Energy conservation in domestic rice cooking

India ranks second in the world production of rice, a major cereal crop next to wheat and maize. The cooking process and the choice of cooked rice texture are different from place to place. However, Indian preference is for medium grain with fluffy, light individual kernel of rice with cooked flavour and without hard core. The two important variables in rice cooking are the amount of water and the control of heating. The water-to-rice ratio is important in keeping the cooked rice from being either too hard or too soft.

Presoaking is a simple technique that offers great savings (energy and cooking time) in cooking stored or freshly milled rice. However, cooking rice without presoaking is the general practice in many parts of the world. While presoaking needs to be promoted as an energy conservation measure, there is a necessity to look for further saving in energy.

The researchers at Central Food Technological Research Institute, Mysore, India and Tezpur University, Assam, India carried out investigations to optimize the energy requirements in rice cooking by controlling the cooking conditions in the domestic cooking appliances such as electric rice-cooker and pressure cooker. During experiment one lot (100 kg) of milled B.T. ‘Bangara Thigadu’ variety rice was procured from the local market and stored in a refrigerator at 4°C and the required quantity of rice was taken out as and when necessary for the experimental work. The moisture content of the raw rice was 12.8% (w.b.) as determined by oven dry method (105°C for 24 hours). Experiments were conducted to measure the energy consumption during normal and controlled cooking of both unsoaked and presoaked rice using two types of domestic cooking appliance, namely, an electric rice cooker and a pressure cooker. Cooking rice with controlled energy input, under pressure and with presoaking were the three approaches, which resulted in saving of energy. Electric rice cooker was found to be the most energy-efficient among the different combinations of cooking appliance and the types of heat source used in the study. The energy consumption was much less (23-57%) compared to other methods. Prior soaking of rice generally reduced energy consumption as well as cooking time, more prominently during normal cooking. Controlled cooking offered more savings in energy compared to presoaking rice. Considering the energy consumption and cooking time, controlled cooking of presoaked rice was found to be the best among the several approaches investigated. Measurement of water evaporation loss appears to be a good indirect method of assessing the efficiency of heat utilization. Controlled energy input is another useful method that optimizes the energy utilization for cooking, besides presoaking and pressure cooking. Controlled cooking is desirable in all types of rice cooking [Das Tribeni, Subramanian R, Chakkaravarthi A, Singh Vasudeva, Ali SZ and Bordoloi PK, Energy conservation in domestic rice cooking, J Food Eng, 2006, 75(2), 156-166].

Fruit

Commercial scale drying of Aonla

In traditional system dry aonla (Emblica officinalis Gaertn.) is used in large quantities for various medicines and cosmetics preparation. Therefore, for commercial production of dry aonla adequate processing is very essential for getting good quality and earn more money. The scientists at college of Dairy and Food Science Technology, Maharana Pratap University of Agriculture and Technology, Udaipur, India have developed a new approach for drying of aonla. This approach includes installation of an aonla Shredder unit and a Solar Tunnel dryer. They evaluated design specifications and performance of different devices used in drying the pulp of aonla. An integrated approach to use aonla in efficient manner has been developed, which include different unit operations, viz. removing seeds from aonla fruit through shredder stones extractor machine and drying of one tonne of aonla pulp in Solar Tunnel dryer [Rathore NS, Jhala AS and Vijayvargiya Jully, New approach for drying of Aonla on commercial scale, Beverage Food World, 2006, 33(3), 50-53].
Litchi (*Litchi chinensis Sonn.*) has a white, juicy aril which is surrounded by a reddish prickly leather-like skin and contains a shiny brown, usually large seed. The major litchi production areas in the world are China, Taiwan, Vietnam, Thailand, India, South Africa and the Malagasy Republic. Availability of the fresh fruit is limited because of its short production period and shelf life. The most common process to preserve litchi is canning. As with many other fruits and vegetables, a pink discoloration occurs in canned litchi. This phenomena is not only of sensory importance but also leads to nutritional losses. Increasing consumer demand for safe, high-quality, fresh like products that are shelf-stable, minimally processed and additive free stimulated the interest of the food manufacturing industries in such novel processing techniques as high-pressure. This process has good potential for the development of new processes for food preservation or product modifications. For the development of high pressure processed fruits and vegetables, it is essential to know the influence of high pressure on the activities of such enzymes as polyphenol oxidase (PPO), peroxidase (POD) and lipoxygenase. PPO catalyzes the oxidative reaction associated with undesirable browning of damaged tissues in fresh fruits and vegetables. POD is associated with off-flavours and off-colours in raw and unblanched vegetables.

Researchers from Thailand investigated the effect of combined ultra-high pressure/temperature on POD and PPO activities in litchi and some quality parameters of interest. To evaluate the possibility of using high pressure as an alternative to canning for litchi preservation, fresh litchi and samples preserved in syrup were subjected to various pressures (200-600 MPa), temperatures (20-60°C) and times (10 or 20 min) and subsequently analysed for physical attributes, POD and PPO activities. Pressure treatment caused less loss of visual quality in both fresh and syrup processed litchi than thermal processing. The optimal pH for litchi POD and PPO were 5.0-8.0 and 7.0, respectively. Pressure treatment at 200 MPa caused a marked increase of POD activity and this effect was greater at 40°C than at 20 and 60°C. Pressure treatment at 400 and 600 MPa, and temperatures of 20-40°C, did not affect the activity of POD, but some inactivation at 60°C was observed. The combined effect of pressure and temperature on POD activity were more marked at the longer treatment time (20 min) and under the more severe treatments. A pressure 600 MPa, at 60°C for 20 min caused extensive inactivation of POD and PPO in fresh litchi, over 50% and 90%, respectively but for those processed in syrup, the effects were less marked, presumably due to baroprotection by the syrup. Overall litchi POD was more pressure resistant than PPO. It is concluded that the use of high pressures and moderate temperatures may be an effective means of extending the shelf life of litchi with minimal effect on the quality [Phunchaisri C and Apichartsrangkoon A, Effects of ultra-high pressure on biochemical and physical modification of lychee (*Litchi chinensis* Sonn.), *Food Chem*, 2005, 93 (1), 57-64].

Post-cutting storage of fresh-cut pineapple

The scientists’ team at Spain and USA carried out studies on influences of storage temperature and modified O₂ and CO₂ concentrations in the atmosphere on the post-cutting life and quality of fresh-cut pineapple [*Ananas comosus* (Linn.] Merrill]. The main effect of reduced (8kPa or lower) O₂ levels was better retention of the yellow colour of the pulp pieces, as reflected in higher final chroma values, whereas elevated (10kPa) CO₂ levels led to a reduction in browning (higher L values). Modified atmosphere packaging allowed conservation of pulp pieces for over 2 weeks at 5°C or lower without undesirable changes in quality parameters [Marrero Antonio and Kader Adel A, Optimal temperature and modified atmosphere for keeping quality of fresh-cut pineapples, *Postharvest Biol Technol*, 2006, 39(2), 163-168].
Effect of $O_2$ and $CO_2$ concentrations on physiology and quality of Litchi fruit in storage

Litchi (*Litchi chinensis* Sonn.), native to southern China, is adapted to the warm subtropics, cropping best in regions with brief cool dry frost-free winters and long hot summers with high rainfall and humidity. The fruit easily loses its commercial value after harvest due to pericarp browning, quality deterioration and decay. Browning of litchi pericarp is still considered to be a major problem affecting its market value. Modified atmosphere packaging (MAP) has been considered to be beneficial to maintain high humidity, essential for prevention of water loss and browning of litchi pericarp. Researchers from China conducted studies to investigate the effects of different storage conditions, such as MAP, controlled atmospheres (CA) at 3°C with high-$O_2$ or low-$O_2$ and high-$CO_2$ atmospheres, on physiological properties, quality attributes and storability of litchi fruit and to evaluate the relationship between pericarp browning and activities of polyphenol oxidase (PPO) and peroxidase (POD), as well as contents of total phenol and anthocyanidin in pericarp of litchi fruit.

The results indicated that CA conditions were more effective in reducing total phenol content, delaying anthocyanidin decomposition, preventing pericarp browning and decreasing fruit decay in comparison with MAP treatment. PPO, POD, anthocyanin and total phenols were involved in cellular browning. High $O_2$ treatment significantly limited ethanol production of litchi flesh in the early period of storage. The fruit stored in CA conditions for 42 days maintained good quality without any off-flavour [Tian Shiyang, Li Bo-Qiang and Xu Yong, Effects of $O_2$ and $CO_2$ concentrations on physiology and quality of litchi fruit in storage, *Food Chem*, 2005, 91 (4), 659-663].

Antioxidant activity of *Syzygium cumini* fruit

The Black Plums, [*Syzygium cumini* (Linn.) Skeel] fruits are edible and are reported to contain vitamin C, gallic acid, tannins, anthocyanins, including cyanidin-, petunidin- and malvidin-glucoside and other components. The juice of unripe fruits is used for preparing vinegar that is considered to be a stomachic, carminative and diuretic. The ripe fruits are used for making preserves, squashes and jellies.

The antioxidant activity of the fruit skin has been analyzed by scientists at Department of Botany, University of Calcutta, Kolkata, India using different assays, such as hydroxyl radical-scavenging assay, based on the benzoic acid hydroxylation method, superoxide radical-scavenging assay, based on photochemical reduction of nitroblue tetrazolium (NBT) in the presence of a riboflavin-light-NBT system, DPPH radical-scavenging assay, and lipid peroxidation assay, using egg yolk as the lipid-rich source. Total antioxidant capacity was determined by the assay based on the reduction of $Mo(VI)-Mo(V)$ by the extract and subsequent formation of a green phosphate/$Mo(V)$ complex. The fruit skin showed significant antioxidant activity which may come in part from antioxidant vitamins, phenolics or tannins and/or anthocyanins. Thus, consumption of these fruits may supply substantial antioxidants which may provide health promoting and disease preventing effects [Banerjee Archana, Dasgupta Nabasree and De Bratati, *In vitro study of antioxidant activity of Syzygium cumini* fruit, *Food Chem*, 2005, 90 (4), 727-733].
Effect of fruit extracts on *in vitro* accessibility of iron in high-tannin sorghum

Polyphenol oxidase (PPO) is often associated with deterioration of foods because of its involvement in browning reactions. It oxidizes a number of phenolic compounds to the corresponding quinones, which easily undergo secondary reactions with amino acids, proteins or other phenols, to form melanin pigments. The ability of PPO to oxidize phenolic compounds may, however, be utilized to increase the bioavailability of iron in polyphenol-containing plant foods. Coloured cereals, for example, are known to contain large amounts of phenolic compounds, such as condensed tannins. High-tannin sorghum is used as a staple food in many arid areas of the world and the tannins contribute strongly to the low bioavailability of iron in the vegetable diet eaten by the people in these areas. Many fruits and vegetables, such as pear, banana and avocado, have a high PPO activity. In addition, fruit extracts also contain significant amounts of organic acids, which may have a positive effect on iron absorption. However, fruit juices are often ingested at the same time as a meal, which will not enable the PPO to reduce the phenolic content in the food. Scientists at Department of Chemistry and Bioscience/Food Science, Chalmers University of Technology, Göteborg, Sweden carried out studies to investigate how incubation of dephytinized high-tannin sorghum with fruit extracts containing PPO activity affects the phenolic content and the *in vitro* accessible iron.

Dephytinized high-tannin sorghum flour was incubated with crude extracts from pear (*Pyrus communis* Linn.), banana (*Musa* sp.) or avocado (*Persea americana* Mill.), respectively, followed by investigation of the effects on the phenolic content and on *in vitro* accessible iron. All fruits contained PPO activity and incubation resulted in significant reduction of phenolic compounds. Incubation with avocado extract resulted in the lowest levels of phenolic compounds, as well as the highest amount of *in vitro* accessible iron. Peroxidase activity and some organic acids in the fruit extracts might also have contributed to the positive effect on iron accessibility. Nevertheless, incubation of the sorghum flour with the fruit extracts under conditions enabling the PPO to oxidize phenolic compounds, resulted in the highest accessibility of iron.

To conclude, crude extracts from different fruits can be used, in combination with dephytinization, to effectively increase the accessibility of iron in high-tannin cereals. When high-tannin cereal flours were incubated with fruit extracts, the polyphenol oxidase in the extracts was found to reduce the phenolic content of the cereals. The content of organic acids in the fruit extract, as well as a high peroxidase activity, may further increase the iron accessibility. Many fruits in low-income countries contain PPO activity, which makes them suitable for the proposed incubation process. In combination with simple methods that degrade phytate, incubation with fruit extracts could be used at a house-hold level to increase the bioavailability of iron in high-tannin staple cereals [Matuschek Erika and Svanberg Ulf, The effect of fruit extracts with polyphenol oxidase (PPO) activity on the *in vitro* accessibility of iron in high-tannin sorghum, *Food Chem*, 2005, 90 (4), 765-771].
Mulberry extract inhibits the development of atherosclerosis

Mulberry (Morus alba Linn.) fruit is a traditional Chinese edible fruit that is used effectively in folk medicines to treat fever, protect liver from damage, strengthen the joints, facilitate discharge of urine and lower blood pressure. Recently, it has gained an important position in the local soft drink market, although its biological and pharmacological effects are still poorly defined. Researchers of Taiwan investigated the effect of Mulberry water extract (MWE) on experimental atherosclerosis in rabbits. New Zealand white rabbits were fed with a normal diet, high cholesterol (1.3%), lard oil (3%) diet (HCD) with or without 0.5 or 1% MWE for 10 weeks. Feeding MWE (0.5 or 1% in the diet) to rabbits significantly reduced severe atherosclerosis in the aorta by 42-63%. It is concluded, that MWE lowered the serum cholesterol and triglyceride and repress progression of atherosclerosis in HCD-fed rabbits. This might be attributed to the preventative effect of anthocyanins against LDL-oxidation in the arterial wall and supports the use of MWE for lowering the incidence of atherosclerosis and coronary heart [Chen Chang-Che, Liu Li-Kaung, Hsu Jeng-Dong, Huang Hui-Pei, Yang Mon-Yuan and Wang Chau-Jong, Mulberry extract inhibits the development of atherosclerosis in cholesterol-fed rabbits, Food Chem, 2005, 91 (4), 601-607].

Development of a cactus-mucilage edible coating to extend strawberry shelf-life

Strawberries (Fragaria ananassa Duch.) are delicate and perishable fruits, susceptible to mechanical damage, physiological deterioration, water loss and decay. They have a very short post-harvest life and losses can reach 40% during storage. Reduction in turgidity as a result of water loss causes shrivelling and faster depletion of nutrients and organoleptic properties and is a major cause of fruit deterioration. The use of prickly pear cactus [Opuntia ficus-indica (Linn.) Mill.] mucilage was investigated by researchers of Spain as an edible coating to extend the shelf-life of strawberries. Different methods for mucilage extraction were tested in order to obtain the best coating. Edible films were tested to determine their effects on reduction economic losses due to spoilage produced from mechanical damage during handling and transportation. Colour properties of the samples were not affected by the coating as compared to the blank. Sensorial analysis showed that judges had a preference for coated samples at the end of the nine-day holding period. The coating did not affect the natural taste of strawberries, which is an important aspect regarding the use of edible coatings when taste modification is undesirable. It is concluded that the use of mucilage coatings leads to increased strawberry shelf-life [Del-Valle V, Hernández-Muñoz P, Guarda A and Galotto MJ, Development of a cactus-mucilage edible coating (Opuntia ficus-indica) and its application to extend strawberry (Fragaria ananassa) shelf-life, Food Chem, 2005, 91 (4), 751-756].
Fruit

Chemical changes and antioxidant property in pomegranate arils during fruit development

Pomegranate (Punica granatum Linn.) is a widely grown horticulture crop in many tropical and subtropical countries. It is one of the hardest fruit crops and thrives well under arid and semi-arid climatic conditions. The fruits are generally harvested when fully ripe and possess a waxy shining surface of reddish yellow. The edible part of the fruit is called arils and constitutes 52% of total fruit (w/w), comprising 78% juice and 22% seeds. Incidence of internal browning of arils is one of the major problems in pomegranates, which usually occurs in over-ripe fruits. Browning of tissues is generally attributed to oxidation of phenolics. Harvest maturity is also known to influence quality and the nature of disorders during storage life of fresh fruits. Early harvest may impede the development of the characteristic colour, taste and aroma of pomegranates, while late-harvested fruits exhibit a reduced shelf life; early deterioration was observed in apple, mango and other tropical fruits. There is an increased concern about the quality of fruit during development and prior to harvest aimed at minimizing post-harvest deterioration. The researchers at Fruit and Vegetable Technology Department, Central Food Technological Research Institute, Mysore, India investigated changes in the major chemical composition, along with antioxidant activity, in pomegranate arils during different stages of fruit development and maturation. Pomegranate arils showed a significant ($P \leq 0.05$) increase in total soluble solids, total sugar and reducing sugar contents up to 100 days of fruit development, followed by a steady-state in their rate of accumulation. The highest anthocyanin pigment content (138 mg/100 g) was observed in 100 day-old fruit. Significant ($P \leq 0.05$) decreases, of 76.2% and 71.1% in the concentration of ascorbic acid and total phenolics, respectively, were recorded from 20 to 100 days of fruit development. The high antioxidant activity (71.2%) of arils recorded in 20 day-old fruit decreased significantly (by 13%) up to 60 days, concomitant with a decrease in ascorbic acid and total phenolics by 68.4% and 63.9%, respectively. An increase in antioxidant activity by 10.6% in the late-developmental stage was due to a build up of anthocyanins. The trend in accumulation and depletion of the above mentioned chemicals marked the different stages of fruit development, maturity and onset of ripening. A decrease in anthocyanin pigment concentration (9.3%) from 100 days onwards, as well as a significant decrease in acidity was found to be the major chemical factor for increased incidence of internal browning in over-ripe fruits [Kulkarni Anand P and Aradhya Somaradhya Mallikarjuna, Chemical changes and antioxidant activity in pomegranate arils during fruit development, Food Chem, 2005, 93(2), 319-324].

Colour change of fresh-cut apples coated with whey protein concentrate-based edible coatings

The effect of antioxidant type and content alone or in combination with edible coatings for fresh-cut apples was studied by the scientists at Spain. Edible composite coatings were prepared from whey protein concentrate (WPC) and beeswax (BW). Ascorbic acid (AA) at 0.5 and 1% content, cysteine (Cys) at 0.1, 0.3 and 0.5% content, and 4-hexylresorcinol (4-hexyl) at 0.005 and 0.02% were incorporated in the formulations as antioxidants. Results showed that incorporation of the antioxidant to the coating reduced browning compared to the use of the antioxidant alone. 4-Hexyl was the least effective at reducing browning, even when incorporated into the WPC-based coating. Increasing AA and Cys content decreased browning of coated samples. The most effective treatments were WPC-BW-based coatings with 1% AA or 0.5% Cys. Apple pieces treated with 0.3 and 0.1% Cys aqueous solutions showed a pinkish-red appearance, whereas this effect was not shown when similar levels of Cys were incorporated into the WPC-BW-based coating [Perez-Gago MB, Serra M and del Río MA, Color change of fresh-cut apples coated with whey protein concentrate-based edible coatings, Postharvest Biol Technol, 2006, 39(1), 84-92].