

# Advanced techniques for preservation, processing and value addition of fruits and vegetables to generate extra income

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Apart from fruits, vegetables play an important role in the balanced diet of human being by providing not only energy rich food but also premise supply of vital protective nutrients like vitamins and minerals. Micronutrient deficiencies have detrimental effects on human health. Nearly 2 billion people worldwide are iron deficient resulting in anaemia in 1.2 billion and more than 600 million people have iodine deficiency disorders. It is estimated that the requirement of vegetables per capita is 240g / day but, the availability is only 140g / day. Therefore, we shall have to produce more to meet the requirement. The food processing industry ranks fifth in its contribution to value addition but tops the list in terms of employment opportunities with approximately 15 lakhs employed consisting of 19 percent of the total investment in the industrial sector but contributes 18 percent to the GDP. Employment potential in post-harvest and value addition sector is considered to be very high. Every Rs. 1 crore invested in fruits and vegetable processing in the organized sector generates 140 persons per year of employment. Heat is widely used in preservation of food by cooking, microwave heating, blanching, frying, canning, pasteurizing, boiling or heating foods prior to consumption. The thermal processed foods (bottled and canned) are totally sterile. In these processed foods both pathogenic and toxin-producing organisms are destroyed.

**Key Words :** Value addition of fruits, Vegetable, Extra income

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## INTRODUCTION

Processing and value addition of Nutritional crops such as fruits, vegetables, spices, and flower etc., assume a key position in the agro- industrial developmental plan of the country. Nutritional crops based processing industries can stimulate the commercial growers to cultivate high quality crops for better economic returns

to generate, in turns, enormous income and employment opportunity in production sphere of activities (Ahmed and Bora, 1998).

Apart from fruits, vegetables play an important role in the balanced diet of human being by providing not only energy rich food but also premise supply of vital protective nutrients like vitamins and minerals. Micronutrient deficiencies have detrimental effects on human health. Nearly 2 billion people worldwide are iron deficient resulting in anaemia in 1.2 billion and more than 600 million people have iodine deficiency disorders. It is estimated that the requirement of vegetables per capita is 240g / day but, the availability is only 140g / day. Therefore, we

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shall have to produce more to meet the requirement. The improvements made over four decades of green revolution era in agriculture are selection of the indigenous varieties for higher yield and disease, insect pest resistance. Frequent consumption of vegetables especially green and yellow vegetable is associated with decreased susceptibility to some forms of cancer. A diet rich in cruciferous vegetables (cabbage, cauliflower, broccoli, Brussels sprout, Chinese cabbage etc.) has been associated with inhibition of chemically induced carcinogenesis. About 100 different forms of glucosinolates have been identified in cruciferous vegetables which break down to isothiocyanates that act as anticarcinogens in human body.

Shelf- life extension of fresh fruits and vegetables is a major technological need to overcome the post- harvest losses owing to their perishable nature. In recent years, there has been a considerable increase in the demand for high quality fruits and vegetables, coupled with convenience and safety (an, 2004). High quality usually implies fresh- like quality characteristics of flavour, texture, colour, aroma, and overall appearance and consumers are indicating a strong preference to these fruits and vegetables over their counterparts.

#### **An overview of post harvest value addition in India:**

Post-harvest value addition includes primary, secondary, and tertiary processing, operations performed on farm produce. It is to provide longer shelf life, maintain/improve quality, and enhance form, space and time utility of the produce for food, feed, Flower fibre, and industrial purposes. The post harvest operations include on-farm handling, cleaning, grading, moisture conditioning, milling, extraction, cooling, freezing, roasting, puffing, flaking, retort processing, packaging, transport and storage.

#### **Food processing industry and marketing in India :**

The food processing industry is one of the largest industries in India - it is ranked fifth in terms of production, consumption, export and expected growth. The industry is worth Rs. 350,000 crores including Rs. 99,000 crores worth of value added products. Food processing is a large sector that covers activities such as agriculture, horticulture, plantation, animal husbandry and fisheries. It also includes other industries that use agriculture inputs for manufacturing of edible products. Processed food industry in India contributes 6.3% of the GDP, and

accounts for 13% of export and 6% of the capital investment. India produces about 600 million tonnes of farm produce annually. The production of different agricultural commodities in the year 2004-2005 (in million tonnes) .There were 7,521 regulated markets and 27,294 rural periodic markets in the country for handling part of these produce. In addition there are 100 units for aerated cold beverages (2500 million liter production capacity), 215 units for packages potable water, 12 joint ventures for production of alcoholic beverages (capacity: 33,919 kilo liter), and 56 beer units (Barbaste and Badrie, 2000).

The export of processed food from India is also growing at more than 10-12 per cent per annum. According to the Reserve Bank of India, the actual inflow of foreign direct investment (FDI) in the food and food-processing sector has been over US\$ 711.4 million (Rs. 3187 crores) till March 2004. Nearly 30 percent of FDI in this sector comes from EU countries such as Netherlands, Germany, Italy and France.

The market for processed foods in 2014-2015 in comparison to 2003-2004 is expected to go up 11 times for fruits and vegetables, 16 times for ready-to-eat (RTE) foods, 9.3 times for sugar and sugar based products, 4.8 times for alcoholic beverages, 2.5 times for aerated cold beverages, twice for pulses and 4.5 times for spices. The growth per annum in processed foods would be about 10%, primary processed foods 7%, and value added foods 15%. The share of value added products would increase from the existing 38% to 58% by 2014-2015.

#### **Fresh steps in value addition and processing industries in India :**

- Food Policy is proposed to support projects for reduction in post-harvest losses, enhance the level of processing, encourage value addition, employment generation and ensure remunerative price to farmers. In the Government of India Budget 2006-2007, Food Processing has been placed as a priority sector for bank credit.

- National Bank for Agriculture and Rural Development (NABARD) has set aside Rs. 1,000 crore, especially for agro-processing infrastructure and market development.

- Excise duties have been significantly reduced. For instance, on Dairy Processing equipment, excise duty has been reduced from 16% to zero, food grade hexane from 32 to 16%, and meat, poultry and fish from 16 to

8%, packaging machinery from 15 to 5% and so on.

- Excise duty has been reduced to zero in case of condensed milk, ice cream, preparations of meat, fish and poultry, pectins, pasta and yeast.

- Cess on coffee export @ Rs. 500 per tonne was abolished. Additional excise duty levied on tea during 2005-2006 is also withdrawn.

- Presently, food and food processing is regulated by 13 different laws and regulatory orders. Efforts are being made to integrate them.

- The Ministry of Food Processing Industries has already approved establishment of 47 Food Parks in different parts of the country having facilities for cold storing, IQF, packaging and so on at one place.

### **Quality standards for value addition and processing industry :**

The quality standards that govern the food industry include;

- Prevention of Food Adulteration Act, 1954 (PFA) (Juran, 1995), Vegetables Product Order, 1967 (VPO), Food Products Order, 1955 (FPO), Meat and Food Products Order, 1973 (MFPO), Meat and Meat Product Order, 1992 (MMPO). Agri-produce (Grading and Marketing) Act, 1937, Bureau of Indian Standard (BIS), Export (Quality Control and Inspection Act) (1963) (State of Orissa v. Appa Rao *et al.*, 1990).

- There are few standards for unprocessed/ raw food materials. Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP), Hazard Analysis Critical Control Point (HACCP), Codex, International Standards Organisation (ISO) 9000 are some other certification procedures applicable to processing of foods and products.

- Codex covers 234 foods, 32 functional groups (additives), 36 flavouring agents, 6 labeling standards, 49 codes of practices, and 41 guidelines.

- BIS has about 700 Indian Standards for use in the area of agricultural produce and value added products.

- The key issues addressed by these standards include preventing adulteration, regulate hygienic conditions, inform consumers about the product, manufacturer etc., provide product specifications as well as export specifications

- An integrated food law *viz.*, Food Safety and Standards Act 2005 has come into existence that consolidates most of the food related laws in India to meet the international standards.

### **Employment generation under post harvest and value addition :**

The food processing industry ranks fifth in its contribution to value addition but tops the list in terms of employment opportunities with approximately 15 lakhs employed consisting of 19 percent of the total investment in the industrial sector but contributes 18 percent to the GDP.

Employment potential in post-harvest and value addition sector is considered to be very high. Every Rs. 1 crore invested in fruits and vegetable processing in the organized sector generates 140 persons per year of employment. The same levels of investment in Small Scale Investment (SSI) units create 1050 person day of employment per year. The SSI unit in food industry employs 4,80,000 persons, which accounts for 13% of all SSI units employed.

### **Value addition by processing of fruit and vegetable:**

Approximately 20-25% of the horticulture produce goes waste due to improper post harvest operations which reduces the growers share in the present marketing arrangements. Since they are highly perishable, they need to be preserved and processed in various value-added products. There is, therefore, a need to evolve a marketing system where growers and consumers both benefit. The efforts are also on the Value Addition activities where the fruits and vegetables are processed, that fetches higher remunerative prices of the produce.

### **Heat preservation and processing :**

Heat is widely used in preservation of food by cooking, microwave heating, blanching, frying, canning, pasteurizing, boiling or heating foods prior to consumption. The thermal processed foods (bottled and canned) are totally sterile. In these processed foods both pathogenic and toxin-producing organisms are destroyed.

### **Canning (sterilization) :**

For canning, fruits and vegetables should be absolutely fresh. The fruits should be fully mature, ripe and firm, whereas tender, fully ripe and firm vegetables are ideal. The unit operations include sorting and grading, washing, peeling, coring and pitting, blanching, can filling, syruping (for fruits) or brining (for vegetables), lidding or clinching, exhausting, sealing and processing by heating

to inactivate bacteria. Almost all fruits being acidic in nature can be processed satisfactorily in syrup of sugar, glucose or corn at a temperature of 100°C (in boiling water). Vegetables except more acidic (tomato and rhubarb) which are generally non-acidic, however, require to be processed at high temperature 115°–121°C (high pressure of 10–15 lb/inch<sup>2</sup>) in the autoclave.

#### **Bottling :**

Bottles which can stand high temperature can be sealed airtight. Pasteurization, canning, freezing, carbonation and drying are used for preservation. Various tomato products are heat processed.

#### **Pasteurization :**

Pasteurization of fruit and vegetable juices by over flow method by heat is most popular. The heating of juice at 85°–90°C for 30 minutes can kill spore forming bacteria, mould spore and enzymes. They can be flash pasteurized, *i.e.* at a high temperature for short time only (90°–95°C for 1 minute) and then filled into containers which are sealed airtight under cover of steam to sterilize the seal and then cooled.

#### **Low temperature preservation and processing :**

Freezing is accomplished by exposing the food to very low temperature resulting in converting the water molecules of food into ice crystals. Once the food is frozen, it has to be stored under very low temperature. Freezing and cold storage are the oldest methods of food preservation. Commercial and household refrigerators are usually run at 4.4<sup>0</sup>–7.2<sup>0</sup> C, whereas in frozen storages frozen condition is maintained at zero degree or below. Refrigerated or cool storage preserves perishables for days or weeks depending upon the commodity. Frozen storage preserves perishables for months or even years because of very low temperature. Although low temperature is not lethal to bacterial growth and multiplication, yet it retards their activities. Freezing preserves the food without major changes in its physico-chemical composition. Freezing with cryogenic liquids (liquid nitrogen at –196<sup>0</sup> C or liquid CO<sub>2</sub> at –43°C) is gaining importance.

#### **Preservation by removing moisture :**

Drying (removing moisture) helps in preservation of foods. Microbes cannot grow and multiply in absence of

sufficient water in their environment. Many of the enzymatic reactions are hydrolytic in nature, requiring water. Chemical reactions in food materials are slowed down when the reactions are in solid state. Hence by removing water from the commodity, it should be possible to preserve them by checking the important spoilage agents. This principle forms the basis for dehydrated foods and for osmotic dehydration where high sugar or salt acts as a preservative. Fruits and vegetables may be dried in air, super heated steam, in vacuum, in inert gases or by direct application of heat.

#### **Drying, dehydration and concentration :**

Removal of moisture by applying heat is called drying. Dehydration is drying by artificially heating under controlled temperature, humidity and air flow. In India, dehydration of fruits and vegetables is of much greater importance to reduce the considerable spoilage. Foods are concentrated to remove moisture either by dehydration or freezing (Prajapati *et al.*, 2010).

Concentration can be a form of preservation of fruit and vegetable pulps and juices. They are concentrated in flash evaporators or concentrators. Different types of beverages are made from concentrates. Their colour and flavour retention is better than in dehydration and drying (powders).

#### **Preservation with sugar :**

Jam, jelly, marmalade, and preserved and candied fruits are preserved by adding sugar. These commercial products form an important class. High concentration of sugar facilitates preservation. Jam is prepared by boiling the fruit pulp with a sufficient quantity of sugar (minimum 68.0%) to a reasonably thick consistency, firm enough to hold fruit tissues in position. Whereas, jelly is prepared by fruit juice/or clear water extract of fruit.

Preserve (murrabba) is made by cooking or heat processing of raw or mature, peeled or punctured and pre-treated whole or cut fruits and vegetables in sugar syrup.

Candied fruits are made by dehydrating them by osmotic pressure of sugar solution (osmotic dehydration). Preserves when drained free from syrup and dried is called candy which is prepared largely from karonda, cherry, citrus peels, petha and ginger.

Fruit syrups (or sharbat) contain more than 66% sugar that generally does not ferment. The sugar absorbs

most of the available water which is not available for the growth of micro-organisms. Thus sugar acts as a preservative by osmosis. Sugar is dissolved in juice by gentle heating.

#### **Preservation by salt :**

The concentration of salt necessary to inhibit the growth of micro-organisms in food is related to water content, type of infection, pH, temperature, protein content and presence of inhibitory substances such as acids. The water content is obviously of major importance, since it is the concentration of salt in water phase and not the amount in food as a whole which is significant.

Curing of raw fruits and vegetables in dry salt or brine and subsequent preserving by spices and condiment or in vinegar is known as pickling. Spices, condiments and edible oils may also be used to improve their palatability. Mango, lemon, turnip, carrot, cauliflower, onion and mixed vegetables are important for pickle making.

#### **Preservation by food additives :**

A chemical additive or food additive can be defined as a chemical (substance) or mixture of chemicals, other than basic food stuff that is added intentionally either during production, processing, storage or packaging directly or indirectly to improve or maintain nutritional value, enhance quality and consumer acceptability, improve keeping quality and check spoilage caused by microbes and enzymes and facilitate preparation. Common types of intentional food additives are salt, sugars, acids, spices, essential oils, buffers, bleaching agents, emulsifying and thickening agents, food flavour, colour, preservatives, antioxidants, clarifying agents and humectant. Use of food additives is another effective approach/method for preserving fruits and vegetables. Some of them in combination can check microbial activity, enzymatic and non-enzymatic browning of the preserved products during storage. Acids lower the pH and act as antimicrobial agents like chemical preservatives. They have bacteriostatic and bactericidal properties. The permitted preservatives used in our country for various products are benzoic acid including salts (sodium benzoate) and sulphurous acid including salts (potassium metabisulphite) or combination of these. They are used either alone (in high concentration) or in combination (in low concentration) to check spoilage in fruits and vegetables and their products as well as to

increase their shelf-life by keeping proper nutritional value. Preservation by this method is cheap and easy to operate technology, best suited for its application in the developing countries to preserve perishable commodities.

#### **Preservation :**

Seasonal fruit pulps and juices from fruits and vegetables such as peaches, plums, bael, apricot, mango, guava, pineapple, litchi, citrus fruits, phalsa, jamun, carrot, tomato etc. can easily be preserved and stored after heating them to 80°–85°C (except citrus juices) and then by adding chemical preservative and acid. Potassium metabisulphite is used to preserve most of the pulps/juices, whereas sodium benzoate is used for coloured juices/pulps along with citric acid (only in non-acidic fruits).

#### **Preparation and preservation of beverages :**

Pure fruit juice can be preserved and processed in various types of beverages like squash, nectar, syrup, cordial as well as fermented, carbonated and 'Ready to Serve' (RTS) drinks by adding food additives. Fruit beverages are prepared as per the specification. Mixed fruit juice, squash (cocktails) or spiced beverages can also be prepared such as lime ginger squash, lime and pineapple squash, spiced mango and aonla drinks etc.

#### **Processing of sauce, chutney and ketchup :**

The tomato juice is concentrated with spices, salt, sugar etc. About 1/3 of the sugar is added initially at the time of commencing the boiling and the balance is added a little before the ketchup is ready. The sugar added initially helps to intensify and fix the red tomato colour. However if whole sugar is added initially with the pulp, it will require the boiling of pulp for longer duration, which will adversely affect the colour of the ketchup. Salt is added towards the end of boiling, as otherwise, it bleaches the tomato colour. Spices are placed in the muslin cloth and cloth is placed in boiling mixture. At the end cloth bag is pressed to squeeze the spices and cloth is taken out. Vinegar should be added when the ketchup has thickened sufficiently, so that the acid does not volatilize away. Tomato ketchup generally contains 1.25-1.50% acid. The tomato ketchup is generally concentrated to 25-30% solids, out of which 12% solids are tomato solids. The ketchup is filled hot 88°C into pre-sterilized glass bottles, crown corked and processed for 30 minutes and cooled at room temperature. Tomato ketchup may also

contain benzoic acid as preservative.

Raw mango chutney (sour and sweet), tomato chutney and lime chutney are very popular. Plum, apple and papaya chutneys are also delicious. The preparation of chutney is similar to that of jams except that spices and vinegar are added. Chutney and sauces possess appetizing properties. Sauces are of 2 kinds-thin and thick. Thin sauces mainly consist of vinegar extract of various flavoring materials like spices and herbs. Their quality depends mostly on the piquancy of the material used. Mixed vegetable sauce, yellow pumpkin sauce, tomato sauce (tomato ketchup) are very common.

### **Preservation by fermentation :**

Fermentation encourages the multiplication of micro-organisms and their metabolic activities in food. In this method, food is preserved chemically. Micro-organisms are used to ferment sugar either by complete oxidation or partial oxidation in alcoholic fermentation (for wine and fermented beverages), acetic fermentation (for vinegar) and lactic fermentation (fermented pickles) and other minor fermentative actions.

### **Cold sterilization/filtration and irradiation :**

#### *Filtration :*

The spoilage in fruits and vegetables can also be controlled by mechanical removal of micro-organisms by ultra filtration. It is known as the cold process. It is applied in the treatment of fruit juices, beers and wines. It is of course, applicable only for clear, liquid products.

#### *Irradiation :*

In this method, food is preserved by ionizing radiation.

The irradiation of food can destroy micro-organisms and enzymes. It is more efficient to employ ionizing radiation to kill micro-organisms than enzymes. It may be desirable to inactivate enzymes by other means, in complement to the irradiation action. The sterilization of food with ionizing radiation involves 2 major considerations, the food product and a suitable radiation source. Since the temperature remains 4<sup>0</sup>-5<sup>0</sup> C, it is also called cold sterilization technique. Irradiation technique has been successfully used in controlling the ripening process of fruits and also for checking sprouting of roots, tubers and bulbs apart from general food preservation.

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