MICROBES are present all around us, ever ready to attack our food stuffs. In small numbers they do no harm, but if suitable conditions of air, moisture, warmth, correct pH and a supply of food to grow on are available, they grow quickly to countless numbers. And soon they make our food look poor in appearance, bad in taste, unpleasant in smell, and most importantly produce dangerous levels of toxins in the food. Bacteria, fungi and yeasts are the main culprits. Isn’t it irritating when coconut chutney prepared in the morning becomes useless and has to be thrown out in the evening. No wonder granny used to repeatedly tell us to add salt, tamarind, etc. in correct proportions while preparing food items, not to touch them with hands and always use dry spoons for serving. She insisted on tightly putting lids on dishes and pickle bottles and not to keep them open for a long time.

Well, grandma knew how to keep away the micro-organisms. What were her weapons? She used chemical weapons to attack the harmful microbes. However, she doesn’t consider them as chemicals. Yes, sugar, salt, honey, vinegar are chemicals indeed!

Our kitchens contain a battery of chemicals each fulfilling a specific purpose. Food preservatives are food additives that serve the specific purpose of preserving the food for extended periods of time. Honey is a natural food with sufficiently long shelf life. We must be grateful to honeybees! They collect the sweet nectar from various flowers, refine it with the help of their saliva and regurgitate into the honeycomb cells of the beehive and fan it to reduce the water content of honey. The water content of good quality honey being below 20% doesn’t allow airborne micro-organisms to breed and multiply.

Adding to this, the acidic environment with a very low pH ranging from 3 to 4.5 inhibits the growth of many micro-organisms. Chemically honey is made up of carbohydrates. Fructose is the major monosaccharide while the other carbohydrates present are glucose, maltose and sucrose. The combination of high sugar concentration and low water content prevents it from spoilage. Pure honey properly stored in glass or ceramic containers with tight lids can be relished for ages together.

All organisms live in a narrow range of conditions. No microbe, not even bacteria, can live in too sweet, too sour, too salty, too hot or too cold environment. We prepare jams using sugar. As long as water doesn’t separate out we see no spoilage, but we observe patches of mould on jam, where water has formed on the surface. When this water reduces the concentration of sugar, there arises an opportunity for the microbes to grow in millions in just a few hours. Jam preparations contain high concentrations of sugar. Sugar draws water from microbes in the food by the process of osmosis and dehydrates them.

Food substances can be immersed in thick
concentrated sugar syrup or they can be cooked in sugar until sugar reaches the point of crystallization. These methods are in vogue since centuries.

Salt has been used to preserve food items like meat and fish since ages. Salt binds the water by entering the tiny food tissues, drawing out the moisture completely. This dehydration by osmosis curbs the growth of food-spoiling bacteria.

Vinegar is another natural food preservative, prepared by a process of fermentation of sugar and water solution beyond the alcohol stage. It contains acetic acid which kills the bacteria with its acidity. Vinegar is used to preserve meats and vegetables in the processes of pickling and canning to increase the shelf life of the food items. For example, cucumber is put in salt solution for a few days, then washed thoroughly, and left in vinegar, so that it remains edible for a long time. Propionic acid is used as a natural food preservative just like vinegar to prevent fungus, bacteria in bakery stuff, and bread making.

Rosemary (Rosmarinus officinalis) is a woody, perennial herb with fragrant, evergreen, needle-like leaves, known for its antioxidant properties, pleasant aroma and flavor. Rosemary extract is made by the distillation of rosemary leaves and is used as a preservative to prevent oxidation which can lead to discoloration or rancidity of food items. It helps the food stuff to retain its original flavor and taste. It has been shown to improve the shelf life and heat stability of omega 3-rich oils, which are prone to rancidity.

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Sauerkraut has a long shelf-life due to the lactic acid that forms when the bacteria ferment the sugars in the cabbage.

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Sorbitic acid is a natural food preservative, first isolated by A.W. Van Hoffman from the berries of the rowan tree (Sorbus aucuparia). Sorbic acid and its salts, such as sodium sorbate, potassium sorbate, and calcium sorbate, are antimicrobial agents often used as preservatives in food and drinks. Sorbic acid preservatives effectively inhibit the activity of molds, yeasts and aerobic bacteria, and prevent the growth and reproduction of botulimum, staphylococcus, salmonella and other harmful micro-organisms.

Preservation Flows from History
Crops and vegetables grown in a particular area very much depend on the seasonal conditions in that area. Hence the preservation of harvested and prepared food for future consumption is a necessity since fresh food may not be always available, for example to those on voyage. This necessity motivated human beings to invent certain food preservation methods.

In 1795, Napoleon offered a cash prize for a new method to preserve food to feed his army. Nicolas Appert conducted a series of trial-and-error experiments, and finally succeeded and
submitted his invention, the first of its kind, now commonly called canning and won the prize in January 1810. He filled thick, large-mouthed glass bottles with food stuffs to be preserved, sealed them with cork and sealing wax leaving some space in the bottle, and then placed them in boiling water to kill any microbes in the food – the sealed can prevents fresh contamination. In honor of Appert, canning is sometimes called ‘appertisation’.

Appert’s method was used commercially in 1910 by Peter Durand using metal cans. In earlier days lead was used to solder the cans. However, as exposure to lead may lead to poisoning, modern techniques of canning use vacuum sealing and plastic wrappings.

Appert’s early attempts at food preservation by boiling involved cooking the food to a temperature far in excess of what is now used in pasteurization [70 °C (158 °F)]. Milk, ice cream, fruit juices, beer, and non carbonated beverages are some examples of foods that are commonly pasteurized. Milk can be pasteurized by heating to 62.8°C for half an hour or 72.8°C for 15 seconds. Pasteurization kills certain bacteria but not all, and disables certain enzymes.

Nowadays, we find a variety of canned food items. We get ‘canned milk’ in boxes. Milk is made complete sterile by ultra high temperature pasteurization (UHT) where the temperature of milk is raised to 141°C for one or two seconds and then it is sealed inside the box. Once we open the box, bacteria enter and begin to attack the food. Boiling food in a can generally changes its taste and texture as well as its nutritional content.

Drying is one of the oldest methods of food preservation. Our ancestors are known to have had dried fruits, vegetables and meat. This method reduces the size and weight of the food stuff, making it more portable. Good raw mangoes are cut into small pieces and sun-dried after application of salt. These dried mango pieces can be used throughout the year in various food preparations like dhal, curries, etc.

The Incas stored their potatoes and other foods at high altitudes where they lived in the Andes Mountains. The food froze at these cold temperatures, and because of the reduced atmospheric pressure, the water dissipated more quickly than it would have at sea level. Early in the twentieth century this process was then further developed and is known as freeze-drying.

The addiction to processed food with added chemical preservatives may lead to many health-related disorders in future generations.

Freeze-drying uses vacuum and freezing to remove all water from perishable foods.

The drying process may also include smoking, which is one of the oldest methods of food preservation. Smoking involves hanging the foodstuff in the wood smoke and heating from a low fire, usually with wood selected for both flavoring aspects and the correct amount of moisture to create enough smoke. This dries the food, cooks it to kill bacteria and imparts a distinctive taste to the finished product. This method is still in vogue. Some meat, bacon, and fish such as haddock and salmon are preserved by smoking.

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This is a special form of drying, which uses vacuum and freezing to remove all
water from perishable foods. First the foodstuff is cooled far below the freezing point of water so that all of the water contained inside the food is frozen into solid crystals. The basic structure of the fruit, vegetable or meat does not change. Then the frozen foodstuff is placed in a vacuum chamber, and the surrounding air is pumped out. The frozen water crystals in the food sublimate, that is, change from solid ice to a gas, bypassing the liquid state altogether. The final products thus obtained are vacuum-sealed and stored at room temperature for years without spoilage, in small packets that occupy limited space. The food is reconstituted with water later for consumption. Instant coffee is often made by freeze drying process.

During World War II troops were supplied with freeze-dried orange juice. Campers, soldiers and astronauts have freeze-dried meals, specially created for their convenience and ease in carrying.

Pickling uses the preservative qualities of salt combined with low pH nature of acidic ingredients to prepare pickles. In India, homemade pickles are usually prepared in hot summer. Most vegetables like amla (gooseberry), unripe mango, lime, lemon, citron, garlic, ginger, chilies, tomatoes, onions, gongura etc, are preserved as pickles. The high concentrations of salt, oil (usually sesame oil or mustard oil),and spices act as preservatives. Commonly used spices include powders of red chilli and mustard, salt, the seeds of fenugreek, asafoetida and turmeric. Lemon juice, tamarind, or vinegar is used to lower the pH and also

<table>
<thead>
<tr>
<th>Preservative</th>
<th>Activity</th>
<th>Type of food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzoates and sorbates</td>
<td>Antimicrobial</td>
<td>Pickles, margarine, fruit juices, jams, cheese</td>
</tr>
<tr>
<td>Propionates</td>
<td>Antimicrobial</td>
<td>Bakery products, cheese, fruits</td>
</tr>
<tr>
<td>Sulfites and sulfur dioxide</td>
<td>Antimicrobial</td>
<td>Dry fruits and fruits, molasses, wine, fried or frozen potatoes, prevent discoloration in fresh shrimp and lobster</td>
</tr>
<tr>
<td>Nitrites and nitrates</td>
<td>Antimicrobial</td>
<td>Meat products</td>
</tr>
<tr>
<td>Propyl gallate</td>
<td>Antioxidant</td>
<td>Baked foods, meats</td>
</tr>
<tr>
<td>BHA (Butylated Hydroxy Anisole)</td>
<td>BHT (Butylated Hydroxy Toluene)</td>
<td>Baked foods and snacks, meats, breakfast cereals, potato products</td>
</tr>
<tr>
<td>Tert-Butyl Hydro Quinone</td>
<td>Antioxidant</td>
<td>Baked foods and snacks, meats</td>
</tr>
<tr>
<td>Iso-ascorbic acid, citric acid</td>
<td>Antienzymatic</td>
<td>Soft drinks, juices, wine, and cured meats</td>
</tr>
</tbody>
</table>

Once we open the box/seal, bacteria enter and begin to attack the food.

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Drying is one of the oldest methods of food preservation.

to give sour taste where ever necessary. Many commercially produced pickles use preservatives like vinegar citric acid and sodium benzoate

Refrigeration and freezing are probably the most popular forms of food preservation. Refrigeration slows bacterial action in food while freezing stops bacterial action altogether. Refrigeration and freezing are used on almost all foods: meats, fruits, vegetables, beverages, etc. to increase their shelf life.

Ionizing radiation of shorter wavelengths is also used in food preservation. During irradiation, energy waves damage micro-organisms that contaminate food or cause food spoilage but are not retained in the food, thereby extending the shelf life of foods. Foods that are sterilized by irradiation can be stored for years without refrigeration just like canned foods.

The irradiation process works with both large and small quantities. For example, a single serving of poultry can be irradiated for use on a space flight; a large quantity of potatoes can be treated to reduce sprouting during warehouse storage. Both large and small containers can be used and food can be irradiated after being packaged or frozen. However, irradiation cannot be used with all foods. It causes undesirable flavor changes in dairy products, and tissue softening in some fruits such as peaches.

Synthetic food preservatives can be categorized into three general types: antimicrobials that inhibit growth of bacteria, yeasts, or molds; antioxidants that slow air oxidation of fats and lipids, which leads to rancidity; and a third type that blocks the natural ripening and enzymatic processes that continue to occur in foodstuffs after harvest. These are added to various foodstuffs as preservative additives.

Although these are used to keep the food fresh and to stop the bacterial growth, there are certain preservatives in food that are harmful if taken in more than the prescribed limits. To cite an example benzoates are banned in Russia because of their role in triggering allergies, asthma and skin rashes. These preservatives are also considered to cause brain damage.

Some common chemical preservatives and their primary activity and the type of food products they are used are shown in the table given above.

Busy parents are today increasingly getting attracted towards readymade foods, which are readily available in the market in beautiful packaging. Consequently, children are getting used to and prefer processed food. This addiction to processed food with added chemical preservatives may lead to many health-related disorders in future generations.

Dr. Chaganty Krishna Kumari retired as Associate Professor (Reader) in Chemistry. Address: 204, Saradagopalan Apartment, St. No. 8, Himayatnagar, Hyderabad - 500029, AP; Email: chaganty_krishnakumari@yahoo.com