CHAPTER III

MATERIALS AND METHODS

Present study was conducted during ber fruit season of Dec.- Jan. 1991-92 and 1992-93 and it involved a series of investigations covering the determination of the physicochemical properties of fruits of different ber cultivars, sensory evaluation of the various ber products prepared from various cultivars using different methods for four quality attributes viz. colour, taste, flavour and texture at different storage periods i.e. 0, 180, 270 and 360 days. Determination of the changes in chemical attributes like total acidity, ascorbic acid, reducing and non reducing sugars as well as total soluble solids in the ber products after the storage of 0, 90, 180, 270 and 360 days. The materials and equipments used, methodology followed and experimental techniques adopted are presented in this chapter.

3.1 Materials

The fresh fully matured fruits of six ber cultivars of these fruits of Gola, Kadaka, Mehrun, Sanaur and Umran were obtained from the orchards of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola while that of Nagpuri cultivar were obtained from the local market. Fruits selected were nearly of the same stage of maturity (Plate 3.1).

3.2 Physicochemical Properties of Ber

3.2.1 Physical properties

The fresh ber properties pertaining to size and shape namely, length, diameter, fruit weight, colour, taste and flavour, percentage of pulp and stone were determined as follows.

a) Dimensions: Ten fruits of each cultivar were randomly selected and their length and diameter were measured by using micrometer (least count 0.01 mm). However, fruit weight (g) was recorded by using electronic balance.
Plate 3.1: Matured fruits of ber cultivars

Plate 3.2: Pricking Machine
b) Pulp and stone: 100 g fresh ber fruits were taken and their pulp and stones were separated by using knife. Percentage of pulp and stone was determined on the basis of their weight with respect to the total weight.

3.2.2 Chemical composition

The proximate chemical composition of the fresh ber pertaining to the total acidity in terms of citric acid, ascorbic acid (Vitamin -'C'), reducing and non-reducing sugars as well as total soluble solids (T.S.S.) were determined by using the analytical procedures suggested by Ranganna, (1977).

3.3 Standardization and preparation of ber products

All the six cultivars were used for preparation of Ber candy, Ber preserve, Ber jam, Ber jelly, canned ber and dehydrated ber. All these products were prepared by using different processes during the preliminary studies. The process which was observed to be most suitable for the respective product was employed during further investigations as a standardized method. Producers were standardized with variations as needed in relation to different varieties and products.

3.3.1 Ber candy

A fruit impregnated with Cane sugar and glucose and subsequently drained and dried, is called candied fruit.

3.3.1.1 Selection of ber

Matured large sized ber fruits per variety were selected for candy making. They were washed thoroughly, dried and then pricked with pricking machine (Plate 3.2).

3.3.1.2 Blanching of ber

Fruits were blanched by dipping in boiling water (Plate 3.3) for two minutes for removing undesirable acrid elements and astringent taste of the peel and also for improving the flavour.
Plate 3.3: Water Blanching Process

Plate 3.4: Hand Refractometer
3.3.1.3 Preparation

The ber candy of different varieties were prepared using slow and quick method separately.

I) Slow method

30\(^0\) brix cane sugar syrup was prepared and 0.1 % Citric acid was added to it. Then the blanched ber were boiled in this cane sugar syrup for 10-15 minutes and thereafter left in the syrup for 24 hours. Next day ber were drained out. The brix of the syrup was raised to 40\(^0\) brix by adding more cane sugar and ber were added in this syrup and the whole mass was boiled for about five minutes and left for 24 hours. Next day the ber were again drained out and the brix of the syrup was again raised to 50\(^0\) by adding more Cane sugar and ber were boiled in syrup for about 5 minutes and left for 24 hours. Next day the ber were boiled in 60\(^0\) brix and left for 24 hours. After that the strength increased by 5\(^0\) brix at every time by adding more sugar. And the mass were boiled in the syrup on every alternate day and fruits were left for 48 hours in the syrup until the final concentration of syrup reached to 75\(^0\) brix. The sample calculations to obtain the quantity of sugar to be added everyday by adopting Pearson formula are shown in Appendix G.

Draining and drying

Then, the ber were removed from the syrup and drained for half an hour. Thereafter they were wiped with a wet ponge to remove the adhering syrup and were dried in shade for 3-4 days.

Glacing

Dried candied ber were then passed through confectionery glucose, one by one with a fork and placed on tin sheets in a warm dry room. After becoming crisp, canned bers were packed in polyethylene bags.
II) **Quick Method**

Selection of fruits and blanching thereof was done as in slow method. Thereafter the blanched fruits were cooked in $30^0$ brix sugar syrup, continuously till the final concentration of Sugar syrup reaches to $75^0$ brix. Candied ber were then drained out, glazed, dried and packed as in case of slow method. These products were stored and evaluated for its qualities. As pilot study during 91-92 revealed that the candy prepared from the varieties Mehrun and Sanaur was excellent in quality of the six varieties studied. Therefore during 1992-93 the candy was prepared by slow method only by using these two varieties and stored upto 180 days of storage period at room and low temperature (freeze).

3.3.2. **Ber preserve**

Properly matured fruits when cooked in a syrup and kept in syrup, called a preserve.

3.3.2.1 **Selection of ber**

Matured and almost uniform sized ber fruits were selected. Fruits so selected were washed thoroughly and then pricked with wooden needle and pricking machine.

3.3.2.2 **Blanching of ber**

Bers were blanched by dipping in boiling water for two minutes to make it just soft for absorption of sugar.

3.3.2.3 **Preparation**

Ber preserve of different varieties were prepared by slow and quick method.

I) **Slow method**

$30^0$ brix cane sugar syrup was prepared and one percent citric acid was added to it. Blanched bers were boiled in $30^0$ brix syrup, for 10-15 minutes and the mass was allowed as such for 24 hours in a vessel. Next day, fruits were drained out and more sugar was added in syrup to raise the strength of the syrup to $40^0$ brix. The whole mass
was then boiled for 5 minutes and left for 24 hours. On the third day, again ber were
drained out. Then the strength of the syrup was raised to about 50° brix and a small
quantity of citric acid was also added in it. The ber with syrup were again boiled for 4-5
minutes and left for 24 hours. On fourth day the strength of the syrup was raised to 60°
brix after draining out the fruits and process was repeated. Finally the strength of the
syrup was raised to 70° brix on 5th day. The drained fruits were boiled in this syrup again
for 5-10 minutes. The ber then were left in the syrup for 3-4 days. When the strength of
the syrup is reached to 70° brix, the bers in the syrup are stored in air tight glass
container.

II) Quick method

For preparing preserve by quick method, the fruits so selected were similar to
those used in slow method. The fruits were blanched as usual. In quick method the
blanched fruits were cooked in low sugar syrup of 30° brix with one percent citric acid
and it was boiled continuously with gentle heating until the syrup concentration reaches
to 70° brix. Preserved bers with syrup then were stored in air tight glass bottles.

3.3.3 Ber jam

Jam is a product prepared by boiling the fruit pulp with sufficient quantity of sugar
to a reasonably thick consistency, firm enough to hold the fruit tissues in position.

3.3.3.1 Selection of ber

Ber fruits which reached to maturity were selected for making jam. Large sized
healthy fruits were sorted and washed thoroughly to remove adhering dust and dirt, stalks,
and other undesirable plant parts.

3.3.3.2 Preparation

Jam was prepared by pulping and grating method.
1) **Pulping method**

Washed fruits were cut into thin pieces and the stones were removed and then passed through mixer to make a pulp. The pulp then was mixed with equal quantity of sugar while 0.7 percent of citric acid was added in mixture to supplement the acidity of ber for jam making. One percent of pectin was also added to the mixture as ber contain low pectin. Appropriate combination of pectin, sugar and acid is essential to give a 'set' to the jam. The ber and sugar mixture was then boiled to concentrate the soluble solids to about 70\(^0\) brix and also to bring the jam nearly to the necessary degree of inversion of sugar.

**Packing**

Soon after the end point is ascertained, the jam should be cooled in a pan and filled into small, even sized wide mouthed glass bottles and then covered with a thin layer of paraffin wax and lid and stored at a fairly cooled place.

Total content of soluble solids is of a great importance in attributing shelf life to jam. Total soluble solids (T.S.S.) was determined with a hand refractometer (Plate 3.4), while boiling was in progress. Sample was taken and cooled immediately so as to get correct measure of soluble solids.

11) **Grating method**

The jam was prepared by grating method where instead of pulp, grated ber was used and rest of the procedure adopted was same as in case of pulp method.

3.3.4 **Mixed fruit jam**

On the basis of evaluation of ber jam prepared in 1991-92, during next year 1992-93, attempts were made to prepare the mixed fruit jam of two ber cultivars, i.e. Sanaur and Umaran selected on the basis of the performance studies of six varieties in 1991-92. Mixed jam was prepared by mixing Papaya in different proportions.
a. 100 percent ber pulp  
b. 75 percent ber pulp + 25 percent papaya pulp.  
c. 50 percent ber pulp + 50 percent papaya pulp.  

The method used for preparing mix fruit jam and the percentage of sugar, acid and pectin added was similar to that used for ber jam prepared by pulping method as explained in section 3.3.3.2 (I).  

The jam prepared was then filled in glass bottles and sealed with paraffin wax and stored separately at room and at low temperature (refrigerator).  

3.3.5 Canned ber  

All the six cultivars were considered for canning studies by both pricked and non-pricked method in 35\(^\circ\) brix syrup.  

3.3.5.1 Selection of ber fruits  

Fresh, ripe, firm and evenly matured bers were selected for canning. Bers were healthy and free from any blemishes, insects damage and malformations.  

3.3.5.2 Washing  

Selected bers were thoroughly washed by soaking in water to remove the soil and dirt.  

3.3.5.3 Blanching  

Pricked and non pricked ber fruits were blanched in boiling water for two minutes. This loosens the skin, which facilitates close filling in the can, and drives out the air from the tissues, eliminate micro-organisms and also inactivates the enzymes, thus preventing possibility of discolouration.  

3.3.5.4 Preparation of can and product filling  

The (SR) Lacquered A2 can (790 x 1140 mm) was selected for canning of ber. Can bodies were formed on the can forming machine (Plate 3.5) and flanged on flanging
Plate 3.5: Can Forming Machine
Plate 3.7: Double Seaming Machine
Plate 3.8: Can Filling with Ber and Hot Sugar Syrup
Plate 3.9: Cans bers with hot sugar syrup containing bers and hot sugar syrup with loose lids

Plate 3.10: Cans exhausting in Autoclave
Plate 3.11: Sealing of can top lid on double seaming machine
3.3.5.7 Cooling

After processing, the cans were cooled rapidly by dipping in cold water tank to stop the further cooking process and to prevent stack burning.

3.3.5.8 Labelling and storing

Canned products were finally tested for leaks and imperfect seals. After that they were dried and labelled as pricked and non pricked each with 35\(^{0}\) brix and 40\(^{0}\) brix. Then the cans were stored in cool and dry place.

3.3.6 Dried and dehydrated bers

Preservation of fruits by sun drying is the oldest method. The modern method "dehydration" is drying of fruits and vegetables under controlled temperature and humidity with the help of dehydrator.

3.3.6.1 Selection of ber fruits

Uniformly matured ber fruits which just are showing change in colour from green to light yellowish scarlet or yellowish with brownish lines were selected for drying and dehydration and then washed thoroughly.

3.3.6.2. Blanching

Washed bers were blanched for 5 minutes by dipping them in boiling water and were pricked with pricking machine.

3.3.6.3 Sulphuring

Blanched bers were then treated with sulphur fumes to maintain their colour and to avoid spoilage by micro organisms. This was done in a wooden chamber by burning a sulphur in a receptacle placed on bottom. Blanched bers were spread on a perforated compartment and were exposed to burning sulphur fumes for 3 hours as shown in plate 3.12. After sulphuring fruits were kept for drying in sun as control and in dehydrator (Plate 3.13).
Plate 3.12: Wooden chamber for sulphur fumigation
Plate 3.13:  Dehydrator
3.3.6.4 Sundrying

Sundrying being one of the traditional and cheapest method of drying was considered and adopted as a control to assess the quality of samples dehydrated at $45^0$, $55^0$ and $65^0$ of temperatures. The weighed sample of 500 g, after sulphuring were spread uniformly over a wire mesh and care was taken to avoid any loss due to birds. Bers were turned oftenly till they are dried. Observations on loss of weight were recorded till constant weight is reached on complete drying.

3.3.6.5 Dehydration

The sulphur treated bers of the six varieties were placed in dehydrator, where the temperature, humidity and rate of air flow were controlled. The desirable drying temperature were maintained respectively at $45^0$, $55^0$ and $65^0$C. The loading time and the successive weight loss of the product was recorded at an interval of four hours in order to record drying rate. The samples were weighed on top pan balance and kept for drying. The drying process was continued till the constant weight of the ber samples was attained as shown in plate 3.14.

3.3.7 Ber jelly

Jelly was prepared by boiling the fruits in water, straining, mixing the strained and clear juice extract with sugar and boiling the mixture to a stage at which it set to a clear jel.

3.3.7.1 Selection of fruits

Fully matured and good flavoured healthy bers which just changed their colour or started changing their colour from yellow to red, were selected.

3.3.7.2 Preparation

Bers were thoroughly washed with water to remove any adhering dirt and then cut into thin pieces.
Plate 3.14: Mechanism to record the loss in weight during continuous drying process
3.3.7.3 Extraction of pectin

Equal quantity of water was added into pieces of ber and the mass was boiled for 15-20 minutes to get the desired pectin and at this mass gives sticky feeling. Boiling also destroys enzymes responsible for the destruction of pectin. The extract was strained through muslin cloth folded several times.

3.3.7.4 Pectin test

Pectin test for pectin content was done with jel meter and sugar was added to it according to the jel meter reading. Also 1% citric acid and pectin was added.

3.3.7.5 Cooking

Mass was cooked to the desired consistency or setting state and the end point was determined by,

a. Temperature \((220^\circ F - 221^\circ F)\)

b. Sheeting or laddle test

c. Weighing finished jelly weight should be about 1 and 1/2 times the weight of sugar added.

After ascertaining the end point, the jelly was ready. At this, foam on top was removed. Then cooled slightly and then poured into wide mouthed sterilized jelly bottles by leaving half inch head space.

3.3.7.6 Standardization

During present study for standardization of ber jelly different percentage of sugar (50 to 100%) and pectin (0.5 to 2.5%) and citric acid (0.5 to 2.5%) were used.

3.4 Methodology

All the products so prepared were subjected for study of shelf life for a period of one year. Products were open periodically at an interval of 90 days i.e. at 90th, 180th, 270th and 360th day and analysed for sensory evaluation and chemical changes. Chemical
analysis was carried out as per the procedure suggested by Ranganna, (1977). Factorial randomized block design (FRBD) was used to process the data both in case of sensory and chemical evaluation (Amerine, et al., 1965 and More, 1993).

3.4.1 Total soluble solids

Total soluble solids (TSS) was determined by using Abbe Refractometer having the range of 0-50° and 50-85° brix. It gave direct reading of total soluble solids content in percent.

3.4.2 Titrable acidity

Total acidity content of the products was estimated in terms of citric acid. It was determined by titrating the sample against 0.1 N Sodium Hydroxide (NaOH) solution. A few drops of one percent phenolphthalein was used as an indicator.

Determination of total acidity

1. Pipette out 10 ml of juice into 250 ml measuring flask.
2. Add 100 ml of distilled water.
3. Take 10 ml of above mixture in a flask.
4. Add 2-3 drops of phenolphthalein.
5. Allow 0.1 N NaOH from the burette into the flask till the solution attains a light pink colour. After that calculate the percentage of total acidity by the formula as given below

\[
\text{Total acidity (°) = } \frac{\text{Titre} \times \text{Normality of alkali} \times 100}{\text{Vol. of sample taken for estimation} \times \text{Vol. of sample} \times \text{Equivalent wt. of acid}}
\]

\[
= 0.64 \times \text{Titre}
\]

3.4.3 Ascorbic acid

The vitamin 'C' content of the product was determined in terms of ascorbic acid. Sample was diluted with 3% metaphosphoric acid (HPO₃) and then it was titrated with 2.6
- dichlorophenol indophenol dye solution till light but distinct pink colour persists for not less than 15 seconds. 2,6 - dichlorophenol indophenol oxidises ascorbic acid to dehydroascorbic acid and in terms get reduced to colourless leuco-base. From the titre value the amount of Vitamin 'C' (Ascorbic acid) was determined by adopting the following procedure,

**Determination of ascorbic acid**

1. Take 10 ml of sample and its volume was made upto 100ml with 3% Methphosphoric acid (HPO₃).
2. Filter the sample by using Whatman no. 4 filter paper.
3. Take 10 ml of above mixture and titrate with the standard dye to a faint pink colour which should persist for at least 15 seconds
4. Calculate the ascorbic acid content (mg/100g) as,

\[
\text{Ascorbic acid} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Vol. made up} \times 100}{\text{Aliquot of extract} \times \text{Volume of taken for estimation} \times \text{sample for estimation}}
\]

in which,

\[
\text{Dye factor} = \frac{0.5}{a}
\]

Where 'a' is the volume of dye solution required to titrate 5 ml of standard ascorbic acid and 5 ml of 3% metaphosphoric acid (HPO₃).

**3.4.4 Reducing sugar**

Reducing sugar was estimated as per Lane and Eynon method as given by Ranganna (1977). It was done by using Fehling solution. Invert sugar reduces the copper in Fehling solution to red insoluble cuprous oxide. Reducing sugar was determined by adopting the procedure given below.
Determination of reducing sugar

1. Take 25 ml of sample in a flask and its volume was made upto 100 ml, by adding distilled water.

2. Then neutralize the above sample with 1 N NaOH Solution.

3. Then add 2 ml of lead acetate and 2 ml of potassium oxalate solution and prepare the mixture and filter.

4. Then Pipette out 5 ml of Fehling A and 5ml of Fehling B solution into 250 ml conical flask.

5. Then add 40 ml distilled water and 2-3 drops of methylene blue. Raise the contents to boil.

6. When contents boil vigorously, add the above sample from burette till the colour changes to faint brickred.

7. Note the volume of sample run down the burette and calculate the percent of reducing sugar as,

\[
\text{Reducing sugar (\%)} = \frac{\text{Factor} \times \text{Dilution} \times 100}{\text{Titre} \times \text{volume of sample}}
\]

in which, 'Factor' indicate the factor of Fehling solution.

3.4.5 Total sugar

For estimation of total sugar, a known volume of clarified extract was hydrolysed with 10 ml HCl (1+1), after 24 hours excess acid was neutralized with concentrated NaOH and made upto known volume. This was then used for titration against Fehling solution.

3.4.6 Non reducing sugar

A percentage of non reducing sugar was obtained by subtracting the percentage of reducing sugar from the percent total sugar.
3.5 Experimental design

3.5.1 Factor analysis

Factor analysis is the name given to the technique used for estimating the various parameters in such studies. It is a statistical method originally invented and developed primarily by psychologists to study the human mind (Holzinger and Harman, 1941). Cattell, (1952), Thurstone, (1954) and Baker, et al., (1961) illustrated the use of factor analysis.

In the present study for carrying out the statistical analysis of FRBD, judges were considered as replications and different varieties and storage duration (days) studied were considered as factors of treatments for independent evaluation of varietal and duration differences and their interactions.

3.5.2 Evaluation and data processing

3.5.2.1 Sensory evaluation

A panel of six judges was formulated and asked to evaluate the colour, taste, flavour, texture of all the products at 0, 120, 240, and 360 days of storage. Ten point hedonic scale was used to score all these attributes. Score below 4 was considered as not acceptable, 4-6 as fair, 6-8 as good and 8-10 as excellent. The statistical analysis was carried out as per the procedure for FRBD as used by Amerine, et al., (1965).

3.5.2.2 Chemical evaluation

The observations recorded in three replications for chemical compositions i.e. Total soluble solids (TSS), total titratable acidity, ascorbic acid (Vitamin-C) as well as for reducing, non reducing and total sugar at an interval of 0, 90, 180, 270 and 360 days and changes in chemical composition were determined by adopting the procedures as explained earlier in sections 3.4.1. to 3.4.6. Statistical analysis was carried out by adopting the procedure for FRBD.
3.6 Computation of relationship between the chemical attributes and storage period for ber products

The relationship of the various chemical attributes viz total titrable acidity, ascorbic acid, and reducing, non reducing and total sugars with increase in the storage period of the ber products prepared from various varieties using different methods are obtained. Values of constants are determined by using the least square method (Eqn. 3.1 and 3.2).

3.7 Computation of the relationship between moisture content and drying time for ber cultivars

Relationships between moisture content (g/100g) and drying time in days for sundrying and in hours for mechanical drying at 45, 55 and 65°C are obtained by using the least square technique as explained earlier in section 3.6.

\[ \Sigma Y = na + b\Sigma x \quad \ldots \quad 3.1 \]
\[ \Sigma xy = a\Sigma x + b\Sigma x^2 \quad \ldots \quad 3.2 \]

in which,

- \( Y \) = Dependent variable, (chemical attribute/parameter).
- \( X \) = Independent variable (storage period, days).
- \( a \) and \( b \) are the constants.

By solving the quadratic equations 3.1 and 3.2 we can obtain the values of constant \( a \) and \( b \) and then by putting these values of \( a \) and \( b \) in following equation of straight line,

\[ Y = bx \pm a \quad \ldots \quad 3.3 \]

the relationships between various chemical attributes and storage period are obtained. Further to see the linearity between the changes in chemical attributes with the respective storage period or the statistical significance of the equation 3.3, the correlation coefficient values (\( r \)) are also obtained with the help of following equation,
\[ r = \frac{\sum xy - \left( \frac{\sum x \cdot \sum y}{n} \right)}{\sqrt{\left[ \sum x^2 - \left( \frac{\sum x^2}{n} \right) \right] \left[ \sum y^2 - \left( \frac{\sum y^2}{n} \right) \right]}} \ldots \text{3.4} \]

3.8 Consumer index

The consumer index was determined by dividing the score obtained for sample by total score for overall acceptability i.e. 10 as a ten point hedonic scale was adopted.

3.9 Cost of production and economics

Cost of production of the various ber products on the laboratory scale was determined considering the various parameters given in Table 3.1.

Table 3.1 : Cost of the production of the ber products

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>Quantity</th>
<th>Rate/Total</th>
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<tbody>
<tr>
<td>A.</td>
<td>1. Weight of ber fruits taken, (kg)</td>
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<td></td>
<td>2. Pulp obtained after crushing, (kg)</td>
<td></td>
<td></td>
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<td></td>
<td>3. Quantity of citric acid</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>4. Quantity of pectin (s) added</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>5. Quantity of sugar added (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Cost of bottles/cans</td>
<td></td>
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</tr>
<tr>
<td>B.</td>
<td>Add 20% of total cost (A) as over head cost (Rs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>Grand total. (A + B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>Add 20% of the grand total (C) for management cost (Rs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td>Sale price per bottle (Rs)</td>
<td>(A + B + C + D)</td>
<td></td>
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