CHAPTER II

REVIEW OF LITERATURE

Ber is a very hardy fruit crop which can be grown successfully in low rainfall areas. Ber fruits and its leaves are very good source of protein, sugars and minerals. Ber is a crop, which is said to be highly paying and rich in food value (Daulta and Chavan, 1982).

Jawanda and Bal, (1978) also reported that ber fruits are highly nutritious and are eaten with great relish by one and all. Depending upon variety the fruit pulp may contain 13 to 20% T. S.S. and 0.20 to 0.80% acidity at fully ripe stage. In vitamin 'C' content, it ranks next to aonla and guava containing 70-165 mg ascorbic acid/100 g of pulp, which is much higher than the vitamin 'C' content of citrus fruits - a well known potential source of the vitamin-C. Ber fruit is also very rich in vitamin 'A' containing nearly 80 mg of β-carotene/100g of fruit. The fully ripe ber fruit contains 0.9% protein and 12.8% carbohydrates. The reducing and non reducing sugars are 3.1 and 10% respectively. In minerals, i.e. content of calcium, phosphorous and iron, ber fruit excel even apple and oranges.

Mostly wild and local ber types were seen stray and scattered in past and rarely cultivated. How ever, now a days its cultivation is being commercialized to some extent, and number of ber varieties are found grown on scattered scale all over the country especially in the states of Maharashtra, Madhya Pradesh, Haryana and Punjab. Unfortunately reports on ber varieties are few, and no systematic work has been done to compare the performance of these. This has happened due to lesser importance so far given to this fruit all over the country not only by the growers and research workers, but by the processors too. (Hayes, 1960; Singh, 1957 and 1962).
In view of the adaptability of ber to a vast range of soil and climatic conditions as well as its heavy bearing and limited cultural requirements, ber provides a good source of income to growers, as well as processing industries. Therefore to popularize, it needs systematic development on varietal improvement and its evaluation, cultivation practices, transportation and processing etc. Recently ber is gaining importance and in near future it may increase in many folds as it has been included in the Horticultural Development programme of the state of Maharashtra through E.G.S.

Since 1955, efforts have been made to collect a large number of ber Varieties at Bahadurgarh (Patiala) under the Ber Improvement Scheme of the Indian Council of Agricultural Research. At present there are 40 varieties primarily collected from Punjab, Haryana, Uttar Pradesh, Maharashtra and West Bengal. Their important characteristics i.e. fruit weight, colour, shape, size, skin thinness, pulp percentage, texture, seed size, taste, flavor, T.S.S., acidity, Vitamin-'C' and average yield were studied (Chadha et al., 1972).

2.1 Varieties, growth and developmental changes-physical characteristics

Some varieties of the ber with wide range of qualities are available now in the country. Growers and processors have no knowledge of the best varieties available. However, Chadha et al., (1972) studied the performance of 35 varieties of ber and grouped them in three maturity groups i.e. early, mid season and late. Mid-season and late varieties are observed heavy yielder than early. The plus point in their cultivation is that its ripening period synchronizes with the slack season of other fruits in the market. Early ber varieties start ripening in mid-February while fruits of some late varieties ripe in the month of April. The early varieties includes Sufeda, Rohtaki, Gola, Seo, Nazuk and Noki while late varieties are Umran, Kala gola, Illaichi and Z.G.4.

Of the various physical characters, colour, shape and pulp characters, and fruit as well as seed size determines the quality of ber. Golden yellow colour of the variety
Umran, Dandan and Narikellee is preferred to green or greenish yellow colour. Similarly oval or oblong oval shaped varieties like Umran, Sanaur are preferred to round varieties like Gola or oblong varieties with tapering apex like Mirchia, Noki. Also smooth and glossy surface of varieties like Umran is preferred to varieties with tough and dull surface as Pathania and Z.G.4. Soft and thin skin of varieties like kaithly, Banarasi, Illaichi, Nazuk is preferred over thick skin varieties Gola, Gorva and Katha Bombay as the skin of these is not separated while eating. Fruit size also considered as an important character. Varieties with large size fruits namely Umran, Sanaur, Gola, Kaithli are preferred for table purpose over varieties with small sized fruits i.e, Mirchia Z.G.4.

Seed size is also important as it determines the edible portion in the fruit. A small seed in varieties Umran, Sanaur results in a large pulp percentage of about 90% where as varieties like Mirchia, Mehrun with large seed have pulp content of only 81% . Pulp should be reasonably hard in texture as in varieties like Umran so that they can stand transport very well.

Edible quality is also one of the main deciding factor of commercial acceptability of ber varieties. Varieties with astringent taste even though high yielding are not accepted by consumers. Ber varieties possesses T.S.S.range of 15-21 percent and acidity range from 0.20 to 1.4 percent. The ber is the rich source of Vitamin 'C' contents ranges from 70 to 165.50 mg/100 g of fruit weight.

Ber varieties were found to yield from 50 to 250 kg of fruits per tree. Variety Sanaur found to yield more than 200 kg while varieties Umran and Gola yielded 150 - 200kg.

Over all, the ber varieties must possess attractive colour and shape, good size, high pulp percentage, good edible quality and heavy yield. Variety Zazuk which has a golden yellow colour, thin skin is very sweet and yields around 80 kg fruits per tree. However,
being tender it can not be transported to very long distances. Variety Seo has also an attractive fruit size and shape and is also more firm than Nazuk and can be transported well. However variety and has attractive fruit colour but fetches very low price on account of its astringent in taste and can not be recommended for commercial cultivation. Sufeda an other very sweet early variety is very shy bearing other early varieties namely Katha Gurgaon, Rohtaki, Gola and selected sufeda are all astringent in taste and can not be recommended.

Of the mid-season varieties, Dandan, Sanaur no. 2 and Kaithli varieties can be recommended for commercial cultivation. Of these varieties Sanaur no. 2 has extremely attractive appearance, fine quality and is heavy yielding. Kaithli also posses all these qualities and has the highest pulp percentage but is tender and can not stand in transportation well. It is, however, very good for local market. It has also been found to be highly susceptible to powdery mildew. Variety Dandan also has attractive golden yellow colour, is very sweet in taste and is heavy yielder. Other varieties which comes next to these varieties and have some commercial attributes includes Banarasi, Chhuara, Narikelee, Sanaur no. 1 and Thornless. Of these Chhuara has fine quality and is sweet with soft pulp. It can be successfully sun dried. Other mid season varieties namely Desi Alwar, Glory, Katha Bombay, Nalagarhi, Rasmi, Sanaur no. 3, Sandhura Narnaul and Wallaiti are inferior due to one character or the other and are not recommended.

Of the late ripening varieties Umran and Ilaichi varieties recommended for cultivation. Umran has proven to be the best variety out of the 40 varieties existing in the collection at the Regional fruit Research station, Bahadurgarh. It has an attractive colour, largest fruit size, firm texture and good yields. It can stand transportation very well and found to be suitable for making candy. Ilaichi, though a very fine variety with highest T.S.S., excellent edible quality and colour is handicapped by a small fruit size. It is
therefore and ideal variety for home garden. Mirchia is another variety with good T.S.S., pleasant flavour and moderate yield. However, this has a very large seed resulting in the lowest pulp percentage.

Gupta et al., (1984) reported that fruit size, in terms of length and diameter increased with development of fruit from fruit set to maturity. The most active growth phases in ber variety Kaithli were from 15 to 45 days and 90 to 135 days after fruit set. While in variety Jogia corresponding growth phases were 15 to 30 days and 75 to 135 days. The stone size also increased with increase in fruit size with the development of fruit. Stone length and diameter increased rapidly within 45 days after fruit set followed by slow and minor changes. The results corroborate the findings of Jawanda and Bal, (1980). The fruit weight continued to increase from fruit set till maturity. The gain in weight was slow in the first 75 days after fruit set and there after it becomes rapid. According to Bollard, (1970), this might be attributed, to an increase in the size of cells and accumulation of food substances in the intercellular spaces in fruit flesh. A similar trend was also observed by Bal and Singh, (1978) and Jawanda and Bal, (1980). Stone pulp ratio was maximum in immature fruits which decreases with the advancement of maturity. There was a slow and gradual decrease in this ratio upto 75 days of fruit growth followed by a sharp decline. This rapid decrease in stone pulp ratio can be due to relatively higher increase in pulp as a result of food accumulation. Jawanda and Bal, (1980) also reported that after 45 days of fruit growth, pulp percentage increased rapidly where as seed percentage sharply decreased in fruits.

### 2.2 Chemical Composition

The maximum T.S.S. content observed in Jogia and Kaithli cultivars were 17.00 and 14.80 percent respectively at 150 days after fruit set. T.S.S. content increased and slowly in the beginning and increased rapidly after 120 days of fruit set, which may be
attributed to conversion of starch into sugar and ultimately with the increase in total soluble solids Jawanda and Bal, (1980) also reported rapid increase in T.S.S. towards ripening in different ber cultivars.

The crude protein content of ber fruits decreased with the advancement of maturity. In Jogia however, protein content decreased rapidly during the first six and last ten weeks of fruit growth, whereas in Kaithli, it remained constant upto first six weeks followed by a sharp decrease upto eleven weeks and then a gradual declined till ripening. Similar findings were reported by Bal et al., (1968).

The vitamin- C content in Jogia and Kaithli varied from 104.94 to 263.00 mg/100 g and 119.54 to 286.34 mg/100 g respectively during the period of 15 to 150 days after fruit set. Upto 45 days after set Vitamin - 'C' in both the cultivars remained nearly unchanged during early growth followed by a rapid increase towards maturity. The rapid increase in vitamin C content towards maturity might be associated with increase in total sugars which serve as a precursors for its synthesis in fruits (Mapson, 1970). The results are in line with the findings of Jawanda and Bal, (1980).

The total chlorophyll content decreased in both the cultivars with the advancement of fruit growth and development. At 15 and 150 days after fruit set, total chlorophyll content was 0.17 and 0.01 mg/g in Jogia and 0.19 and 0.02 mg/g in Kaithli respectively. The decrease in chlorophyll continued upto 105 days, there after, it remained constant. Bal and Josan, (1980) also observed similar decrease in chlorophyll content in ber peel towards maturity. Gortener et al., (1967) reported that the decrease in chlorophyll content might have resulted from the degradation of chlorophyll followed by unmasking of the new pigments towards maturity.

The reducing sugars in both the cultivars increased rapidly towards maturity and was 4.41 and 2.74 percent in Jogia and Kaithli respectively. However, after 90 days,
concentration of reducing sugar increased rapidly in Jogia where as in kaithli it increased gradually. Bal and Singh, (1978) also reported a rapid increase in reducing sugars after 75 days of fruit set in Umran. Jawanda and Bal, (1980) reported that increase in reducing sugars was gradual throughout the period of development in ber cultivars.

Sweetness of the fruits in both the cultivars increased towards ripening with the increase in total sugar content. The maximum total sugar content in Jogia and Kaithli was 16.41 and 13.65 percent, respectively at last picking. Total sugar content remained nearly same upto 90 days followed by a sharp increase till ripening. This increase in sugar content is mainly due to conversion of starch into sugars. Bal and Singh, (1978) also reported the similar pattern of rapid increase in total sugar content in Umran.

2.3 Physicochemical changes during shelf life of ber fruit

Normally, ber fruits after harvest remain for 3-4 days in good condition at room temperature. Thus shelf life depends on number of factors like variety, time of harvest, methods of packing etc. After harvest and thereafter during storage, the vitamin 'C' content of fruit decreases continuously. While T.S.S. and sugars increases initially and decreases afterwards along with loss in fruit weight. However, Sandbhor and Desai, (1991) reported that, these chemical changes were delayed by BA, GA and also by polyethylene packaging. The loss in weight of control fruits over a 7 days period of storage was more than 17 percent but it was less than 1 percent in the treated fruits packed in polyethylene. Dipping the fruits for 5 minutes in 10 ppm BA solution and then packing them in 150 gauge polyethylene bags, was the best treatment to control weight loss and chemical changes and retain palatability. The treatment permits post harvest storage for a minimum period of 8 days at ambient conditions.

The open fruits loose moisture rapidly, but the polyethylene packaging arrests the moisture loss. It also helps to change favourable O₂ and CO₂ concentrations around the
packed fruits. The changed gaseous composition then becomes less favourable for ethylene action (Roberts and Hooley, 1988). This helps to prolong shelf life of fruits as reported by several workers Reddy and Thimma, 1981, Dhoot et al., 1984 and Kumbhar and Desai, 1986).

In early studies Cytokinins (Hanson, 1963; Desai et al., 1980; Dhoot et al., 1984 and gibberellins (Rao and Chundawat, 1984, Kumbhar and Desai, 1986; Tarkase and Desai, 1989) have been reported to produce beneficial effects on storage of fruits on the similar line as reported by Sandbhor and Desai, (1991).

Dhingra, (1983) reported that peel is the major source of tannins in ber fruits. The tannins content tend to decrease in the peels with ripening but show a slight increase in the pulp. He further reported that the cultivars Reshmi, Gola and Kathaphal fruits contain more tannins (2.03 to 3.25 %) while Umran and Kaithli fruits contain comparatively lesser amount of tannins (1.54 to 1.64 %). For processing, if peel of the fruits are removed, then the interference of tannins in making quality products can be considerably reduced. Tannin contain varies with varieties.

2.4 Processing and preservation of ber fruits

Ber fruits are processed in a number of ways and methods, and preserved for longer period of 1-2 years in the form of different products. Various products prepared and preserved are dehydrated fruits, fruit preserves and candy, jams and jellies etc. The standard methods so for known and recommended are as suggested by Mahindre (1991). During processing of different products number of physicochemical changes occurs.

2.4.1 Browning reaction

During processing as well as storage deleterious changes occur in fruits, vegetables which affect their colour, flavour, appearance and odour. These changes occur as a result
of the enzymatic or non enzymatic development of the brown pigmented material (Salunke et al., 1984).

The enzymatic browning takes place fast following a mechanical injury sustained during handling and processing of the food material because of active enzymes like polyphenoloxidase. Therefore foods are treated to inactivate the enzymes by means of heat or sulphur dioxide prior to food processing. Non-enzymatic browning occurs in dried food material during protected storage. Hodge, (1953) investigated these reactions and noted three types of non enzymatic browning viz. Carbonyramic acid type, Carmelization type and oxidative reaction type.

2.5 Physicochemical changes in processed and preserved fruits during storage

Tripathi et al., (1988) studied various chemical changes related to the processing in different aonla products like preserve, jam, juice, candy and dehydrated aonla. The loss in ascorbic acid content during processing and storage as compared to fresh fruit was very significant in all the products. Organoleptic evaluation of all five products indicated acceptability of all the five products. The acceptability of aonla preserve and jam increased while that of aonla candy, juice and the dehydrated product decreased with storage period. Aonla juice and jam exhibited a rise in acidity where as a decreasing trend was noticed in aonla preserve, candy and the dehydrated product during storage. Similar observations have been noted by Sastry et al., (1959) Deb, et al., (1960), Prasad et al., (1968), Srivastava, et al., (1964), Mehta and Rathore, (1976) and Jain et al., (1983).

Khurdia and Anand (1981) studied ready to serve beverages from phalsa fruit and they reported that beverage can be best stored upto 100 days. The acceptability of the beverage goes down when stored at 20°C or at room temperature. Colour of the beverage was best retained at 3°C. A gradual increase in reducing sugar was noticed in the
beverage during 20 days storage at room temperature and much slower at 20°C and 3°C up to 100 days storage.

Study on changes in T.S.S., acidity, pH, total and reducing sugars and pectin content either due to processing method of preservation or storage was carried out by Ranote and Bains, (1982) and they found that the reducing sugar increased in general due to processing and storage. This increase in the reducing sugar contents was attributed to inversion of non-reducing sugar due to hydrolysis. The decrease in ascorbic acid content was rapid initially but it was slower after 6 weeks of storage at room temperature (30°C to 38°C). The retention of ascorbic acid in the SO2 preserved juice was higher than in the heat processed bottle juice. The results compared with those of Sarmah (1976), Pollard and Timberlake, (1971). Exposure to light was a significant factor.

During their studies, Sandhu et al., (1988) observed that organoleptic evaluations revealed that Beauty seedless grape juice was superior to others in flavour, colour and acidity followed by Himrod. However the whole of the ascorbic acid was lost in the first four weeks of storage. Acidity score of heat processed samples was found decreased with storage.

Charanjit Kaur and Khurdia, (1989) also reported that storage temperature had appreciable effect on the ascorbic acid, carotenoids and reducing sugar. Loss in ascorbic acid were more rapid at ambient temperature. Similar observations were noted by Nanjundaswamy, et al., (1966) and Kapse, et al., (1985).

Jain, et al., (1984) reported that the ascorbic acid content was continuously decreased as the storage period advanced. No appreciable changes in T.S.S. values during storage were noted but increasing trend in reducing sugar was observed during storage which might be due to gradual inversion of non-reducing sugar by hydrolysis.
Mehta and Bajaj, (1983) studied the effect of storage and methods of preservation on the physicochemical characteristics of citrus juice. During their studies, they observed that potassium metabisulphite treatment seemed to be effective for colour retention also pasteurization of kinnnow juice had retained its original color during storage. Similar results have been reported for jack fruit squashes by Bhatia, et al., (1956) significant change in colour of lemon juice was also noticed by Palaniswamy and Muthukrishan, (1974). Such change in colour of citrus juice could be attributed to oxidation and chemical reactions apparently followed by the formation of pigments was observed by Bhatia, et al., (1956), Kosachwa, (1960) and Sastry, et al., (1963).

Singh and Mathur, (1953) observed an increase in T.S.S., in cashew apples under cold storage at different temperature the increase being greater at higher storage temperature. Irving, (1961) and Palaniswamy and Muthukrishan, (1974) observed similar results for lemon juices during storage.

Loss of ascorbic acid in citrus juice during storage were observed statistically significant by Mehta and Bajaj, (1983) during the studies. Palaniswamy and Muthukrishan, (1974) also reported ascorbic acid loss of 24.77 mg per 100 g juice during a period of seven months. Irving, (1961) and Verma and Sastry, (1969) observed a similar results and were noticed a similar losses in lemon juices and lime juice. These findings are in conformity with the study of Bhatia, et al., (1956) for jack fruits squashes and Siddapa, et al., (1959) for coorg orange juice and squash. The ascorbic acid gets easily destroyed by heat and oxidation.

Singh and Mathur, (1953) reported decrease in titrable acidity in cashew apples kept under cold storage till the time the fermentation set in. Uprety, et al., (1963) have observed increase in acidity in stored lime juice. Palaniswamy and Muthukrishan, (1974) have shown that decrease in acidity of lemon juice during seven months storage. The
decrease in acidity in citrus juices could be attributed to the chemical interaction between the organic constituents of juices indicated by temperature and the action of enzymes.

Mehta and Bajaj, (1983), Singh and Mathur, (1953) and Irving, (1961) observed that total soluble solids increased during storage in orange juice cashew apples and lemon juice respectively. Palaniswamy and Muthukrishan, (1974) also observed increase in total sugar content during seven months storage of lemon juices. It can be safely stated that the increase in total sugar content coincides with the increase in amount of T.S.S.

Mehta and Bajaj, (1983) reported that there is a gradual increase in reducing sugars of stored orange juice of the three varieties preserved by using different methods of preservation. The increase being statistically significant, Singh and Mathur, (1953) observed similar increases in reducing sugar content in cashew apples kept under cold storage, the increase being greater at high temperature. Palaniswamy and Muthukrishan, (1974) also reported an increase in reducing sugars of lemon juice. The increase in reducing sugar content during storage could be attributed to gradual inversion of non-reducing sugar. Higher temperature and acidity accelerated in hydrolysis.

A slight increase in pH value of orange juice during storage was observed. Increase in pH could be attributed to decrease in acidity of juice during storage. However Bhatia, et al., (1956) reported that pH of Jack fruit squash did not change during storage.

Effect of different storage conditions on the maintenance of natural colour and organoleptic quality of squashes prepared from phalsa, Kaphal and Litchi fruits has been studied by Jain, et al., (1984) and reported that squashes stored at low temperature (6 - 11°C) were superior to other storage conditions. There were no change in natural colour, taste and flavour for a period of six months in phalsa and kaphal squash and twelve months in case of litchi squash. The squash bottles kept under the dark conditions were rated as next in the order of merit. The quality of squash packed in bottles covered with
black cellophane papers were better in contrast to the bottle covered with other types, red, yellow, green or blue cellophane papers. Storage of the squashes under dark conditions and covering of bottle with black papers seem to be more economical for the retention of natural colour and taste as compared to other methods.

Shreshta and Bhatia, (1982) during their studies on apple juice, reported that there was no change in total soluble solids. Statistical analysis of the data showed significant differences among the varieties. Acidity decrease during the storage, the value being highest for Maharaji and lowest of American variety. Reducing of acidity was more at 37\textdegree C than at room temperature changes in reducing sugars and tannin decreased during storage. Significant effect of temperature was observed in the changes of reducing sugars. The decrease was more at 37\textdegree C than at room temperature indicating that further temperature during storage could lead to gradual inversion of non reducing sugars to reducing sugar by hydrolysis.

Bhatia, et al., (1956) made a detailed study on jack fruit squash during a storage period of 60 weeks at 37\textdegree C room temperature (24 - 30\textdegree C) and at 2-5\textdegree C. The squash retained its normal colour, characteristic fruit taste and armo during the entire period of storage at room and 2-5\textdegree C temperature. At 37\textdegree C, the quality of the product deteriorated considerably.

Sadasivan and Neelkantan, (1976) stored squash at room temperature for one year without any change in quality except for a slight reduction in ascorbic acid in the product was very much dependent on the storage temperature.

2.5.1 Candy

Upasana Rani and Bhatia, (1985) studied the processing conditions for the preparation of candy from Sandpear and Bagugosha pears. The products elucidated high consumer acceptability. Packed in cellophane polyethylene bags, the candy retained
characteristic pear flavour, for about 16 weeks at $37^0\text{C}$ and 40 weeks under ambient conditions. Sandpear candy was rated superior to Bagugosha candy. Pricking the fruit made hardly any difference in the rate of sugar impregnation. Longer syruping (slow method) of Sandpear fruit as compared to Bagugosha produced, softer candy than the short cut method developed for Bagugosha candy. There was a fairly high inversion in the sugar component as a result of candy preparation. Ascorbic acid retained in the candy stored at room temperature was 50 per cent. There was a gradual increase in T.S.S. and reducing sugars in candy samples with storage with continuous decrease in the titrable acidity. Temperature of storage significantly affected the composition changes which were higher at $37^0\text{C}$ as compared to room temperature and refrigerator storage.

Shrio and Takeshi, (1970) patented a method of preparation of candy from juicy fruits like cherries, plums and apricots to sugar concentration of 72% without shrinking. The fruits usually required the stepwise addition of sugar over 7 weeks but fruits treated with an enzyme mixture produced by cultures of Trametes Sanguineo (polyporus sanguineus ATCC 14622) before or at the beginning of candying could be candied in 4-5 days.

2.5.2 Fruit preserve

Lal, et al., (1986) noted that, the bers of large size are preferred for the preparation of ber preserve and candy. Preserve have an attractive appearance and when they are stored for a long period their natural colour and flavour deteriorates on account of oxidative changes. Rapid boiling in quick process, will make the fruit tough. The flavour and colour of the product, suffer considerably during boiling.

Sethi and Anand, (1983) found that 25% of ascorbic acid and 20.4% of tannins in aonla are lost during blanching. Sethi, (1986) recommended blanching of the fruits for 4 minutes, while making aonla preserve which prevents non-enzymatic browning and retains
better colour of the processed product during storage because of higher degree of inactivation of polyphenol oxidase.

Darkening and fermentation are the major problems associated with storage of aonla preserve. It has been observed that darkening starts from the surface of the fruit and penetrates gradually inside towards the stone during storage (Anand, 1963).

Johar and Anand, (1952) reported that during storage preserve usually undergoes gaseous fermentation causing spoilage and emitting undesirable odours. The taste of the fruit alters and the fruit starts disintegration.

Sethi and Anand, (1982) studied the market samples of preserve and reported that the micro-organisms associated with contamination of preserve are Saccharomyces Rouxii, var. polymorphous and Bacillus cereus. They further reported that in preserve (pH 2.6) fermentation is affected by heat resistant spore forming Bacillus cereus which increase the acidity.

In the studies of aonla and carrot preserve, Sethi and Anand, (1983) reported that complete inactivation of the most heat tolerant enzyme i.e. peroxidase was achieved by blanching. During blanching there was decrease in β-carotene from 11.88 to 11.67 mg/100 g. In case of aonla fruit ascorbic acid was depleted by 126.96 mg/100 g from 539.62 mg/100 g of the original value and tannins came down from 2.70 to 2.15 %. The blanch fruits retained 74.6% ascorbic acid and 79.6% tannins. The lower retention of these two constituents reported by Sastry and Sidappa, (1959); Anand, (1970). Mehta and Tomar, (1979), viz. 3.0 to 33.6% ascorbic acid and 16.6 to 37.0% tannins in the blanched fruits may be ascribed to difference in variety as well as time of blanching.

In aonla preserve the fruit portion contained 137.0 mg/100 g ascorbic acid thus retaining only 25.38% of their initial vitamin-C content. Most of it was leached out in the surrounding syrup which carried 48.83% of the vitmin C thus lost. Preserve fruit taken
with syrup, the preserve provided a good source of vitamin C.

Sastry, et al., (1959) and Anand, (1970) reported 5.0 to 15.9% retention of ascorbic acid and 45.5% of tannins in aonla preserve made by conventional method. Prolonged brine treatment found to destroy the ascorbic acid content to the extent of 93%.

Siddapa and Bhatia, (1959) reported that the blanching time and method of preparation are affected the quality of the finished product as well as retention of vitamin C. If the brining treatment is avoided and optimal blanching is carried out, there will be sufficient retention of ascorbic acid in the preserved fruits. They also reported that vitamin C in canned preserve stored for a long time was found to be small (1-15 mg/100g) and entire sugar was almost in the inverted form due to high acidity (0.5 to 3.8%) and low pH 2.4. The fruits are more acidic than syrup. Aonla preserve reported (Anon, 1958) to have only 12.2 and 38.0 mg/100g ascorbic acid in fruit and syrup respectively as against initial value of 600 mg/100 g in the fresh fruit.

Anand, (1963) reported that the preserve retained approximately 40% of vitamin C during preparation and storage of product upto one month and later he found that Banarasi aonla though large in size yet contains less vitamins than the Desi variety. Most of the vitamin C is lost during smoking and blanching.

The retention of nutrient in the final product depends on the method of preparation. Blanching and pricking of the fruits is necessary to render the preserve soft and to facilitate uniform absorption of sugar (Siddapa and Bhatia, 1959).

More than 95% of the vitamin C was found lost during blanching (Giri, et al., 1937). Sastry and Siddappa, (1959) reported that incubation method showed most destructive effect on ascorbic acid and tannin content. the retention in the vacuum method was quite high.

Prasad, et al., (1968) reported that the development of deep browning in the
process of concentration of juice and further darkening of the end product during storage at room temperature apparently caused by the oxidation of polyphenols and degradation of ascorbic acid and sugars.

Fourteen Michurian Cherry varieties were investigated by Vomek, et al., (1956) for their chemical and technological evaluation, and their suitability for preserves and jam. Genevkovskaya, (1973) also studied the cherry varieties for chemico-technological indices and observed that the varieties having large fruits and comparatively small stones and a distinct acidity are suitable for preserve. The vitamin C content is relatively low, but preserve had good organoleptic properties.

Sethi and Anand, (1982) recorded great variability in the composition of carrot and aonla preserves as compared with fresh fruits. vitamin C in its preserve was very low. Vitamin C being heat labile and water soluble is destroyed and leached out during preparation of the preserve. The astringency in aonla fruits was due to the presence of polyphenols or tannin which make them unpalatable (Sastry, et al., 1958). Pretreatment like brining, blanching and heat treatment were thus instrumental in destroying a major portion of vitamin C in the finish preserve. Alternatively vacuum method of preparing the preserve may be tried instead of the conventional open pan method to retain more of vitamin C in the finished product as suggested by Siddappa and Bhatia, (1959).

2.5.3 Fruit jam

Addition of sugar in jam depends not only on the fruit, but also on its acidity and degree of ripeness. Finished jam should contain 30-50% invert sugar to avoid crystallization of cane sugar in the jam during storage. If percentage of sugar is less than 30, cane sugar may crystalize out if it is more than 50% and jam will develop into a honey like mass due to formation of small crystals of glucose (Lal, et al., 1986).

Bhatnagar, (1991) prepared jam from watermelon rind alone, and in combination
with pink berries of grape cultivar beauty seedless and observed that the addition of grape berries have resulted mixed jam rich in all the factors, however organoleptic rating showed, pure jam had high acceptability over mixed jam. Mixed jam was rated very high for its better colour, consistency and flavour. Chemical analysis of jam indicated that the mixed jam contained more acid, pectin, and colour than the pure jam. Organoleptic quality of jam degraded as the storage period resulting change in taste, consistency and colour of the product. Acceptability of both types of jam was even after six months of storage. Maximum acid content was recorded in the mixed jam throughout the storage period as compared to pure jam.

Bhatnagar et al., (1984) reported similar findings with muskmelon mixed jam and observed that mixed jam had high optical density values as compared to pure jam throughout the storage period might be attributable to enzymatic browning. Further increase referred as non-enzymatic browning resulting into the formation of brown pigments.

Kalra, et al., (1991) studied the evaluation of mango papaya blended beverage and reported that Dashehari and Chausa mango varieties blended with 25-33% papaya produced the best blends without affecting the study and acceptability of the mango beverage. They also reported that any proportion of papaya may be blended with mango with minor effect but from the organoleptic score it seems that 25-33% papaya with mango would be more appropriate and good beverage could be prepared with long storablity.

with pink berries of grape cultivar beauty seedless and observed that the addition of grape berries have resulted mixed jam rich in all the factors, however organoleptic rating showed, pure jam had high acceptability over mixed jam. Mixed jam was rated very high for its better colour, consistency and flavour. Chemical analysis of jam indicated that the mixed jam contained more acid, pectin, and colour than the pure jam. Organoleptic quality of jam degraded as the storage period resulting change in taste, consistency and colour of the product. Acceptability of both types of jam was even after six months of storage. Maximum acid content was recorded in the mixed jam throughout the storage period as compared to pure jam.

Bhatnagar et al., (1984) reported similar findings with muskmelon mixed jam and observed that mixed jam had high optical density values as compared to pure jam throughout the storage period might be attributable to enzymatic browning. Further increase referred as non-enzymatic browning resulting into the formation of brown pigments.

Kalra, et al., (1991) studied the evaluation of mango papaya blended beverage and reported that Dashehari and Chausa mango varieties blended with 25-33% papaya produced the best blends without affecting the study and acceptability of the mango beverage. They also reported that any proportion of papaya may be blended with mango with minor effect but from the organoleptic score it seems that 25-33% papaya with mango would be more appropriate and good beverage could be prepared with long storability.

2.5.4 Fruit canning

Alterations in the organoleptic properties of the fruits are the most important changes which take place during canning. Any discolouration which arises during preparation of the fruit will be carried through to the final product and will result in a loss of consumer acceptability. Many fruits undergo rapid browning as a result of cellular disruption and access to oxygen during the operations prior to canning, the browning reaction is mainly caused by the enzymes polyphenol oxidase acting on a suitable phenolic substrate in the presence of oxygen (Joslyn and Pointing, 1951). These changes are controlled either by heat (blanching) or by chemical inhibition. Steam at 93\(^{\circ}\)C or higher is used to give a rapid blanch (Tate, et al., 1964).

If the texture is soft before the fruit goes into the can it will be even worse after heat processing. Control of the texture breakdown can be achieved by limiting the activity of pectic enzymes naturally present in the fruits, and by the application of calcium salts. As texture is of prime importance in such products, the PG activity (polygalacturonase) must be inhibited (Van Buren, 1967). This can be done effectively by addition 0.01-0.025%. "Nacconal" (a commercial preparation of sodium alkyl aryl sulphonate) to the brine, only a trace of which remains in the finished product. Furthermore, it has been showed (Buch, et al., 1961) than when raw, red tart cherries are allowed to stand in air or water prior to canning, a small amount of demethylation by PE gives an increased firmness in the canned product.

Some of the compounds responsible for flavour are volatile to a greater or lesser degree, and so can be lost by evaporation from the fruit during peeling, cutting and pulping operations without any action of degrading enzymes. Prolonged soaking or brining of fruit may affect flavour by leaching of the free acids and sugars into the soaking liquid. Thus, it has been reported (Peterson, 1938) that cherries, soaked in water at 10-12\(^{\circ}\)C for
12-24 hours, show losses in flavour which increase with soaking time and correspond to losses of acids. Similarly, the blanching of figs, a necessary step required to remove their raw taste, is carried out in the cans in steam to prevent loss of natural fruit sugars (Cruess, 1958).

Blanching loosens the skin, facilitates close filling in the can and drives out the air from the tissues. It helps to clean the fruit or vegetables and to eliminate microorganisms. It also inactivates the enzyme and prevents the possibility of discolouration. By removing undesirable acid elements and astringent taste of the peel, it also improves the flavour (Lal, et al., 1986). Over cooking spoils the flavour as well as the appearance of the product.

According to Siddappa, et al., (1948) the white heart cherry which is of fairly big size and has a creamy white flesh and the red cherry which rather small in size and has a creamy white flesh, are good for canning. They further studied extensively the possibility of canning the fruit along with other fruits in the form of a few cocktail. The fruit is a valuable one in every respect, and the exotic strong flavour can be reduced considerable by processing and the product made acceptable to a large section of people. There is a growing interest in the fruit in several quarters.

2.5.4.1 Processing and storage of canned fruit

The first change which takes place as soon as the hot syrup makes contact with the fruit is the redistribution of the water soluble pigments between fruit and syrup. This continues rapidly during processing and at a slow rate during storage, until equilibrium is attained, usually within a few weeks of storage. The second change which accompanies redistribution involves the chemical interaction between pigments, fruit and syrup constituents. When gooseberries and apples are given long processing treatments at high temperatures in lacquered cans, brown colours form in the fruit and the syrup which is
thought to be due to polymerization of the colourless, "Leucoanthocyanins" into brown, "Phlobaphenes" (Anthistle and Dickinson, 1959). A similar reaction may occur during the canning of bananas in acidified syrup, (Board and Seale, 1954).

The application of heat, either during processing or storage of the canned fruits, may lead to irreversible alterations in texture caused by loss of the semi-permeability of the cell membranes and by the breakdown of pectic substances. The main factors which appear to be involved in protopectin stability and therefore, in the maintenance of a good texture, are the type of fruit, its acidity at the time of canning, the length and temperature of processing and the length and temperature of storage (Al-Delaimy, et al., 1966).

When a fruit is canned in syrup, it shrinks because water leaves the fruit faster than syrup solutes can move in order to equalize solute concentrations depending on the relative sugar concentration. The cell walls then absorb sugar, probably by hydrogen bonding of the latter with polysaccharides in the wall and this causes cessation of water movement from the fruit followed by a reverse in its direction. Because of this dehydration effect, fruit canned in heavier syrup will be firmer than fruit canned in a lighter one (Sterling, 1959).

The principal demarcation in the acidity classification of canned foods (Cameron and Esty, 1940) lies at pH 4.5 i.e. between the low and medium acid groups on the one hand and the high acid groups on the other. At the pH persisting in canned fruit, i.e. generally within the range 3.0-4.5, bacterial spores are usually destroyed under such atmospheric processing conditions, whilst the growth of any surviving spores is inhibited by the low pH. In cases where there is a risk of the final pH being greater than 4.5, e.g. in canned tomatoes, pears, mangoes and figs, it is recommended that small amounts of citric or malic acid be added to the syrup prior to processing, the final quality of the product is much improved with the reduction of acidification.
2.5.4.2 Nutritional loss in canned fruits

Factor affecting vitamin loss in canned fruit is the thermal stability of the vitamins. Vitamin 'A' is fairly stable to heat (90-95%) and vitamin $\beta_1$ is heat stable in acid media (90% retention in canned tomatoes). Vitamin $\beta_2$ and nicotinic acid are both stable to heat. Vitamin $\beta_6$ is resistant to heat, oxygen and acids whereas vitamin E is heat stable. The rate of destruction of vitamin $\beta_1$ is increased by the presence of copper and oxygen but the effect is less than the destruction of vitamin C (Huelin, 1958). The high retention of ascorbic acid in fruits canned under commercial conditions was demonstrated by Olliver, (1936) using chemical methods and substantiated, in the case of black currants, by animal feeding tests.

According to Adam, (1941), the effect of increasing headspace is, as might have been expected, to decrease the vitamin C retention but the temperature of the syrup at the time of closing the can is not important in this respect. Whilst oxygen is present in the can, the aerobic destruction of vitamin C in the presence of metal catalysts, such as copper will be the main reaction.

According to Powers, et al., (1958), when blanching is a necessary step in the preparation of the fruit for canning then steam is preferred to hot water. Loss of water soluble vitamins by leaching will then be minimized. Considerable losses in vitamin C have been shown at this stage during the Blanching of bananas and guavas (Dhopshwarkar and Magar, 1952), probably due to the increased activity of ascorbic acid oxidase during the heating of the fruit tissue.

Losses of vitamin C in canned fruit during storage are generally slight, but this depends a great deal on storage time and temperature. Longer the storage time and higher the storage temperature the greater is the breakdown of vitamin 'C' in the canned fruit (Cameron et al., 1955). The results suggest that storage temperature of $10^0$C or below
must be used for maximum retention of ascorbic acid. The total retention of vitamin-'C' in fruits during canning, taking into account the losses incurred at all stages of the canning process ranges from 65 to 95%.

Vitamin-'C' will be less stable in canned fruits containing a high level of anthocyanin. It has been shown that 40-60% of original ascorbic acid is destroyed on processing strawberries and after 15 weeks, storage at 37°C only about 40% of the quantity present at the beginning of storage remained (Kyzlink and Curdova, 1966).

Kulwal, (1985) reported loss of vacuum during storage both at room temperature and 37°C, was not much upto 60 days of storage. Thereafter vacuum decreased considerably in products stored at 37°C. Also a slight increase in acidity was noticed at 150 days of storage in products stored at 37°C. Though there was no change in pH, total sugars remained unaltered however, increase in reducing sugars was observed as a result of storage. Rate of sugar hydrolysis was very fast at 37°C storage.

2.5.4.3 Drained weight of canned segments

Immediately after processing, segments starts to equilibrate with the syrup and the drained weight falling to 60-70% of the filled weight. The segments then increase in weight by upto 10% probably by absorption of sugar reaching their equilibrium value 2-3 weeks after canning. The rate of this equilibration depends on temperature, being slower at low temperature (Ludin, et al., 1969). Bakal and Mannheim, (1968), reported that during first 4-6 days grape fruit segments loose water by osmosis. It is considerably reduced by using less concentrated sugar syrup, vacuum syruping and the use of dry sugar also increases the drained weight.

Garson, (1968) studied the effect of quality and composition of syrup with special reference to the drained weight of cherries and the attainment.
2.5.5 Dehydration of fruits

Dehydration has usually been somewhat more costly than sundrying, but undoubtedly the superior cooking quality of the dehydrated products, when cooked, nearly resemble the cooked fresh fruits in flavour and colour than do-cooked sundried fruits and gives a somewhat higher yield of dried products than sundrying. This difference is probably due to the loss of sugar in sundrying through respiration or fermentation. Fruits acquires the colour of the fully mature fruits in sundrying, while in dehydration, the fruit retains the colour possessed at the time of cutting. The dehydrated fruits in all cases are superior to the Sundried for cooking purposes and also superior in appearance before cooking (Cruess, 1958).

Perry, (1944) noted that the rate of drying depends upon the temperature of the fruit and it is more convenient to refer to the temperature of air passing around the fruit. The drying rates, according to Perry, (1944) are roughly proportional to the fourth power of the Fahrenheit temperature.

2.5.5.1 Aspects of dehydration

Van Arsdel, (1963) stated the theoretical aspects of dehydration that the most important operation in dehydration is the mass transfer of moisture. In living fruit tissues water loss largely occurs by diffusion from the cells of the intracellular spaces, followed by diffusion, probably as vapour, from the intercellular spaces through pores in their skin. During dehydration, evaporation commences from the outer surface of the tissue water gradually drawn mainly as vapour from the cell through the plasma membrane and cell wall and then partly via the intracellular spaces out through the skin when this has not been removed before drying. As drying proceeds, cell wall collapse and some capillaries contract and ultimately seal off, resulting in a falling rate of water transfer. If water is removed too rapidly from the drying surface, capillaries may be closed so quickly that
water movement from the interior is outstripped. Such conditions is called "case hardening" and causes substantially reduced drying rates. During early stages of drying, evaporation rate is so high that the surface remains relatively cooler than air temperature. In later stages the temperature of the dried tissue gradually approaches that of the drying air. This increase in temperature accelerates certain biochemical changes, results in deteriorates changes in flavour, texture and colour. Thus, the temperature of the material in the terminal rate of drying is a most important factor in determining the quality of the product.

The capacity of air to take moisture, rapidly increase with rise of temperature, and the amount of heat necessary to evaporate a given weight of water decrease with rise in temperature. The temperature of air used in dehydration greatly affects not only the time required for drying, but also the quality of the finished products (Mrak, et al. 1946).

Maxie, et al., (1967) reported that peaches loss less moisture than nectarines under the same conditions of temperature and relative humidity. They state the removal of the "fuzz" will increase moisture loss in two ways one by eliminating the barrier against air movement around the lenticels and stomata and another by the broken hairs leave new openings in the skins of the fruit through which water vapour can be lost.

According to Christie, et al., (1929) labour costs are less in dehydration than in sun drying and the saving in cost of this item partially compensates for the extra cost of fuel and power. While costs of dehydration are considerably higher at present, nevertheless the Christies experiments indicates a higher yield by dehydration than in sundrying.

The condensation of reducing sugars with amino acids, a process accelerated by heat, is responsible for much of the darkening with giving brown colour and also imparts a "Caramel" flavour to the product which occurs in fruit tissues during storage. Apart
from increased solids concentration due to water removal partial inversion of sucrose occurs in those fruits which contain large amounts of sucrose particularly if the acid content is also high. These changes which may result in a more hygroscopic dried fruit with altered taste, texture or appearance are not always undesirable (McBean, et al., 1971).

The deteriorative changes in flavour, texture and colour initiated during drying and possibly during predrying procedures continue when fruit is held or stored after drying. Such deterioration increase with increasing time and temperature of storage. Dried fruits stored for a long time even at moderate temperatures develop off-flavours which render them unacceptable. Texture changes also occur during storage of dried fruits. These are indicated by an increasing reluctance of the tissue to absorb water. The changes in colour which occur in dried fruits during storage with the production of brown pigments; Reynolds, (1963,1965) has considered in detail the possible reactions which occur before the appearance of brown pigmentation; such as time of storage, temperature, SO2 level, moisture content and oxygen availability on the rate of browning has been extensively studied (Stadtman, et al., 1946 a, b, c).

Stadtman, et al., (1946a) reported that in absence of oxygen, the rate of darkening of dried apricots increased with decrease in moisture content over the range 40-10% and reached a maximum at a moisture content of between 5 and 10% exposure to oxygen decreases the storage life of dried apricots (Stadtman, et al., 1946 b).

2.5.5.2 Nutritional loss in dehydrated vegetables and fruits

In drying, food losses the moisture content which results in increasing the concentration of the nutrients in the remaining mass. Proteins, fats and carbohydrates are present in large amounts per unit weight in dried foods than their fresh counterparts. In dried food there is a loss in vitamin content as water soluble vitamins and minerals are diminished during blanching (Desrosier and Desrosier, 1977).
Ramnath and Dubashi, (1981) conducted studies on loss of colour and vitamins on dehydration of vegetables. They found that the dehydration at higher temperature of 850-90°C lead to greater destruction of both carotenoids as well as ascorbic acid than the corresponding losses encountered by dehydration at lower temperature. Carotenoid losses could be reduced by 50% by simple dehydration at 55°C instead of 90°C. However, these changes in drying temperature does not materially reduced ascorbic acid.

Sethi, (1986) reported that the fresh aonla dried in the form of pulp gave better nutritive value as compared to whole blanched and unblanched fruits. Drying of raw aonla pulp is advocated which yielded an organoleptically acceptable product for use in curries and soups.

2.5.6 Sun and solar dried fruits and vegetables

Khurdia and Roy, (1986) reported that a maximum temperature and faster drying rate of whole ber was observed in the solar drier with plain glass, followed by amber glass, chimney and direct sun. The product when dried in solar drier, had better retention of sulphur dioxide in both ber and potato slices along with less changes in reducing and total sugar in ber. The drying rate of potato slices was faster in direct sun followed by solar drier with plane glass, amber glass and chimney.

2.5.7 Rehydration

The process of rehydration after drying can never be a simple reversal of drying mechanism. Number of studies have shown that irreversible change of the colloidal constituents of vegetable tissues do in fact occurs. The elasticity of cell walls and swelling power of starch gel, both important for good rehydration, are reduced by heat treatment. The rehydrated product is generally reported to be less juicy and more crumbly than the original one, (Van Arsdel, 1973).