below:

Nutrition information	
Typical values	250 ml provides
Energy	480kJ /113 Kcal
Protein	2 g
Carbohydrate	28.5 g
of which sugars	23.5 g
Fat	0.25 g
Fibre	0.7 g
Sodium	trace
Vitamin C	120 mg (200% of RDA)

## 6.3 Carbohydrates

The carbohydrates to be found in fruit juices are sugars – glucose, fructose and sucrose. These occur naturally in the fruit. Apple juice usually contains around 11% by weight of solids. Approximately 90% of these solids are carbohydrates. Other carbohydrates can be present in fruit juice. These include glucose syrup and malodextrin. Most soft drinks contain fewer carbohydrates than fruit juice.

### Percentage of sugar contained in the most popular fruit juices

Juice	Percentage of sugar
Orange	11 – 12%
Apple	10 – 12%
Grapefruit	10 – 11%
Pineapple	12 – 16%
Lemon	0.5 – 3%
Tomato	4.5 – 6.5%
Sweetened Grapefruit	12 – 16%

Source: BSDA members, 1996

## 6.4 Acids

Fruit juices contain natural acids from the fruit from which they are produced. As well as providing an agreeable taste profile, acids perform an important microbiological control function.

Most bacteria grow in moist warm environments that do not exhibit extremes of acidity or alkalinity. Main food-poisoning organisms, in particular, need near neutral conditions to grow and multiply. Acidic foods and drinks, whether naturally acidic or which have acids added deliberately, provide a level of preservation by lowering the pH level of the product.

### Percentage of acid contained in the most popular fruit juices

Juice	Percentage of acid	pH
Orange	0.75 – 1%	3.3 – 3.5
Apple*	0.4 – 0.7%	3.4 – 3.7
Grapefruit	1.1 – 1.6%	3.1 – 3.4
Pineapple	0.4 – 1.0%	3.3 – 3.7
Lemon	4.6 – 6.4%	3.0 – 3.2
Tomato	0.3 – 0.45%	4.2 – 4.5
Sweetened Grapefruit	1.1 – 1.6%	3.1 – 3.4

\*Contains malic acid; all others contain citric acid.

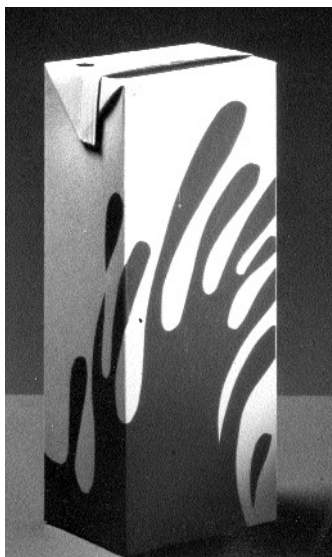
Source: BSDA members, 1996

# Fruit Juice

## 7 PACKAGING

Fruit juices can be packed in any of the following containers:

- cartons for short-life juice
- cartons for long-life juice
- cartons for single drinks (with straw)
- glass bottles
- returnable glass bottles
- plastic bottles
- juices on draught (bag-in-box)
- cans
- cups (filled under aseptic conditions)



High standards of hygiene are a priority to enable production of good quality fruit juices. The temperatures and packaging techniques used to process and package fruit juices ensure that no micro-organisms contaminate the end products.

## 7.1 Labelling

Labels on pure fruit juice on first appearance may seem to contain far less information than that found on soft drinks labels. The ingredient list for example will be very short simply because there is only one ingredient.

However, as in the case of other soft drinks, fruit juices labels must contain best before information, any storage instructions, the name of the manufacturer and its address. If the juice has been reconstituted the label will also state 'made from concentrated juice'. All fruit juices will also include storage instructions before and after opening.

If sugar has been added for technical correction purposes, i.e. less than 15 g per 1000 ml (see **Legislation and Good Practice**), then the product will no longer be called pure. Although not labelled as sweetened, sugar will be listed as an ingredient in the ingredient list. Those products that have more than 15 g per litre of sugar added will be labelled as sweetened.

Some fruit juices will also show nutritional information, giving typical values either by 100 ml or 200 ml. This may also contain information regarding various vitamins, e.g. vitamin C, giving details on the quantity an average serving will contribute to recommended daily allowances.

### Nutritional Information Typical Values per 100ml

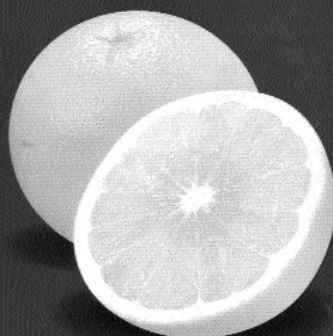
Energy	169kJ/40kcal
Protein	0.4g
Carbohydrate	8.5g
(of which sugars)	8.5g
Fat	0.1g
(of which saturates)	Trace
Fibre	Trace
Sodium	Trace
Vitamin C (50% of RDA)	30mg

RDA = Recommended Daily Allowance  
A 200ml serving provides 100% of the  
Recommended Daily Allowance of Vitamin C

Ingredients:  
Grapefruit Juice

### PURE GRAPEFRUIT JUICE

100% Pure and Natural



Best Before end:  
Aug 2004

Best served chilled  
After opening, store in a  
refrigerator and drink  
within 4 days

Made with  
concentrated  
Grapefruit juice  
unsweetened

# Fruit Juice

## Packaging fruit juices

Type of container	Approximate percentage of fruit juice
Paper – cartons (1 litre)	75%
Paper – small cartons (mainly 200 ml)	6%
Plastic – mainly HDPE	9%
Glass	4%
Others – bag-in-box, cans	6%

Source: Zenith International, 2002