A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

Photographs
(not more than two)

Organization’s
LOGO

Name & Address of Organization (CL)

2014
A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

Consortium Partner
Central Institute of Post Harvest Engineering & Technology
Abohar – Punjab 152116
Title of Sub-project:

A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

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2013
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compact fruit grader (Qy oxhZdj.k)
Executive Summary

The project entitled “A value chain on commercial exploitation of underutilized fruits of tribal zones of Rajasthan” was undertaken to develop commercially viable machineries and processing technologies for utilization of underutilized fruits such as custard apple, aonla, ber and jamun grown in tribal areas of Rajasthan. In the absence of simple and efficient processing techniques, fruit growers are forced to sell their produce at a through away price which is uneconomical and does not even meet the cost of harvesting and transportation for marketing. Therefore, simple and cost effective technologies were developed for post-harvest management, processing and value addition of underutilized fruits.

Harvesting tool for ber, jamun and aonla were developed to ease the operation and to improve the efficiency of harvesting of such fruits. For reducing the bruising and mechanical damage during harvesting, nylon net platform was developed for collection of aonla and jamun fruits. In order to help the farmer, whole seller and retailer to provide uniform size fruits, roller type ber fruit grader and compact fruit grader were developed. Large scale compact fruit grader was designed and fabricated for ber with grading efficiency of 95% and less than 0.5% mechanical damage. This grader also gave 99% grading efficiency for aonla and tomato. Thus, the equipment can be used as multi-crop grading unit. For the separation of stones from fruit prior to its value addition, a ber destoner was developed with a capacity of 300 kg/h at 20 RPM for ber. The destoner was improved by developing a hand tool for separation of stones. The hand tool can further be used for designing a semi-automatic device for destoning of fruits.
Automatic custard apple pulper with the capacity of 120 kg/hr has been designed and developed. It contains three mechanism viz. fruit cutting mechanism, fruit scooping mechanism and pulping mechanism. Fruit cutting and scooping mechanism were made with pneumatic actuators and electric controls. The efficiency of cutting and scooping mechanism is around 94% pulp recovery, 6% pulp wastage along with peels, 11% peel in pulp outlet. While, the efficiency of pulping mechanism is: 70-72% coarse/intact pulp recovery and 28-30% fine pulp recovery. The equipment has been successfully adopted by the entrepreneurs/manufacturer.

Tray dryer was optimized for dehydration of different fruit products which has a unique design of plenum chamber to facilitate horizontal as well as vertical hot air movement. The equipment has minimized the problem of non-uniform drying of food materials in different trays in the tray dryer.

Process technologies for processing and value addition such as dehydrated products, preserve, candy, pulp, supari and beverages etc. from different fruit were standardized. Aonla fruit based fruit cheese was prepared with mixing of Aonla, Pineapple, Papaya and Guava. The final product is rich in nutritional value with a shelf life of more than 6 months under refrigerated conditions. Technology for preparation of ber fruit based mixed fruit soft candy was optimized by mixing ber, pineapple and carrot in appropriate proportion. The product can be stored for more than 6 months under refrigerated conditions.

The process and recipe for preparation of mint fortified jamun beverage viz. ready to serve (RTS) drink and squash was optimized. RTS drink was prepared with 10 % pulp, 12 % TSS, 0.25 % acidity and 5 % mint leaf extract while squash was manufactured by 25 % pulp, 45 % sugar, 1.2 % acidity and 10 % mint leaf extract. Further, the recipe and blending of fruit pulp for preparation of RTS beverages from ber and jamun was standardized. Use of carboxymethyl cellulose (CMC) and sodium lauryl sulphate (SDS) was evaluated for foaming of jamun pulp for its use in preparation of dried jamun pulp powder. Among aonla cultivars viz. NA-7, NA-10 and Chakaiya, NA-7 was found suitable for fresh as well as processing purposes. Aonla processing plant was established with aonla size grader, aonla fruit pricking machine, cabinet air dryer, aonla fruit shredder, hydraulic juice extractor and double jacketed kettle for pulp/juice processing. Besides, technology for processing and value addition of aonla was optimized by developing various new products such as dried powder, candy, supari, laddu and juice etc. The processing plant was scaled up to semi-automated pilot plant for aonla processing.
The Entrepreneurship Development Programme were organized for processing and utilization of aonla fruits by conducting hands on trainings. Regular demonstrations were conducted for transfer of developed technologies to the end users. The developed machineries and processing technologies were found suitable for exploitation of custard apple, aonla, ber and jamun fruit grown in tribal areas of Rajasthan.

Part-I: General Information of Sub-project

1. **Title of the sub-project:** A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

2. **Sub-project code:**

3. **Component:** 2

4. **Date of sanction of sub-project:** December 5, 2008

5. **Date of completion:** June 30, 2012

6. **Extension if granted, from ________July 2012________ to________March 2014_______

7. **Duration of the sub project:** Five Years Four Months

8. **Total sanctioned amount for the sub-project:** 343.714 lakhs

9. **Total expenditure of the sub-project:**

10. **Consortium leader:**
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11. **List of consortium partners:**

<table>
<thead>
<tr>
<th>Name of CPI/ CCPI with designation</th>
<th>Name of organization and address, phone &amp; fax, email</th>
<th>Duration (From-To)</th>
<th>Budget (` Lakhs)</th>
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<td>Dr. R.A. Kaushik, Professor &amp; Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Phone (O): 0294 2417713, Fax: 0294 2418976 Mobile: 09887281595</td>
<td></td>
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</tr>
</tbody>
</table>
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CPI-Consortia Principal Investigator; CCPI-Consortia Co-Principal Investigator


<table>
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CPI-Consortia Principal Investigator; CCPI-Consortia Co-Principal Investigator
Part-II: Technical Details

1. Introduction
   (Give background information for taking up this sub-project)

   The agro-climatic conditions of Rajasthan make it possible for cultivation of large number of fruit species. As the population in general prefers to consume fresh fruits, the processing industry is relatively small. Individual aspects such as production technology and marketing of fruits have been studied, but the value chain, especially those of underutilized fruits such as custard apple, aonla, ber and jamun, have not been adequately developed and analyzed. Hence, the research was carried out to develop a value chain for these fruit species. Although under-utilized, these species have the potential to become a component in farming system of smallholders. Fruit like custard apple, aonla, jamun and ber have emerged as a favored species for small farm agroforestry in Rajasthan and many other parts of India due to their high nutritional and medicinal properties. Hence these underutilized fruits were explored for their suitability of processing into a wide range of products.

   Extraction of pulp is a major constraint in processing of custard apple fruits. Development of enzymatic browning within an hour of pulp extraction, and presence of gritty cells are problems encountered during processing of fruits. If the pulp is heated to control the browning, bitterness and unpleasant off flavor becomes the limiting factor in its processing. Besides, there was a need for designing and fabrication of custard apple cutting and scooping machine followed by pulp extractor in its commercial processing. Therefore, new technologies were developed so that products from this delicious fruit can be prepared and marketed to improve the socio-economic condition of arid and tribal farmers of India in general and Rajasthan in particular.

   Aonla is a drought tolerant crop, and it lends itself to high density planting even in marginal and wastelands. Since aonla plantations require less after-care as compared to other fruit crop and gives higher production per unit area, many farmers have started cultivation of aonla in their orchards. This fruit however do not find easy marketing for fresh fruit consumption. Therefore, there is need to develop technologies for pre and post-harvest management, processing and value addition adoptable at semi-commercial level.

   Ber is cultivated all over India including Rajasthan for its fresh fruits, which are rich in vitamins (C, A and B-complex) and minerals. But the harvesting of this fruit is major
constraint due to its thorny nature and processing is limited to traditional products. Therefore, it is essential to develop harvesting tools, processing technologies and value added products.

Similarly, jamun is also suitable for Rajasthan’s harsh agro-climatic conditions and have the medicinal values especially for diabetic patients. It has short shelf-life of 2-3 days. Owing to this factor the post-harvest losses during transportation and subsequent storage amount to 50-60 per cent. Further, lack of knowledge on harvesting indices was also leading to the improper ripening, poor quality and low shelf life of the jamun fruits. Jamun fruit is very delicate and get spoiled due to bruising and wounding due to non-availability of harvesting tools and platform with collection mechanism. Therefore, there is a need to develop harvesting tools, collection platform, processing technologies and value added products for jamun fruit.

The major factors responsible for poor production and huge post-harvest losses of these fruits are improper harvesting and handling practices, inadequate sorting and grading, inappropriate packaging, non-effective primary processing, transport and storage method and therefore the quality of the fresh produce gets deteriorated. Owing to restricted availability period and high perishability of these fruits, value addition through processing would be appropriate for good economy and increased production of these crops in future.

Therefore, research work was carried out to develop need based machineries and technologies for value addition of these fruits, which will ultimately lead to higher returns to farmers in arid region thus improving the economic lot of the tribal population dominated in the area.

2. Overall Sub-project Objectives

- To standardize post-harvest management for underutilized fruits such as custard apple, anola, ber and jamun to increase shelf-life
- To develop novel products and value chain for these fruits for higher economic returns
- Transfer of technologies among farmers and industries for commercial exploitation and sustainability

3. Sub-project Technical Profile

(Indicate briefly objective-wise work plan, monitoring indicators, expected output and expected outcome)

**Objective:**

1) To standardize post-harvest management technologies for underutilized fruits such as custard apple, anola, ber and jamun to increase shelf-life

**Work plan:**
1. Development of tools for safe harvesting
2. Development of technology for extraction of custard apple pulp.
3. Development of equipments for sorting/grading, shredding and pricking and scaling up to pilot scale semi automation processing set up.
4. Development of aonla pricking tools
5. Development of ber/aonla de-stoner
6. Development of aonla juicer
7. Up scaled semi-automated processing set up

Monitoring Indicators
i) Harvesting tool for ber, aonla and jamun fruits
ii) Platform for collecting harvested fruits
iii) Fruit grader for fruits
iv) Custard apple pulp extractor
v) Pricking machine for pricking ber and aonla
vi) Semi-automatic mechanized aonla processing plant

Expected output:

a) Simple, convenient, low cost and efficient harvesting device for harvesting of ber, aonla and jamun fruits
b) Higher farm incomes of participating beneficiaries by 10 per cent through minimization of losses
c) Mechanical device for grading of fruits prior to fresh marketing and processing
d) Mechanical system for removal of stone from fruit for better processing
e) Simplification of custard apple pulp extraction technology
f) Large scale processing plant for aonla processing

Expected outcome:

a) Simple, convenient, low cost and efficient harvesting tool for ber, aonla and jamun fruits
b) Uniform size graded fruits in the market
c) Uniform quality fruits for processing with increased efficiency of all unit operations
d) Automatic custard apple cutting and scooping machine and pulper for use in the food industry
e) Semi-automatic mechanized processing of aonla fruit

2) To develop novel products and value chain for ber, aonla and jamun fruit fruits for higher economic returns
**Work plan:**

1. Development of value added products from juice like RTS beverages, carbonated beverages, and blended fruit juices
2. Development of technology for powder making
3. Standardize the recipe for *laddu, barfi* and flavored *supari*
4. Semi-automated technology for aonla candy preparation

**Monitoring indicators:**

a) Process technology for preparation of beverages from underutilized fruits
b) Method and recipe for manufacturing noble products from Aonla
c) Technology for pilot scale manufacture of aonla candy preparation

**Expected output:**

i) Simple, convenient, low cost and efficient processing technology for preparing different value added products from ber, jamun and aonla fruits
ii) Technology for preparation jamun juice powder
iii) Higher processor incomes of those participating beneficiaries by 10 per cent through efficient processing and value added products
iv) Standardized recipe for preparation of laddu, barfi and flavoured supari from aonla fruits

**Expected outcomes:**

a) Complete technology for utilization of aonla fruits in processing
b) Technology for utilization of jamun fruits in preparation of fruit beverages
c) Protocol for utilization of ber fruits for preparation of value added products

**Work plan:**

3) Transfer of technologies among farmers and industries for commercial exploitation and sustainability

- Organization of entrepreneurship development programmes (EDP) on developed processing technologies
- Empowerment of new entrepreneur for commercial processed product
- Income generation through production of value added products

**Monitoring indicators:**

a) Entrepreneurship development program for demonstration of technology
b) Number of value added products developed and demonstrated
c) Demonstration organized for developed machineries
d) Technologies commercialized

**Expected output:**
i) Simple, convenient, low cost and efficient harvesting devices, minimal processing, pricking tools, destoner and juicer for under-utilized fruits

ii) Mechanized technologies adopted by the entrepreneur

iii) Better returns to the processor

iv) Better utilization of under-utilized fruits for fresh made and processing

**Expected outcome**

a. Improved harvesting practices for under-utilized fruits with no bruising/damage

b. Uniform quality and size grades of fruit in the market

c. Complete utilization of underutilized fruits

d. Establishment of mechanized processing line for aonla, ber and jamun fruits

e. Trained manpower through in-plant training and providing hands on training through EDP

**Major outcomes of overall project**

- Reduction in post-harvest losses of selected commodity
- Higher income through increased consumption of fresh fruits or value added nutritious processed foods
- New entrepreneur for rural industries empowered in commercial processed product development

4. **Baseline Analysis**

(Baseline data on the pre-project situation supported by tables, charts, photographs)

Fruit like ber, aonla and jamun are harvested by shaking the tree and collecting the same falling on the ground. The fruits are damaged and bruised as such fetch very low price in market. Ripe jamun fruits can be stored only for 1-2 days without decay. It is observed that more than 75 per cent of fruits produced in tribal areas go waste after harvesting due to insufficient fruit handling, insufficient storage techniques and short shelf-life of fruits. Besides the post-harvest handling, there is very little work done on the processing aspect of these valuable fruit.

In the absence of simple and efficient processing techniques, fruit growers are forced to sell their produce at a through away price of Rs. 2.0 per kg, which is uneconomical and does not meet the cost of harvesting and transportation for marketing. In such a scenario farmers are forced to cut the plantation and disheartened leading to distress and discontent. Therefore,
there was a need for development of need based machineries and technologies for post-
harvest management, processing and value addition of custard apple, ber, aonla and jamun
fruits. Therefore, research work is envisaged on developing value added products from these
fruit crops, which will ultimately lead to higher returns to farmers in arid region leading to
improving the livelihood of the tribal population dominated in the area.

5. Research Achievements with Summary
(Give detailed technical progress partner-wise, highlighting the achievements in terms of
targets fixed for each activity and the impact of sub-project. Present statistically analyzed
data through tables/graphs. Attach good quality photographs. Present overall research
achievements with critical discussion of results and conclusions, as if for publication in a
journal. Explain the variation in light of the scientific technological trends,
socioeconomic and agro-ecological conditions.)

Objectives (For CIPHET)

Aonla
1. Development/modifications/adoptions of tools for safe harvesting and
equipments for sorting/grading, pricking, shredding and scaling up to pilot scale
automized processing unit.
2. Development of technology for processing and preparation of value added
products such as dried powder, candy, supari and juice etc.

Ber
1. Development of harvesting tool and destoner.
2. Standardization of technology for processing and value addition such as
dehydrated products, preserve, candy, pulp and beverages etc.

Jamun
1. Development of technology for harvesting and post-harvest management of fruit
for improving shelf life.
2. Development of technology for processing and value addition of fruits and seeds.

Custard apple
1. Development of technology for pulp extraction and its preservation.
AONLA

1) Development of harvesting tool for aonla fruit

Fruit harvester was developed for safe harvesting of aonla. It is simple in design and could be fabricated using a MS pipe 20 feet long by the local artisans. A hook is provided at top of the harvester to pull the fruit from its stem and fruit is detached from the branch.

Fruit collection nylon net platform: The collecting nylon net is fixed in a revolving frame for collecting fruits without damage. The frame is made with the MS pipe in a circular manner. The height of collecting net is 5 feet and collection area is 25 m². Two pipes are fixed in concentric to reduce the size of machine during transportation. Two trees can be harvested per hour without any damage. The total gadget costs was Rs. 7000.

2) Aonla grader

In India, farm level grading of fruits and vegetables is still very less. Manual grading is costly, time consuming and the operation is affected due to less availability of labourers during peak periods. Due to lack of research, handling and grading equipments especially for aonla fruits are not available either in farm level or in commercial level. Therefore, grading machine was developed for aonla fruit. Large scale trial was conducted for aonla and grading efficiency of 99% was observed.

3) Evaluation of aonla cultivars for fresh and processing traits

Three aonla cultivars viz. NA-7, NA-10 and Chakaiya were evaluated for their storage and processing traits (Table 1). The cultivar NA-10 exhibited the maximum TSS and highest Vitamin C content which can be a good processing trait. However, this cultivar is more susceptible to browning due to its high tannin content which acts as a substrate for catalytic activity of PPO enzyme as compared to NA-7 and Chakaiya.
NA-7 exhibited the least browning compared to NA-10 and Chakaiya and hence can be recommended for table or processing purpose.

**Table 1. Composition of different aonla cultivars**

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>TSS (°B)</th>
<th>Acidity (%)</th>
<th>Vitamin C (mg/100g)</th>
<th>Tannins (%)</th>
<th>Browning (%)</th>
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<tr>
<td>NA-7</td>
<td>8.02</td>
<td>1.83</td>
<td>431.11</td>
<td>1.11</td>
<td>5.89</td>
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<tr>
<td>NA-10</td>
<td>8.80</td>
<td>1.90</td>
<td>510.12</td>
<td>1.73</td>
<td>7.11</td>
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<tr>
<td>Chakaiya</td>
<td>8.11</td>
<td>1.81</td>
<td>467.54</td>
<td>1.13</td>
<td>6.56</td>
</tr>
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</table>

4) **Storage behaviour of aonla fruit under ambient condition**

The freshly harvested fruits of NA-7, NA-10 and Chakaiya cultivars after washing with 200 ppm chlorinated water were evaluated for storage in perforated plastic crates at ambient temperature (19-24°C). The result revealed that physiological loss in weight increased with the increase in the storage duration and this increase was more in NA-7 cultivar (Fig 3a). Similarly decay loss increased during storage and least fruit spoilage was noticed in Chakaiya followed by NA-10 (Fig 3b).
Biochemical changes during storage of aonla fruits

The cultivar NA-7 was assessed for its shelf life under ambient condition (Table 2). In general, there was rapid increase in browning and loss of glossiness during storage of aonla. Total soluble solid increased up to 12 days of storage and then decreased. Similarly acidity increased but it showed inconsistent trend during different storage intervals. Vitamin C decreased by 30% from its initial value while tannin content increased by almost 96% at the end of 15 days storage period.

Table 2. Effect of storage duration on fruit quality of aonla cultivar NA-7 at ambient temperature (19-24°C)

<table>
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<th>Biochemical parameters</th>
<th>Storage period (days)</th>
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<th>9</th>
<th>12</th>
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<td>8.48</td>
<td>9.22</td>
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<td>2.11</td>
<td>2.30</td>
<td>2.22</td>
<td>2.35</td>
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<tr>
<td>Vitamin C (mg/100g)</td>
<td></td>
<td>467.54</td>
<td>452.50</td>
<td>401.24</td>
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<td>1.74</td>
<td>2.16</td>
<td>1.91</td>
<td>2.25</td>
<td>2.21</td>
</tr>
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</table>

5) Development of Aonla products

a) Aonla mouth freshener tablets

Aonla mouth freshener tablets were developed by using different ingredients such as aonla powder, sugar (mishri), saunf, mulathi, sweet supari mix, paan supari, black paper, black salt and eliachi. All the ingredients were mixed in powder form and the mixture was sieved using 1mm square screen. The tablets were made using Tablet

![Anola mouth freshner tablets](image_url)
making machine. From 1 kg mixture of various ingredients about 1000-1200 tablets having 0.50-0.70g weight were prepared. The product was found acceptable in all sensory attributes.

b) Ready to drink Aonla beverages
Washed aonla fruits were boiled in hot water for 15-20 minutes and pulp was extracted using pulper and aonla juice concentrate was prepared by adding water in 1:4 ratios. Aonla concentrate was used in preparation of aonla beverage with the use of other ingredients such as water, sugar, black paper, salt, ginger extract, colour, etc. of different Brix (16, 18, and 21°B). The shelf life of beverages was found to be 60 days with no adverse effect on the quality attributes.

c) Preserve and Candy
A segment of aonla fruit impregnated with sugar syrup till up to 48h, it becomes tender and transparent and dried for about 10 h at 60°C in tray dryer for the preparation of candy.

d) Mixed Fruit Anola Cheese
A study was carried out to optimize different fruit pulp ratios and to standardize the process parameters for mixed fruit aonla cheese by response surface methodology (RSM). The pulp used from the selected fruits like Aonla, pineapple, papaya and Guava. The pulp obtained from the selected fruits (Aonla, Pineapple, Papaya and Guava) were mixed in the proportions based on the RSM design.

After preliminary trials, the ingredients for product preparation were optimized as fruit pulp (250g), sugar (1.25kg), butter (70g), citric acid (3g) and salt (2g).

The desired quantity of extracted pulp from different fruits was poured in to a stainless steel vessel and mixed thoroughly and heated to 70°C, just to make the homogeneous mixture. Sugar, citric acid and butter was added to the pulp and heated with constant stirring at 70°C till the mixture became sufficiently thick (approximately one hour) then salt was added and again heated until the mass started leaving the sides of pan. The prepared hot cheese was then
Optimized mixed fruit aonla cheese

poured and spread to 6 mm thick layer on a tray which was coated with butter at the bottom to avoid the stickiness after setting. Then it was allowed to cool and set. After setting, the product was cut into square shape with the help of knife and packed in different packaging materials (viz. aluminium laminate, LDPE pouches and plastic cups) and kept for shelf-life study under refrigerated conditions.

Flow chart for preparation of mixed fruit aonla cheese

- Fruits (firm and ripe)
- Washing
- Cutting into thin slices
- Boiling with equal quantity of water (to soften pulp)
- Sieving (to remove seeds and skin) and making into fine pulp
- Adding sugar, citric acid and butter to pulp
- Mixing thoroughly
- Cooking till sufficiently thick
- Adding salt and colour
- Removing from heat (When the mass starts leaving side of pan)
- Spreading hot cheese in 0.6 cm thick layer on tray smeared with butter
- Allowing to cool and set
- Cutting into small pieces of suitable size
- Wrapping in butter paper or polythene sheet
- Packing in dry jar
- Sealing
Storage

The prepared products were evaluated for sensory quality and colour, water activity, moisture content, TSS, acidity, vitamin C, total sugars, reducing sugar, fat content, and ash content were estimated. Based on the sensory evaluation, the RSM design was analyzed, surface plots have been drawn and optima combination were identified. The optimized values of the ingredients for mixed fruit protein enriched aonla cheese were aonla, pineapple, papaya and guava as 63.586%, 14.030%, 12.384% and 10% respectively.

The physicochemical properties of the optimized sample are shown in Table 1. It was revealed that the mixed fruit aonla cheese is a good source of vitamin C in the health conscious world. It can serve as a mixed but nutritious tit-bit to children as well as adults.

**Quality attributes of Aonla cheese**

<table>
<thead>
<tr>
<th>Quality Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS (total soluble solid)</td>
<td>85°Brix</td>
</tr>
<tr>
<td>Titrable acidity</td>
<td>0.64%</td>
</tr>
<tr>
<td>Moisture content</td>
<td>9.29%</td>
</tr>
<tr>
<td>Water activity</td>
<td>0.51</td>
</tr>
<tr>
<td>Vitamin-C</td>
<td>87.486%</td>
</tr>
<tr>
<td>Protein estimation</td>
<td>1.80%</td>
</tr>
<tr>
<td>Reducing sugar</td>
<td>7.5%</td>
</tr>
<tr>
<td>Non-reducing sugar</td>
<td>11.25%</td>
</tr>
<tr>
<td>Total sugar</td>
<td>18.75%</td>
</tr>
<tr>
<td>Yeast and Mold</td>
<td>Nil</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>9.02064</td>
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<tr>
<td>Ca (mg/100g)</td>
<td>72.727</td>
</tr>
<tr>
<td>Phosphorus (mg/100g)</td>
<td>0.01855</td>
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<tr>
<td>Fe (mg/100g)</td>
<td>3.0755</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>1.1843</td>
</tr>
<tr>
<td>Color</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>21.94</td>
</tr>
<tr>
<td>A</td>
<td>8.93</td>
</tr>
<tr>
<td>B</td>
<td>5.84</td>
</tr>
</tbody>
</table>

The optimized mixed fruit aonla cheese was stored in aluminum laminates, plastic cups and LDPE pouches under refrigerated conditions for one month without any adverse effect on the quality. Thus, aonla fruit can successfully be utilized for preparation of mixed fruit aonla cheese.

e) **Semi-automatic aonla Processing Plant**
Aonla processing plant was established with aonla size grader, aonla fruit pricking machine, cabinet air dryer, aonla fruit shredder, hydraulic juice extractor and double jacketed kettle for processing of fruit into preserve, candy, pulp, juice and dehydrated products. The capacity of...
Farm women operating aonla shredding machine
different machineries were size grader 300 kg/h, aonla pricking machine 50-60 kg/h, shredder 100-120 kg/h, hydraulic juice extractor 200 kg/h and capacity of double jacketed kettle 100 litre. The plant can be operated for a large scale processing unit.

BER
1) Development of harvesting tool for Ber fruit
Harvesting tool was designed for the safe harvesting of Ber. It was fabricated by using a LDPE pipe of diameter 60.0mm and of length 2150mm. A hook is provided at one end of the pipe with suitable bend that pull the fruit from its stem and fruit is detached from the branch. Once the fruit is detached, it passes through the pipe and gets collected in bag which is held in pipe at another end. After filling of about half kg fruit in bag, the bag can be replaced by another one. The farmer can harvest about 50kg of fruits per hour whereas manually it ranges between 15-20 kg/h.
2) **Ber grader (Roller Type)**

Ber grader consists of moving rollers having different clearances for size grading of ber fruits. The unit is provided with 1 hp motor. The capacity of the ber grader is 200 kg/h with grading efficiency of 85-87\% for round shaped ber fruits of cultivar *gola*. The grader grades round shaped fruits into three grades having < 1.25, 1.25 - 1.75 and >1.75 inch dia fruits.

![Ber Grader (Roller Type)](image)

3) **Grader for oblong and round fruits**

In India, farm level grading of fruits and vegetables is still very less. Manual grading is costly, time consuming and the operation is affected due to less availability of labourers during peak periods. Ber (*Zizyphus mauritiana* L) is widely cultivated in different states of India. i.e. Madhya Pradesh, Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra and to limited extent in several parts of the country. Due to lack of research, handling and grading equipments especially for ber fruits are not available either in farm level or in commercial level. Since the commercial variety of ber fruits are ellipsoid, the spherical fruits grader are not efficient or not suitable, thus, a compact ber fruit grader was designed and developed. Large scale trial was conducted for ber and grading efficiency of 95\% was observed with less than 0.5\% mechanical damages.

**Machine Description**

The developed fruit grader is suitable for both at farm level as well as commercial level operations. The machine consists of a rotating disc of 80 cm diameter placed
horizontally. The disc is covered with 1 cm thick rubber sheet. A provision is made at the centre of disc to lift the rubber sheet for creating tapered surface of 1-20° from horizontal. At the periphery of disc, three grading boards of about 50 cm length are placed with a provision to adjust the clearance between disc and bottom of grading boards. The bottom end of board is covered with rubber to avoid mechanical damage to the fruits. These boards are adjustable according to the size grade required. The disc rotates at 10-50 RPM.

Feeding mechanism is the main feature of the grader. The fruits are fed about 20 cm inside the periphery of the disc. A guide plate of elliptical shape is placed for guiding fruits towards grading boards. It also helps in aligning the fruits by distal and proximal ends of fruits horizontally. This allows the grading of fruits by diameter of fruits. The fruits of oblong or round shape can be graded by their diameter only. Other dimensions do not affect the grading.

When the fruits reach near the first grading, they start rotating along the proximal and distal end line. Disc rotation carries the fruits along the periphery of the disc. The fruits of small size pass through the first grading board whereas oversize is carried away to next board. The grader separates the fruits into four grades.
Four outlets are made to collect the fruits. After passing through the grading boards, the fruits fall on collecting trough and can be collected in trays/boxes.

The final grades of ber were less than 30 mm, 30-40 mm, 40-50 mm and more than 50 mm of radial diameter for *Umeran* variety. Overall grading efficiency of the machine was 91% at 20 RPM and less than 0.5% damage. The capacity of machine was 300 kg/h at 20 RPM for ber. Increase in rotational speed resulted in decrease in grading efficiency.

The machine was evaluated for grading of aonla also. Overall grading efficiency for aonla was 96% at 25 RPM with less than 0.3% damage. Capacity of the machine at 25 RPM was 400 kg/h for aonla at 25 RPM. Photograph of the machine is shown below.

4) Development of semi-automatic destoner for ber  
A prototype of the ber destoning machine was fabricated and preliminary trials were conducted on ber fruit. However, the feeding operation is manual and the capacity is very low. The new version of machine includes six plungers for destoning along with other assembly for feeding, holding and collection mechanism. De-stoned Ber fruits could be used for preparation of candy, persevere, pulp, etc. The capacity of ber destoner is 70-80kg fruit per hour. However, due to mechanical chain and gear assembly, the damage to the fruit is more. Manual feeding of six ber fruit at a time limit its use at commercial scale. The rod used for removal of stone, also damage the fruits. Thus, further improvement is needed in the design.

Semi-automatic ber destoner
4.1 **Hand tool for destoning of ber:**
In order to improve the efficiency of removal of stone from ber fruits and its use in development of semi-automatic destoner, a hand tool for destoning of ber was designed. The dimensions of hand tool are 150 mm length, piercing knob and cut space for collecting of stone. The hand tool can further be used for development of pneumatic assisted semi-automatic destoner.

![Ber destoner hand tool](image)

5) **Osmo-air drying of Ber slices (Preparation of Ber Candy)**

The Ber slices were subjected to osmotic dehydration into 4 lots namely slices with peel blanched and un-blanched and without peel blanched and un-blanched. The blanched slices have lighter color than un-blanched one. They were subjected to osmotic dehydration in the sugar syrups at different conc. of 30, 40, 50 and 60ºB for 48 hrs at ambient temperature (28-35ºC) and then they were hot air dried in cabinet tray drier. The prepared Osmo-air dried ber slices were subjected to sensory evaluation. The slices without peel and blanched were more preferred in sensory evaluation.

![Ber candy](image)
6) **Ber beverage**

Ber beverage with different ingredients such as water, sugar, salt, black paper black salt ginger extract etc. was prepared and evaluated for sensory attributes. The product can be adopted at commercial scale/level by the entrepreneurs.

7) **Mixed Ber Fruit Leather**

Mature and ripe fruits (Ber, papaya, pineapple and guava) were procured and selected for the preparation of fruit leather. The leather was prepared by using pulp in different proportions Ber (50-70%), papaya (10-18%): pineapple (10-18%) and guava (10-15%) along

![Mixed ber fruit leather](image)

Mixed ber fruit leather

with soy residue (0-5%). Citric acid was added @0.3% to inhibit possible growth of micro-organisms during drying. The mixture was then heated for two minutes at 80°C and partially cooled; the heat treatment serves to inactivate the enzymes and micro-organisms. The TSS of mixture was adjusted to 30ºB. The mixture was dried at 60°C in tray drier and dried sheets of mixed fruit leather were cut unto rectangular bars, packed in polyethylene pouches. The product was rated highly acceptable in sensory evaluation.

8) **Ber Gummibuster**

For preparation of ber gummibuster the pulp from different fruits (Ber, Pineapple, and carrot) was mixed in the proportions based on the RSM design. Based on the preliminary trials, the ingredients were fixed as mixed fruit pulp (ber pulp, carrot juice, pineapple juice) 70 g, Sugar 32.5g, Pectin 1.75g, citric acid 0.22g, aonla shreds 1.5 g and Rose Extract 2.5 g. The mixture of fruit juices was poured in a stainless steel vessel and cooked at 100°C for 2-3 minutes to make the pulp mixture homogeneous. As the mixture started to boil, sugar, citric acid and aonla shreds were added and cooked again to thicken the mixture (56-58ºB). was poured in a tray, smeared with glycerol at the bottom, to avoid the stickiness after setting. After cooling,
the tray was kept in the refrigerator at 7-10°C to lay down. After setting, product was cut into square shape with help of knife and packed in the LDPE pouches (Flow chart).

**Flow chart for preparation of Ber based soft candy**

Selection of ripe, firm and mature fruits and carrots and rose petals

- Washing
- Peeling (Destoning for ber, coring for pineapple)
- Cutting, Extraction of pineapple juice
- Blanching (for ber and carrot)
- Pulping/juicing

**Flow chart**

- Washing Rose
- Boiling with water (1:5)
- Peeling (Destoning for ber, coring for pineapple)
- Boiling to half of original volume
- Cutting, Extraction of pineapple juice
- Rose extract
- Mixing
- Cooking for 3 minutes at 100°C
  - Addition of sugar, citric acid and aonla shreds
  - Cooking to thicken the mixture (56-58°B)
  - Addition of pectin paste (pectin + boiled juice)
  - Cooking up to 68-70°B
- Spreading hot mixture on tray smeared with glycerol
  - Cooling
  - Keeping in refrigerator to set
  - Cutting and packaging
  - Storage

Based on the sensory evaluation, the RSM design has been analyzed, surface plots have been drawn and optimal combination has been identified as under (Fig 1-3):

- The optimized values of the ingredients for mixed fruit protein enriched ber based soft candy is ber, pineapple and carrot are 38.585, 11.415 and 20 respectively.
• By cooking at low temperature there is better retention of color, vitamin C content, beta carotene value, texture, taste, flavor, overall acceptability.

Fig.1 Variation in color and flavor with different ingredients

Fig .2 Variation in taste and texture in different ingredients

• There was decrease in hardness as well as chewiness of the ber based soft candy with the passage of time. However, in aluminum laminates, little bit better retention was there as compared to polythene pouches.

• The developed ber based soft candy can be kept at refrigerated conditions to retain its characteristic quality parameters.
Fig:3 Variation in overall acceptability in different ingredients

JAMUN

1) **Jamun Fruit harvester and collecting nylon net platform:** Fruit harvester was developed for safe harvesting of Jamun. It is simple in design and could be fabricated using a MS pipe 20 feet long by the local artisans. A hook is provided at top of the harvester to pull the fruit from its stem and fruit is detached from the branch. The collecting nylon net is fixed in a revolving frame for collecting fruits without damage. The frame is made with the MS pipe in a circular manner. The height of collecting net is 5 feet and collection area is 25 m$^2$. Two pipes are fixed in concentric to reduce the size of machine during transportation. Two trees can be harvested per hour without any damage. The total gadget costs was Rs. 7000.

Manual harvesting of Jamun fruits
2) Fruit pulper for Jamun pulp extraction

For the extraction of pulp, the jamun fruit were heated along with small quantity of water (10%) to allow separation of pulp from seeds and passed through the pulper. The capacity of the pulper was found to be 100 kg/h with a pulp recovery of 50%, peel and seed 41% and only 9 percent wastage. The method was optimized for pulp extraction from jamun fruits.

3) Preparation and evaluation of mint based jamun beverages

The feasibility of mint fortified jamun beverages like RTS and squash for utilization of jamun pulp was evaluated. RTS drink was prepared with 10% pulp, 12% TSS and 0.25%
acidity while squash was manufactured by adding 25% pulp, 45% sugar and 1.2% acidity. Mint leaf extract was added to the fruit pulp at rate of 0, 2.5, 5.0, 7.5 and 10.0% for preparation of each product. The developed products were evaluated for their sensory and biochemical composition. The result exhibited the highest organoleptic rating for the RTS drink blended with 5.0% mint leaf extract whereas for squash, 10.0% mint leaf extract was suited best for the highest overall rating.

![Image of Mint based Jamun Squash](image)

**Fig 1. Organoleptic rating of mint fortified jamun beverages**

- **RTS drink**
- **Squash**
4) Drying of Jamun pulp in tray dryer

Drying kinetics of jamun pulp was studied using tray dryer. The undamaged fruits were separated and washed with tap water to remove dust and foreign particles. Then the surface water was removed using tissue paper. The pulp of jamun was extracted using fruit pulper. Pulp was then poured into a stainless steel container, sealed and stored in a deep freezer (-10°C, M/s Micro Scientific Works, New Delhi). Drying of the pulp was done in a cabinet dryer (M/s Micro Scientific Works, New Delhi) at three temperatures viz. 50, 60 and 70°C.

**Drying kinetics**

The time required to dry the jamun pulp from initial moisture content to near equilibrium moisture content was 18.5, 17, 13.5 h at 50, 60 and 70°C respectively. At higher temperature the drying time was less due to high diffusion rate. The decrease of drying time with increase of drying temperature might be due to increase in water vapour pressure within the pulp, which increased the migration of moisture.

The pulp exhibited the characteristic exponential drying behaviour whereby an initial high rate of drying was followed by slower rate of drying in later stages. Similar behaviour of drying for various fruits has been reported in literature (Ghasemzadeh et al., (2010), Mabellini (2005), Kingsly and Singh (2007)). The drying rate ceases as drying time elapsed and attained an equilibrium moisture content at a particular drying temperature. The effect of drying time in decreasing of moisture content is shown in the Fig.4.
A plot of the temporal variation of the computed drying rates established the duration of the constant rate and falling rate periods in the drying process. The effect of three drying temperatures on drying rate curve of the jamun pulp is shown in Fig. 5.

As can be seen from Fig. 5, the drying of Jamun was observed in constant rate period in initial phase and then in falling rate periods. In the end, the drying rate almost seized due to equilibration. The drying took place in constant rate period initially followed by falling rate periods. Two falling rate periods were observed (Fig. 4). The first falling rate period initiated at moisture contents of about 2.0 kg/kg dry matter. The second falling rate period started at the moisture content of about 0.48 kg/kg dry matter. It corresponded to the moisture content of the inflexion point where the high drying rate was transformed into very low drying rate and finally attained equilibrium moisture.
Fig.5. Variation of drying rate with drying time of jamun pulp

Mathematical modelling

The moisture content data observed during the study were fitted to the 10 models. The statistical results of the different models, including the drying model coefficients and the comparison criteria used to evaluate goodness of fit, namely, $R^2$, SEE, MRD and RSS values. The regression coefficients of Newton model, Handerson and Pabis, Peleg model, Page, modified page model, Simplified Fick’s, Two term model, Wang and Singh model, Modified Page equation-2 and Logarithmic model are reported in Table 5.
Table 5: Fitting of models to drying data of jamun pulp for constant rate period.

<table>
<thead>
<tr>
<th>Models Name</th>
<th>Temp(°C)</th>
<th>Equation parameters</th>
<th>R²</th>
<th>SEE</th>
<th>MRD</th>
<th>RSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>k</td>
<td>n</td>
</tr>
<tr>
<td>Newton's model</td>
<td>50</td>
<td>0.158</td>
<td>0.948</td>
<td>64.644</td>
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<tr>
<td></td>
<td>60</td>
<td>0.171</td>
<td>0.927</td>
<td>76.434</td>
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<tr>
<td></td>
<td>70</td>
<td>0.217</td>
<td>0.928</td>
<td>76.197</td>
<td>4.931</td>
<td></td>
</tr>
<tr>
<td>Handerson and pabis model</td>
<td>50</td>
<td>1.119</td>
<td>0.175</td>
<td>0.961</td>
<td>0.377</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>1.137</td>
<td>0.192</td>
<td>0.944</td>
<td>0.472</td>
<td></td>
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<tr>
<td></td>
<td>70</td>
<td>1.121</td>
<td>0.241</td>
<td>0.945</td>
<td>0.373</td>
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<td>Peleg model</td>
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<td>0.678</td>
<td>1.100</td>
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<td></td>
<td>60</td>
<td>3.977</td>
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<td>0.014</td>
<td>0.642</td>
<td>1.165</td>
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<tr>
<td></td>
<td>70</td>
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<td>1.160</td>
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<td>0.165</td>
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<tr>
<td></td>
<td>60</td>
<td>0.041</td>
<td>1.725</td>
<td>0.990</td>
<td>0.193</td>
<td>15.493</td>
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<tr>
<td></td>
<td>70</td>
<td>0.087</td>
<td>1.538</td>
<td>0.990</td>
<td>0.131</td>
<td>19.399</td>
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<tr>
<td>Modified page model</td>
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<td>1.529</td>
<td>0.992</td>
<td>0.136</td>
<td>14.897</td>
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<tr>
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<td>60</td>
<td>0.159</td>
<td>1.725</td>
<td>0.990</td>
<td>0.193</td>
<td>15.495</td>
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<td>70</td>
<td>0.204</td>
<td>1.538</td>
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<td>19.400</td>
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<td>Simplified Fick's model</td>
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<td>60</td>
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<td>0.560</td>
<td>0.175</td>
<td>0.175</td>
<td>0.962</td>
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<td>-------</td>
<td>-------</td>
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<td>-------</td>
</tr>
<tr>
<td>Two term model</td>
<td>60</td>
<td>0.556</td>
<td>0.566</td>
<td>0.199</td>
<td>0.217</td>
<td>0.966</td>
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<tr>
<td></td>
<td>70</td>
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<td>0.55</td>
<td>0.25</td>
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<td>Wang and Sing's model</td>
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<td>-0.112</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>60</td>
<td>-0.134</td>
<td>0.004</td>
<td></td>
<td></td>
<td>0.994</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>-0.155</td>
<td>0.0059</td>
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<td>0.995</td>
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<td>Modified Page eqn 2</td>
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<td>0.940</td>
<td>4.593</td>
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<td></td>
<td>60</td>
<td>0.951</td>
<td>5.879</td>
<td>1.677</td>
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<td>0.997</td>
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<td></td>
<td>70</td>
<td>0.960</td>
<td>7.843</td>
<td>1.651</td>
<td></td>
<td>0.996</td>
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<td>Logarithmic model</td>
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<td></td>
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<td></td>
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<td>1.275</td>
<td>-1.224</td>
<td>0.157</td>
<td></td>
<td>0.989</td>
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</table>
It could be observed from Table 5 that the modified Page Eqn-2 described the drying kinetics of jamun pulp satisfactorily for all temperatures in both constant and drying rate periods.

**Effect of Drying on Colour, pH, Vitamin C and Acidity of Jamun Pulp**

To give a comparative view of change in various organoleptic properties the data are listed below in Table 6.

**Table 6: Effect of drying on chemical composition and colour of jamun pulp**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Content (%)</th>
<th>Initial value</th>
<th>After drying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>50°C</td>
</tr>
<tr>
<td>Moisture content (% d.b.)</td>
<td></td>
<td>597.9</td>
<td>24.63</td>
</tr>
<tr>
<td>Colour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td>23.49</td>
<td>23.301</td>
</tr>
<tr>
<td>a</td>
<td></td>
<td>66.484</td>
<td>9.20</td>
</tr>
<tr>
<td>b</td>
<td></td>
<td>5.04</td>
<td>5.70</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td></td>
<td>1.153</td>
<td>1.488</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>Vitamin C (mg/100g)</td>
<td></td>
<td>16.15</td>
<td>14.59</td>
</tr>
</tbody>
</table>

It could be observed that the vitamin C decreased during drying. The loss of vitamin C increased with increase in drying temperature. Thus, the drying temperature had deleterious effect on nutritive value of jamun pulp.

The characteristics of jamun pulp with about 3.5 mm of the thickness in a hot air cabinet dryer was studied, the thin layer drying kinetics was analyzed, and the results indicated that the Modified Page Eqn-2 fitted the drying experimental data better than the others. The whole drying process of jamun pulp took place in constant rate period initially and then in two falling rate periods. The moisture content of the inflexion point where the constant rate period was transformed into the first falling rate period was about 2.0 kg water/kg dry matter. The moisture content of the inflexion point where the first falling rate period was transformed into the second falling rate period was about 0.48 kg water/kg dry matter. The vitamin C content of the pulp was affected by drying temperature and decreased with increase in temperature.
5) Effect of foaming agent on characteristics of jamun pulp

The foam mat drying of jamun pulp was carried out in cabinet dryer and their effects were evaluated. Freshly harvested jamun fruit were obtained from the local market. Ripened and disease free fruit were selected by manual sorting of fruits. The selected fruits were washed in sodium hypochlorite solution of 200 ppm for five minutes. The peel, seed, and pulp were separated by hand and different proportion of fruit was worked out by taking average of ten fruits. The washed fruit was pulped using a pulper. The pulp/juice thus obtained was stored in deep freezer for further experimentation.

Effect of egg albumin (0.5, 10, 15, and 20 %) was determined in order to assess the foaming efficiency of jamun pulp for foam mat drying. The results indicated that foaming efficiency increased with the increase in the concentration of egg albumin and whipping time (Table 7). However maximum foaming expansion was observed when whipping was performed for three minute. The whipping of jamun pulp with egg albumen turn the pulp into foam with reduced density to 0.65g per cubic centimeter with 15 % egg albumin as against 1.02g per cc for unfoamed pulp. Both foam volume and foam expansion increased while foam density decreased with the increase in the concentration of foaming agent up to 15 % and then there was increase in foam density with a corresponding decrease in foam expansion.

Table 7. Characteristics of jamun pulp as affected by different foaming concentration

<table>
<thead>
<tr>
<th>Foaming agent (%)</th>
<th>Wt. of non-foamed pulp (g)</th>
<th>Vol. of non-foamed pulp (cm³)</th>
<th>Bulk density of non-foamed pulp (g/cm³)</th>
<th>Foam volume (cm³)</th>
<th>Foam expansion (%)</th>
<th>Foam density (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 EA</td>
<td>203</td>
<td>200</td>
<td>1.02</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5 EA</td>
<td>214</td>
<td>210</td>
<td>1.02</td>
<td>220</td>
<td>5</td>
<td>0.97</td>
</tr>
<tr>
<td>10 EA</td>
<td>225</td>
<td>220</td>
<td>1.02</td>
<td>290</td>
<td>29</td>
<td>0.78</td>
</tr>
<tr>
<td>15 EA</td>
<td>235</td>
<td>230</td>
<td>1.02</td>
<td>360</td>
<td>57</td>
<td>0.65</td>
</tr>
<tr>
<td>20 EA</td>
<td>249</td>
<td>240</td>
<td>1.03</td>
<td>340</td>
<td>41</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Process of foaming:

The egg albumen was poured into pulp in appropriated proportion and foam was prepared with the help of whipping machine. This was an electrically operated machine which had high revolving blades. When the machine was operated into pulp for specified time, the revolving blade incorporated air into pulp/juice. The machine was operated for a whipping time of 1 to 5 min for pulp foaming and juice foaming. The air incorporated pulp/juice was considered as foam. After certain time it was observed that foam had been decreasing. Hence to enhance its
stability CMC (carboxy methyl cellulose) was added at the rate of 0.2% in jamun pulp after foaming. The mixing of stabilizer into the foamed pulp/juice was carried out for 30 seconds with the help of beater. The foam was poured into the tray in thin layers of 0.5, 1 and 2 mm. The foamed pulp/juice was dried in cabinet dryer at 50 to 70°C. The drying phenomenon was recorded at an interval of 30 min till moisture content of the end product reaches to 5-7%.

The properties of foam like foam expansion, foam stability and foam density were observed at different concentrations and on these bases the best one was selected.

**Drying behavior**

Unfoamed jamun pulp took longer time to reach the state of constant moisture at the end of drying as compared to the foamed one (Fig. 6). Also the drying time considerably reduced with increase in the temperature of cabinet dryer for both foamed and unfoamed pulp. Unfoamed pulp took 90 min and it was significantly reduced to 60 min when foamed jamun pulp was dried at 60°C, however, this did not differ significantly from the foamed pulp dried at 70°C. Drying at 50°C took the longest time (150 min) to reach the desired moisture level in unfoamed pulp compared to the foamed pulp which took 90 minutes under similar drying temperature. It may be concluded that foam mat drying is faster than unfoamed drying.

![Drying behavior of foamed jamun pulp of 1 mm thickness](image-url)
Effect of thickness on drying of foamed jamun pulp

The effect of foam thickness on the moisture content of foamed pulp and juice during drying at 50°C are shown in Fig. 7. It can be observed that constant moisture content was attained much earlier by 0.5 and 1 mm as compared to 2 mm thick pulp. However, there was no significant difference in drying time of 0.5 and 1 mm thick jamun pulp. Similar trend was observed for drying of foam at 60 and 70°C.

Fig. 7. Effect of pulp thickness on drying time of foamed jamun pulp at 50°C

Jamun pulp was dried by foam mat technique using egg albumin as foaming agent. The optimum dose of foaming agent as egg albumin was found to be 15%. Foam stability was best when the pomegranate juice was stabilized with 2% stabilizer. Faster drying rate was recorded when 1 mm thick jamun pulp was dried at 60°C.

However, the dried powder imparted egg flavor and taste which was not found acceptable among consumers. Thus, the suitability of carboxy methyl cellulose (CMC) and sodium lauryl sulphate (SDS) as foaming agent was evaluated. The jamun pulp was turned into a foam using proportion of 2% CMC and 0.5% SDS and used for drying.

CUSTARD APPLE

1) Automatic machine for scooping out pulp from custard apple fruits
The custard apple pulper contains three mechanism viz. fruit cutting mechanism, fruit scooping mechanism and pulping mechanism. Fruit cutting and scooping mechanism are made with pneumatic actuators and electronic controls. This invention is fully automatic machine assisted
with pneumatic power and electronically controlled. The capacity of the cutting and scooping mechanism is 120 kg/hr and efficiency: 94% pulp recovery, 6% pulp wastage along with peels. The capacity of pulping mechanism is 120 kg/hr and efficiency: Coarse/Intact Pulp recovery: 70-72%; Fine Pulp recovery: 28-30%. 

Automatic custard apple scooper

Custard apple pulp extractor
A machine was designed to separate custard apple pulp from seed. The machine comprises of a food grade stainless steel stainer of cylindrical shape. The cylinder is inclined at 10° from horizontal, which can be changed according to the requirement and raw material. A cutting blade is mounted on a food grade stainless steel shaft which is placed at the center of cylinder. The shaft rotates at 300-900 rpm depending upon the requirement of particle size for further processing. The lower speed results in separation of seeds with pulp whereas the higher speed results in pulp of smaller particle size.

A food grade stainless steel screen is fitted at the outlet end of cylinder to separate pulp from seeds. The machine is operated by 1 hp electric motor. The machine gives capacity of 60-100 kg/h depending upon the rotational speed of cutting blades.

The custard apple bulbs are fed to the machine. Rotating blades tear the bulb and seed is separated from the bulb. The whole mass is conveyed to the outlet due to gravity and falls on the screen. Pulp goes down whereas seeds are retained by the screen.
Table 8  Physical properties of custard apple and value addition

<table>
<thead>
<tr>
<th>Physical property</th>
<th>Firmness properties</th>
<th>Seed/Pulp properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length –7.61 cm</td>
<td>Rupture force –</td>
<td>Weight – 351.03 mg</td>
</tr>
<tr>
<td>Width – 8.4 cm</td>
<td>Immature-14.85 N</td>
<td>Length – 15.60 mm</td>
</tr>
<tr>
<td>Thickness–8.01 cm</td>
<td>Mature fruits-8.65 N</td>
<td>Width – 7.79 mm</td>
</tr>
<tr>
<td>wt. of fruit – 246.04g</td>
<td>Ripe - 6.305 N</td>
<td>Thickness– 5.44 mm</td>
</tr>
<tr>
<td>no of scales – 99</td>
<td>Rupture energy –</td>
<td>TSS</td>
</tr>
<tr>
<td>no of seeds – 70</td>
<td>Immature fruit :90 N-</td>
<td>Mature - 24.3</td>
</tr>
<tr>
<td>% pulp – 26.7 (without</td>
<td>mm</td>
<td>Ripe - 26.5</td>
</tr>
<tr>
<td>scrapping seeds)</td>
<td>Mature fruits:55.87N-</td>
<td>Immature-22.2</td>
</tr>
<tr>
<td>% seed – 14</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>% scales - 53</td>
<td>Ripe fruit :37.23N-mm</td>
<td></td>
</tr>
<tr>
<td>True density – 1840 kg/m3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2)  Custard apple beverage (RTS)

Preliminary trials for preparation of RTS beverage using custard apple were performed. Ripe custard apple fruits were taken and the outer projections were removed manually. The seed was separated manually and the pulp was mixed to make uniform mixture by using mixer. The other ingredients used in preparation of beverage were sugar along with citric acid. The RTS beverage with different brix (10, 12, 14) were developed by adding fruit pulp (10, 15, 20%), and citric acid (0.2, 0.25, 0.35%). The beverage with 10% pulp, 10°B TSS and 0.25% acidity was more acceptable.

Tray Dryer

Tray dryer was developed for dehydration of fruits. It has a unique design of plenum chamber which facilitates horizontal as well as vertical hot air movement. This concept has minimized the problem of non-uniform drying of food materials in different trays in the tray dryer.
6. Innovations
(Describe about the innovations and their impacts, one page each, please be clear about innovation concept and describe only innovation(s) in brief)

a. Custard Apple Pulper

The custard apple pulper contains three mechanism viz. fruit cutting mechanism, fruit scooping mechanism and pulping mechanism. Fruit cutting and scooping mechanism are made with pneumatic actuators and electronic controls. This invention is fully automatic machine assisted with pneumatic power and electronically controlled.

Fruit Cutting Mechanism
This part of machine cuts fruit into two halves which contains two opposite rotating rollers with fruit holding cups. The fruit holding cups are arranged in a way that the fruit is held without any damage and guided while cutting and falling time on the guide plate is provided below the cutting mechanism. The guide plate will give support to the knife, at the same time it also helps the two halves of fruit to fall downwardly (cutting side facing down).

Fruit Scooping Mechanism
This part of machine where scooping of pulp along with seed taking place and it has three parts viz. peel holding sieve, pressing mechanism and scooping mechanism.

Pulping mechanism
This part of machine contains a special sieve and pulping shaft with beaters. The sieve is made with special design to maintain the shape of the pulp which is present with the seed. The speed of the pulping beater and inclination of the pulping chamber is optimized.

Specifications
i) Cutting & Scooping Mechanism
   Overall Dimensions: 180 cm × 120 cm × 140 cm

ii) Pulping Mechanism
    Overall Dimensions: 100 cm × 75 cm × 80 cm

Results
i) Cutting & Scooping Mechanism
   Capacity: 120kg/hr
   Efficiency: 94% pulp recovery, 6% pulp wastage along with peels, 11% peel in pulp outlet

ii) Pulping Mechanism
    Optimized specifications
Capacity: 120kg/hr
Efficiency: Coarse/Intact Pulp recovery: 70-72%; fine pulp recovery: 28-30%

b. **Jamun Fruit harvester and fruit collecting nylon net platform**: Fruit harvester was developed for safe harvesting of Jamun. It is simple in design and could be fabricated using a MS pipe 20 feet long by the local artisans. A hook is provided at top of the harvester to pull the fruit from its stem and fruit is detached from the branch. The collecting nylon net is fixed in a revolving frame to the trunk of tree for collecting fruits without damage. The frame is made with the MS pipe in a circular manner. The height of collecting net is 5 feet and collection area is 25 m². Two pipes are fixed in concentric to reduce the size of machine during transportation. Two trees can be harvested per hour without any damage. The total gadget costs was Rs. 7000.

![Jamun fruit harvester](image)


c. **Compact fruit grader**: In India, farm level grading of fruits and vegetables is still very less. Manual grading is costly, time consuming and the operation is affected due to less availability of labourers during peak periods. Ber (*Zizyphus mauritiana* L) is widely cultivated in different states of India. i.e. Madhya Pradesh, Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra and to limited extent in several parts of the country. Due to lack of research, handling and grading equipments especially for ber fruits are not available either in farm level or in commercial level. Since the commercial variety of ber fruits are ellipsoid, the spherical fruits grader are not efficient or not suitable, thus, a compact ber fruit grader was designed and developed. Large scale trial was conducted for ber and grading efficiency of 95% was observed with less than 0.5% mechanical damages.

d.
Machine Description

The developed fruit grader is suitable for both at farm level as well as commercial level operations. The machine consists of a rotating disc of 80 cm diameter placed horizontally. The disc is covered with 1 cm thick rubber sheet. A provision is made at the centre of disc to lift the rubber sheet for creating tapered surface of 1-20° from horizontal. At the periphery of disc, three grading boards of about 50 cm length are placed with a provision to adjust the clearance between disc and bottom of grading boards. The bottom end of board is covered with rubber to avoid mechanical damage to the fruits. These boards are adjustable according to the size grade required. The disc rotates at 10-50 RPM.

Feeding mechanism is the main feature of the grader. The fruits are fed about 20 cm inside the periphery of the disc. A guide plate of elliptical shape is placed for guiding fruits towards grading boards. It also helps in aligning the fruits by distal and proximal ends of fruits horizontally. This allows the grading of fruits by diameter of fruits. The fruits of oblong or round shape can be graded by their diameter only. Other dimensions do not affect the grading.
When the fruits reach near the first grading, they start rotating along the proximal and distal end line. Disc rotation carries the fruits along the periphery of the disc. The fruits of small size pass through the first grading board whereas oversize is carried away to next board. The grader separates the fruits into four grades.

Four outlets are made to collect the fruits. After passing through the grading boards, the fruits fall on collecting trough and can be collected in trays/ boxes.

The final grades of ber were less than 30 mm, 30-40 mm, 40-50 mm and more than 50 mm of radial diameter for Umeran variety. Overall grading efficiency of the machine was 91% at 20 RPM and less than 0.5% damage. The capacity of machine was 300 kg/h at 20 RPM for ber. Increase in rotational speed resulted in decrease in grading efficiency.

The machine was evaluated for grading of aonla also. Overall grading efficiency for aonla was 96% at 25 RPM with less than 0.3% damage. Capacity of the machine at 25 RPM was 400 kg/h for aonla at 25 RPM. Photograph of the machine is shown below.

7. **Process/ Product/Technology/ Value Chain/ Rural Industry Developed**

(List partner-wise major Process/ Product/Technology developed and their outcome in quantifiable terms)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>(Process/Product/Technology/ Value Chain/ Rural Industry Developed)</th>
<th>Adoption/ Validation/ Commercialization, etc.</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mixed Fruit Aonla Cheese</td>
<td>Hands on training prepared to the entrepreneurs</td>
<td>CIPHET Abohar</td>
</tr>
<tr>
<td>2.</td>
<td>Ber Gummibuster</td>
<td>-------do-------------</td>
<td>-------do----</td>
</tr>
<tr>
<td>3.</td>
<td>Custard apple pulp extractor</td>
<td>Licensed and commercialized</td>
<td>-------do----</td>
</tr>
<tr>
<td>4.</td>
<td>Mint based jamun squash &amp; RTS drink</td>
<td>Hands on training prepared to the entrepreneurs</td>
<td>-------do----</td>
</tr>
<tr>
<td>5.</td>
<td>Fruit harvester</td>
<td>Hand on training prepared to the farmers</td>
<td>-------do----</td>
</tr>
<tr>
<td>6.</td>
<td>Compact fruit grader</td>
<td>Refinement</td>
<td>-------do----</td>
</tr>
<tr>
<td>7.</td>
<td>Collection platform</td>
<td>Hands on training</td>
<td>-------do----</td>
</tr>
<tr>
<td>8.</td>
<td>Semi-automatic Aonla processing line</td>
<td>Hands of training EDP</td>
<td>-------do----</td>
</tr>
</tbody>
</table>

Note: Use pro-forma (1,2, 3) for details.
8. Patents (Filed/Granted)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Title of Patent</th>
<th>Inventor(s) (Name &amp; Address)</th>
<th>Filed/Published/Granted (No./Date)</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CIPHET, Abohar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Linkages and Collaborations

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Linkages developed (Name &amp; Address of Organization)</th>
<th>Date/Period From-To</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Custard apple pulper manufacturer M/s NEXGEN Drying Systems Pvt Ltd, Street Nr 166, Pune</td>
<td></td>
<td>CIPHET, Abohar</td>
</tr>
<tr>
<td>2</td>
<td>NITCON, North India Technical Consultancy Organization (NITCON) Ltd, Chandigarh</td>
<td></td>
<td>CIPHET, Abohar</td>
</tr>
<tr>
<td>3</td>
<td>Punjab Agro Juices Ltd, Alamgarh, Abohar</td>
<td>--------do----------</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Farmer’s First Mahygarh, Abohar</td>
<td>--------do----------</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nissan Foods, Abohar</td>
<td>--------do----------</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Zimidara Farmers, Fazilika</td>
<td>--------do----------</td>
<td></td>
</tr>
</tbody>
</table>

10. Status on Environmental and Social Safeguard Aspects
(Please see NAIP website for clarity on the subject)

**Environmental Issues:**

Fruit collecting nylon net platform collects all fruits in a collection crate without causing any bruise to the fruits thus reducing the wastage. Uniform grading by fruit grader checks carryover of any bruised under/size or insect/rodent damaged fruits to the market thus helps collection of garbage at one single point. Better utilization of ber, custard apple, aonla and jamun fruits reduces environmental pollution.

**Women empowerment:**

The developed technologies are simple, low cost and efficient suitable for adoption by the women enterprises thus empowers them to be self-sustainable. Many products earlier made at a home scale can be undertaken at a commercial level by the women entrepreneurs.

**11. Constraints, if any and Remedial Measures Taken**

NIL

**12. Publications** (As per format of citation in Indian Journal of Agricultural Sciences)

A. Research papers in peer reviewed journals. Details as per the guidelines for citation of publications (Annexure I)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Authors, Title of the paper, Name of Journal, Year, Vol. &amp; Page No.</th>
<th>NAAS Ratings</th>
<th>Responsible Partner</th>
</tr>
</thead>
</table>

B. Books/ Book chapters/ Abstracts/ Popular articles, Brochures, etc.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Authors, Title of the papers</th>
<th>Responsible Partner</th>
</tr>
</thead>
</table>

13. Media Products Developed/Disseminated

<table>
<thead>
<tr>
<th>S. No.</th>
<th>CD, Bulletins, Brochures, etc. (Year wise)</th>
<th>No. of Copies</th>
<th>Distribution</th>
<th>Responsible Partner</th>
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</thead>
</table>

14. Meetings/Seminars/Trainings/Kisan Mela, etc. organized

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details of Meetings/Seminars/Trainings, etc.</th>
<th>Duration (From-To)</th>
<th>No. of Personnel Trained</th>
<th>Budget (₹)</th>
<th>Organizer (Name &amp; Address)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Entrepreneur development program on processing and utilization of Aonla</td>
<td>Dec 16-18, 2013</td>
<td>4</td>
<td>_</td>
<td>Ramesh Kumar Co-PI, CIPHET, Abohar</td>
</tr>
<tr>
<td>2.</td>
<td>Processing of aonla and ber for women entrepreneurs</td>
<td>One day, Jan 2012</td>
<td>20</td>
<td>_</td>
<td>Dr Vishwakarma, CIPHET, Abohar</td>
</tr>
<tr>
<td>3.</td>
<td>Training on processing on aonla</td>
<td>Feb, 2012</td>
<td>12</td>
<td></td>
<td>Dr Vishwakarma, CIPHET, Abohar</td>
</tr>
<tr>
<td>4.</td>
<td>Training on processing and value addition of aonla</td>
<td>29 Nov 2011</td>
<td>50</td>
<td></td>
<td>Dr Vishwakarma, CIPHET, Abohar</td>
</tr>
<tr>
<td>5.</td>
<td>Training on processing and value</td>
<td>18 Oct 2011</td>
<td>30</td>
<td></td>
<td>Dr Vishwakarma, CIPHET, Abohar</td>
</tr>
</tbody>
</table>
15. Participation in Conference/ Meetings/Trainings/ Radio talks, etc.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details of Meetings/Seminars/ Trainings/Radio talk, etc.(Name &amp; Address)</th>
<th>Duration (From-To)</th>
<th>Budget (₹)</th>
<th>Participant (Name &amp; Address)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Radio talk of Dr R K Gupta on the subject vYi iz;qDr p;fur Qyksa dk izlaLdj.k % jkstxkj ds u;s volj in All India Radio Station, Jalandhar</td>
<td>27-07-2011</td>
<td></td>
<td>Dr R K Gupta Head, HCP, CIPHET, Abohar</td>
</tr>
</tbody>
</table>

16. Foreign Trainings/ Undertaken (National/ International) Nil

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name, Designation and Address of the Person</th>
<th>Place of Training</th>
<th>Area of Training</th>
<th>Time and Duration</th>
<th>Total Cost (₹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. Performance Indicators (from inception to completion)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Indicator</th>
<th>Total No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>No. of production technologies released and/or adopted</td>
<td>N.A</td>
</tr>
<tr>
<td>2.</td>
<td>No. of processing technologies released and/or adopted</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Number of technologies/products commercialized based on NAIP research</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>No. of new rural industries/enterprises established/ upgraded</td>
<td>-</td>
</tr>
<tr>
<td>5.</td>
<td>No. of product groups for which quality grades developed and agreed</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Total no. of private sector organizations (including NGOs) participating in consortium</td>
<td>N.A</td>
</tr>
<tr>
<td>7.</td>
<td>No. of farmers involved in consortia activities</td>
<td>20</td>
</tr>
</tbody>
</table>
8. Total number of farmers’ group developed for marketing and processing 1
9. Number of patent/intellectual property protection applications filed based on NAIP research 2
10. Number of patents/intellectual property protections granted/published based on NAIP research -
11. Number of scientists trained overseas in the frontier areas of science -
12. Number of scientists trained overseas in consortium-based subject areas -
13. No. of scientists participated in conference/seminar etc. abroad 2
14. No. of training organized/ farmers trained Training No. 5 Farmers No. 96
15. Success stories -
16. Incremental employment generated (person days/year/HH) Baseline N.A Final -
17. Increase in income of participating households (` per annum) Baseline 1-2% Final 5-7%
18. Number of novel tools/protocols/methodologies developed 5
19. **Publications**
   - Articles in NAAS rated journals 2
   - Articles in other journals -
   - Book(s) -
   - Book chapter(s) -
   - Thesis -
   - Popular article(s) (English) -
   - Newspaper article(s) -
   - Seminar/Symposium/Conference/Workshop Proceedings 2
   - Technical bulletin(s) -
   - Manual(s) -
   - CDs/Videos -
   - Popular article(s) in other language -
   - Folder/Leaflet/Handout -
   - Report(s) 3

18. Employment Generation (man-days/year)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Employment Generation</th>
<th>Employment Generation up to End of Sub-project</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Equipment manufacturer M/S Nexgen Drying Systems Pvt Ltd Pune</td>
<td>1</td>
<td>CIPHET, Abohar</td>
</tr>
<tr>
<td>2.</td>
<td>Ms Alka Sharma (RA)</td>
<td>1</td>
<td>CIPHET, Abohar</td>
</tr>
</tbody>
</table>
### 3. Ms Reena Chandel (SRF)

**1**

CIPHET, Abohar

### 4. Skilled Worker

**1**

CIPHET, Abohar

### 19. Assets Generated

(Details to be given on equipments and works undertaken in the sub-project, costing more than `10,000/- in each case)

#### (i) Equipment/ Vehicles/ Research Facilities

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Equipment with Manufacturers name, Model and Sr.No</th>
<th>Year of purchase</th>
<th>Quantity (Nos)</th>
<th>Total Cost()</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lypholizer m/S Macro scientific works pvt.Ltd Delhi</td>
<td>2009-2010</td>
<td>01</td>
<td>3,28,200</td>
<td>CIPHET- ABOHAR</td>
</tr>
<tr>
<td>2</td>
<td>Work Table M/s Samrat Furniture mart college road Abohar</td>
<td>2009-2010</td>
<td>01</td>
<td>24990</td>
<td>CIPHET, Abohar</td>
</tr>
<tr>
<td>3</td>
<td>Moisture Analyzer M/s Varun Scales, Banglore</td>
<td>2010-2011</td>
<td>01</td>
<td>65830</td>
<td>-do-</td>
</tr>
<tr>
<td>4</td>
<td>Environmental chamber M/s Macro Scientific works P Ltd - Delhi</td>
<td>2010-2011</td>
<td>01</td>
<td>1,87,200</td>
<td>-do-</td>
</tr>
<tr>
<td>5</td>
<td>Deep Freezer M/s Macro Scientific works P Ltd - Delhi</td>
<td>2010-2011</td>
<td>01</td>
<td>2,17,525</td>
<td>-do-</td>
</tr>
<tr>
<td>6</td>
<td>Electric Tray Dryer M/s Macro Scientific works P Ltd - Delhi</td>
<td>2010-2011</td>
<td>01</td>
<td>1,33,200</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>Digital pocket refactometer M/s Atago India Instruments Pvt Ltd, Dongri</td>
<td>2010-2011</td>
<td>01</td>
<td>37700</td>
<td>-do-</td>
</tr>
<tr>
<td>8</td>
<td>Aonla Size Grader M/s Osaw Agro Industries Pvt Ltd Ambala Cantt.</td>
<td>2010-2011</td>
<td>01</td>
<td>2,56,745</td>
<td>-do-</td>
</tr>
<tr>
<td>9</td>
<td>Aonla prickling Machine M/s Osaw Agro Industries Pvt Ltd Ambala Cantt</td>
<td>2010-2011</td>
<td>01</td>
<td>2,47,230</td>
<td>-do-</td>
</tr>
<tr>
<td>10</td>
<td>Aonla juice Extraction machine with jacketed kettle M/s Engineers Consotions Ambala Cantt</td>
<td>2010-2011</td>
<td>01</td>
<td>2,33,048</td>
<td>-do-</td>
</tr>
<tr>
<td>11</td>
<td>Aonla Shredder machine M/s Engineers Consotions Ambala Cantt</td>
<td>2010-2011</td>
<td>01</td>
<td>1,34,625</td>
<td>-do-</td>
</tr>
<tr>
<td>12</td>
<td>Custard apple and pulping machine Designed &amp; Fabricated at Institute workshop</td>
<td>-do-</td>
<td>-do-</td>
<td>43,124</td>
<td>-do-</td>
</tr>
<tr>
<td>12</td>
<td>Ber Destoner (Plunger type) Designed &amp; Fabricated at Institute</td>
<td>-do-</td>
<td>-do-</td>
<td>36,420</td>
<td>-do-</td>
</tr>
<tr>
<td>S. No.</td>
<td>Ber Grader (Roller type)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Designed Fabricated &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Institute workshop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-do-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>21,601</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-do-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(ii) Works  NIL

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars of the Work, Name and Address of Agency Awarded the Work</th>
<th>Year of Work Done</th>
<th>Quantity (Nos.)</th>
<th>Total Cost (() )</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Renovation of Laboratory by M/s Ram Niwas Goyal Builders &amp; Suppliers, Abohar</td>
<td>2010</td>
<td>1</td>
<td>89925</td>
<td>CIPHET Abohar</td>
</tr>
</tbody>
</table>

(iii) Livestock  NA

(Details of livestock procured/produced in the sub-project)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details of Livestock (Breed, etc.)</th>
<th>Year of Procurement/Production</th>
<th>Nos.</th>
<th>Total Cost (() )</th>
<th>Responsible Partner</th>
</tr>
</thead>
</table>

(iv) Revenue Generated

(Details may be given on revenue generated in the sub-project viz., sale of seeds, farm produce, products, patents, commercialization, training, etc.)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Source of Revenue</th>
<th>Year</th>
<th>Total amount (() )</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technology licensing of custard apple pulper to the manufacturer (cutting &amp; scooping and pulping mechanism) M/s M/S Nexgen Drying Systems Pvt Ltd Pune</td>
<td>2012</td>
<td>1,85,000</td>
<td>CIPHET, Abohar</td>
</tr>
<tr>
<td>2.</td>
<td>EDP on processing and utilization of aonla</td>
<td>2013</td>
<td>8000</td>
<td>CIPHET, Abohar</td>
</tr>
</tbody>
</table>

20. Awards and Recognitions
21. Steps Undertaken for Post NAIP Sustainability

   i. Regular entrepreneurship development program to be organized for sustainable adoption of the technologies
   ii. Training Programs to be organized
   iii. Demonstration of technologies in the pilot plant
   iv. Further, refinement to be undertaken for developing Pneumatic assisted commercial scale destoner for ber and other underutilized fruit for developing technology for Canning of Ber
   v. Popularization of developed technologies through electronic media

22. Possible Future Line of Work
(Comments/suggestions of CPI regarding possible future line of work that may be taken up arising out of this sub-project)

   1. Refinement of machineries/prototype for up scaling the equipment for commercialization
   2. Integration of all machineries and technologies to develop a value chain from harvesting to market preparation and processing for value addition

23. Personnel
(Staff of Lead Centre & Partner-wise, their Name, Designation, Discipline and Duration)
<table>
<thead>
<tr>
<th>Research Management (CL)</th>
<th>From – To (DD/MM/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
</tbody>
</table>

**Scientific (CPI, CCPI, others)**

<table>
<thead>
<tr>
<th>CCPI-CIPHET Abohar</th>
<th>From – To (DD/MM/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Dr R K Gupta, Head HCP, CIPHET Abohar</td>
<td>05-12-2008 - 20-10-2011</td>
</tr>
<tr>
<td>3. Dr R K Vishwakarma, Scientist (ASPE) CIPHET, Abohar</td>
<td>21-10-2011 - 17-07-2013</td>
</tr>
<tr>
<td>4. Dr P C Sharma, Head HCP, CIPHET, Abohar</td>
<td>18-07-2013 - 31-03-2014</td>
</tr>
</tbody>
</table>

**Co-PI**

<table>
<thead>
<tr>
<th>From – To (DD/MM/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Dr Ramesh Kumar, Sr Scientist (Hort.), CIPHET, Abohar</td>
</tr>
<tr>
<td>6. Dr AK Thakur, Sr Scientist (ASPE) CIPHET Abohar</td>
</tr>
<tr>
<td>7. Mr G Mandal, Scientist (SS) Hort CIPHET Abohar</td>
</tr>
<tr>
<td>8. Er R K Vishwakarma, Scientist (ASPE) CIPHET, Abohar</td>
</tr>
<tr>
<td>9. Er V E Nambi, Scientist (ASPE) CIPHET Abohar</td>
</tr>
</tbody>
</table>

**Technical (CPI, CCPI, others)**

<table>
<thead>
<tr>
<th>From – To (DD/MM/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
</tr>
</tbody>
</table>

**Contractual (CPI, CCPI, others)**

<table>
<thead>
<tr>
<th>From – To (DD/MM/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Ms Reena Chandel (SRF)</td>
</tr>
<tr>
<td>13.</td>
</tr>
</tbody>
</table>

24. Governance, Management, Implementation and Coordination

A. Composition of the various committees (CIC, CAC, CMU, etc.)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Committee Name</th>
<th>Chairman (From-To)</th>
<th>Members (From-To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>CAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. No.</td>
<td>Details of the meeting</td>
<td>Date</td>
<td>Place &amp; Address (Where meeting was organized)</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------</td>
<td>------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>1.</td>
<td>CIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>CAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>CMU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

List of Meetings organized (CIC, CAC, CMU, etc.)
### Part-III Budget and its Utilization

**STATEMENT OF EXPENDITURE (Final)**

(Period from 05.12.2008 to 31.12.2013)  
(Date of start) (Date of completion)


**Total Sub-project cost:**  
Sanctioned/Revised Sub-project cost (if applicable)  
Date of commencement of Sub-project: 05.12.2008  
Duration: 05.12.2008 to 31.03.2014 (DD/MM/YYYY)

**Funds Received in each year (Rs in Lakh):**

<table>
<thead>
<tr>
<th>Year</th>
<th>I year (2008-09)</th>
<th>II year (2009-10)</th>
<th>III year (2010-11)</th>
<th>IV year (2011-12)</th>
<th>V year (2012-13)</th>
<th>VI year (2013-14)</th>
<th>Total (Rs Lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.20</td>
<td>36.07</td>
<td>10.14</td>
<td>1.89</td>
<td>5.22</td>
<td>40.32</td>
<td>96.84</td>
</tr>
</tbody>
</table>

Bank Interest received on fund (if any)

Total amount received: 96.84

Total expenditure: 41.72

**Expenditure Head-wise: (Rs. In Lakh):**

<table>
<thead>
<tr>
<th>Sanction Heads</th>
<th>Funds allocated</th>
<th>Funds released</th>
<th>Expenditure incurred</th>
<th>Total expenditure</th>
<th>Balance as on date</th>
<th>Requirement of additional funds</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st year</td>
<td>2nd year</td>
<td>3rd year</td>
<td>4th year</td>
<td>5th year</td>
<td>6th year</td>
<td>1st year</td>
</tr>
<tr>
<td>A. Recurring Contingencies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) TA</td>
<td>2.75</td>
<td>0.12</td>
<td>0.24</td>
<td>0.39</td>
<td>-0.09</td>
<td>0.50</td>
<td>0.10</td>
</tr>
<tr>
<td>2) Workshops</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3) Contractual Services/RA/ SRF</td>
<td>15.02</td>
<td>0.41</td>
<td>0.83</td>
<td>3.22</td>
<td>0.88</td>
<td>2.59</td>
<td>0.82</td>
</tr>
<tr>
<td>4) Operational</td>
<td>40.14</td>
<td>1.33</td>
<td>1.38</td>
<td>5.42</td>
<td>1.34</td>
<td>1.93</td>
<td>9.20</td>
</tr>
<tr>
<td><strong>Sub-Total of A(1-)</strong></td>
<td>57.91</td>
<td>1.86</td>
<td>2.45</td>
<td>9.03</td>
<td>2.13</td>
<td>5.02</td>
<td>10.12</td>
</tr>
<tr>
<td></td>
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<td>-----</td>
</tr>
<tr>
<td><strong>B. HRD Component</strong></td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(5) Training</td>
<td>3.25</td>
<td>---</td>
<td>0.50</td>
<td>0.50</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(6) Consultancy</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sub Total of B(5-6)</td>
<td>3.25</td>
<td>---</td>
<td>0.50</td>
<td>0.50</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Non-Recurring</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) Equipment</td>
<td>62.50</td>
<td>---</td>
<td>32.50</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>30.00</td>
</tr>
<tr>
<td>(8) Furniture</td>
<td>0.25</td>
<td>---</td>
<td>0.25</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(9) Works (new renovation)</td>
<td>1.00</td>
<td>1.00</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(10) Others (Animals, Books, etc)</td>
<td>1.00</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Sub-Total of C(7-10)</strong></td>
<td>1.25</td>
<td>33</td>
<td>0.25</td>
<td>0.25</td>
<td>---</td>
<td>---</td>
<td>30.00</td>
</tr>
<tr>
<td><strong>D. Institutional Charges</strong></td>
<td>2.90</td>
<td>0.09</td>
<td>0.12</td>
<td>0.36</td>
<td>0.01</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Grand Total (A+B+C+D)</strong></td>
<td>128.81</td>
<td>3.20</td>
<td>36.07</td>
<td>10.14</td>
<td>1.89</td>
<td>5.22</td>
<td>40.32</td>
</tr>
</tbody>
</table>

*Institutional charges will be 10% of the recurring contingencies for the Lead Consortium and 5% for Consortia partners.*

Name & Signature of CPI: ____________________________

Name & Signature of Competent Financial authority: ____________________________

Date: ________________ Date: ________________

Signature, name and designation of Consortia Leader
PART-IV: DECLARATION

This is to certify that the final report of the Sub-project has been submitted in full consultation with the consortium partners in accordance with the approved objectives and technical programme and the relevant records, note books; materials are available for the same.

Place:_________  
Date:_________  
Signature of Consortium Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator  
(Dr PC Sharma, CIPHET, Abohar)

Signature & Date  
Consortium Co-Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator

Comments & Signature of Consortium Leader

Date:
Pro-forma 1
Details of Technologies Developed/ Validated/ Adopted
(Page limit: 3 pages/ technology)

1) Title of the sub-project: A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

2) Name of CPI/ CCPI: Dr R K Gupta, Er. R K Vishwakarama, Er. V E Nambi and Dr. Ramesh Kumar

3) Title of the technology: Mixed Fruit Aonla Cheese

4) Information on existing farming systems, practices, productivity levels and income in the target area: NA

5) Key Intervention(s) introduced:

A study was carried out to optimize the different fruit pulp ratios and to standardize the process parameters for mixed fruit aonla cheese by response surface methodology (RSM). The pulp obtained from the selected fruits like Aonla, Pineapple, Papaya and Guava.

6) Results

Status of dissemination/ commercialization; and, extent of adoption and success, if applicable; with supporting data (with tables and photographs as annexure):

A study was carried out to optimize the different fruit pulp ratios and to standardize the process parameters for mixed fruit aonla cheese by response surface methodology (RSM). The pulp obtained from the selected fruits (Aonla, Pineapple, Papaya and Guava) were mixed in the proportions based on the RSM design. D-optimal mixture design using Design expert (8.0.2) was used to prepare different combination of mixed fruit aonla cheese. After enough preliminary trials the ingredients were fixed as per the FPO viz. mixed fruit pulp (250g), sugar (1.25kg), butter (70g), citric acid (3g) and salt (2g).

The desired quantity of extracted pulp from different fruits was poured in to a stainless steel vessel and mixed thoroughly and heated to 70°C, just to make the homogeneous mixture. Sugar, citric acid and butter as mentioned above was added to the pulp and heated with constant stirring at 70°C till the mixture became sufficiently thick approximately one hour then salt was added and again heated until the mass started leaving the sides of pan. The prepared hot cheese was then poured and spread to 6 mm thick layer on a tray which is coated with butter at the bottom to avoid the stickiness after
setting. Then it was allowed to cool and set. After setting the material was cut into the square shape with the help of knife and packed in different packaging materials (viz. aluminium laminate, LDPE pouches and plastic cups) and kept for shelf-life study under refrigerated conditions.

**Flow chart of preparation of mixed fruit aonla cheese**

1. Fruits (firm and ripe)
2. Washing
3. Cutting into thin slices
4. Boiling with equal quantity of water (to soften pulp)
5. Sieving (to remove seeds and skin) and making into fine pulp
6. Adding sugar, citric acid and butter to pulp
7. Mixing thoroughly
8. Cooking till sufficiently thick
9. Adding salt and colour
10. Removing from fire (When the mass starts leaving side of pan)
11. Spreading hot cheese in 0.6 cm thick layer on tray smeared with butter
12. Allowing to cool and set
13. Cutting into small pieces of suitable size
14. Wrapping in butter paper or polythene sheet
15. Packing in dry jar
16. Sealing
17. Storage

The prepared products were evaluated sensorily and colour, water activity, moisture content, TSS, acidity, vitamin C, total sugars, reducing sugar, fat content, and ash content were estimated. Based on the sensory evaluation, the RSM design has been analyzed, surface plots have been drawn and optima combination has been identified. The optimized values of the ingredients for mixed fruit protein enriched mixed fruit aonla cheese was aonla, pineapple, papaya and guava as 63.586%, 14.030%, 12.384% and 10% respectively.
Fig. 1 Variation in color and flavor with different ingredients

Fig. 2 Variation in taste and texture with different ingredients
Fig. 3 Variation in overall acceptability with different ingredients

The physicochemical properties of the optimized sample are shown in Table 1. From Table it can be revealed that the mixed fruit aonla cheese was a good source of vitamin C. in the health conscious populations, the product it can serve as a nutritious tit-bit to children as well as adults.

<table>
<thead>
<tr>
<th>Sr no.</th>
<th>Quality Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TSS (total soluble solid)</td>
<td>85°Brix</td>
</tr>
<tr>
<td>2.</td>
<td>Titrable acidity</td>
<td>0.64%</td>
</tr>
<tr>
<td>3.</td>
<td>Moisture content</td>
<td>9.29%</td>
</tr>
<tr>
<td>4.</td>
<td>Water activity</td>
<td>0.51</td>
</tr>
<tr>
<td>5.</td>
<td>Vitamin-C</td>
<td>87.486%</td>
</tr>
<tr>
<td>6.</td>
<td>Protein estimation</td>
<td>1.80%</td>
</tr>
<tr>
<td>7.</td>
<td>Reducing sugar</td>
<td>7.5%</td>
</tr>
<tr>
<td>8.</td>
<td>Non-reducing sugar</td>
<td>11.25%</td>
</tr>
<tr>
<td>9.</td>
<td>Total sugar</td>
<td>18.75%</td>
</tr>
<tr>
<td>10.</td>
<td>Yeast and Mold</td>
<td>Nil</td>
</tr>
<tr>
<td>11.</td>
<td>Ash</td>
<td>9.02064</td>
</tr>
<tr>
<td>12.</td>
<td>Ca (mg/100g)</td>
<td>72.727</td>
</tr>
<tr>
<td>13.</td>
<td>Phosphorus (mg/100g)</td>
<td>0.01855</td>
</tr>
<tr>
<td>14.</td>
<td>Fe (mg/100g)</td>
<td>3.0755</td>
</tr>
<tr>
<td>15.</td>
<td>Crude fat (%)</td>
<td>1.1843</td>
</tr>
<tr>
<td>16.</td>
<td>Color</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>21.94</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>8.93</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>5.84</td>
</tr>
</tbody>
</table>
The optimized mixed fruit aonla cheese was stored in aluminium laminates, plastic cups and LDPE pouches under refrigerated conditions for six month to check the keeping quality. The products remained shelf stable up to six month with good retention of all sensory attributes.

7) Brief description of technology for release:
Aonla fruit based fruit cheese was prepared with mixing of Aonla, Pineapple, Papaya and Guava. The final product is rich in nutritional value. It can be stored for more than 6 months under refrigerated conditions.

8) Expected Outcome/ Impact of the technology:
   8.1. Expected increase in area, production and net income NA
   8.2. Others

9) Whether findings have been published? If so, give the citation and enclose copy of the publication.
   Yet to be published

10) Any other information.
    NA

Note: Use separate pro-forma for each technology
     Attach photograph(s) relevant to the technology.
Pro-forma 1
Details of Technologies Developed/Validated/Adopted
(Page limit: 3 pages/technology)

1) Title of the sub-project: A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

2) Name of CPI/CCPI: Dr R K Gupta, Er. R K Vishwakarama, Er. V E Nambi and Dr. Ramesh Kumar

3) Title of the technology: BER GUMMIBUSTER

4) Information on existing farming systems, practices, productivity levels and income in the target area: NA

5) Key Intervention(s) introduced:

   A study was made with the aim of optimizing the different fruit pulp ratios and to standardize the process parameters

6) Results

   Status of dissemination/commercialization; and, extent of adoption and success, if applicable; with supporting data (with tables and photographs as annexure):

Ber fruit are generally used for medicinal as well as for processing. But due to low shelf-life and mucilaginous matter, their utilization in the preparation of acceptable products is limited. A study was made with the aim of optimizing the different fruit pulp ratios and to standardize the process parameters for ber gummibuster by response surface methodology (RSM) using Design expert (8.0.2).

Methodology

The pulp obtained from the selected fruits (Ber, Pineapple, and carrot) were mixed in the proportions based on the RSM design. Based on the preliminary trials the ingredients have been fixed as mixed fruit pulp (ber pulp, carrot juice, pineapple juice) 70 g, Sugar 32.5g, Pectin 1.75g, citric acid 0.22g, aonla shreds 1.5 g, and Rose Extract 2.5 g. The mixture of fruit juices was poured in a stainless steel vessel and cooked at 100°C for 2-3 minutes to make the pulp mixture homogeneous. As the mixture started to boil sugar, citric acid and aonla shreds were added and cooked again to thicken the mixture (56-58°B). After adding pectin paste the mixture was poured in a tray, smeared with glycerol at the bottom, to avoid the stickiness after setting. After cooling,
the tray was kept in the refrigerator at 7-10°C to lay down. After setting, the material was cut into square shape with help of knife and packed in the LDPE pouches till further analysis.

**Flow chart for preparation of Ber based soft candy**

Selection of ripe, firm and mature fruits, carrots and rose petals

- Washing
- Peeling (Destoning for ber, coring for pineapple)
- Cutting, Extraction of pineapple juice
- Blanching (for ber and carrot)
- Peeling/juicing

Flow chart:

1. Selection of ripe, firm and mature fruits, carrots and rose petals
2. Washing
3. Peeling (Destoning for ber, coring for pineapple)
4. Cutting, Extraction of pineapple juice
5. Blanching (for ber and carrot)
6. Peeling/juicing
7. Mixing
8. Cooking for 3 minutes at 100°C
9. Addition of sugar, citric acid and aonla shreds
10. Cooking to thicken the mixture (56-58°B)
11. Addition of pectin paste (pectin + boiled juice)
12. Cooking up to 68-70°B
13. Spreading hot mixture on tray smeared with glycerol
14. Cooling
15. Keeping in refrigerator to set
16. Cutting and packaging
17. Storage

**Fig.1 Variation in color and flavor with different ingredients**
**Fig. 2** Variation in taste and texture in different ingredients

**Fig. 3** Variation in overall acceptability in different ingredients

**Results**

The prepared pouches were evaluated sensorily and colour, textural properties, water activity, moisture content, TSS, acidity, vitamin C, total sugars, reducing sugar, fat content, anthocyanin, tannin content and ash content were estimated. Based on the sensory evaluation, the RSM design has been analyzed, surface plots have been drawn and optimal combination has been identified.

- The optimized values of the ingredients for mixed fruit protein enriched ber based soft candy is ber, pineapple and carrot are 38.585%, 11.415% and 20% respectively.
- By cooking at low temperature there is better retention of color, vitamin C content, beta carotene value, texture, taste, flavor, overall acceptability.
- The ber based soft candy was acceptable even after one month storage at refrigerated conditions in both the packaging material. But the candy packed in aluminum laminates was preferred more as compared to polythene packed candies as there was better retention of color and flavor.
- There is increase in moisture, water activity, TSS, acidity of the ber based soft candy with storage time whereas decrease in vitamin C, beta carotene, lycopene, total sugars, reducing sugars and non-reducing sugars but at slower rate as compared to aluminum laminates.
- There is decrease in hardness as well as chewiness of the ber based soft candy with the passage of time. However the product in aluminum laminates was better than in polythene pouches.
- Thus, developed ber based soft candy can be kept at refrigerated conditions to retain its characteristic quality parameters.

![Prepared ber gummibuster](image)

7) Brief description of technology for release:

Ber fruit based mixed fruit soft candy was prepared with mixing of ber, pineapple and carrot. The final product is rich in protein, vitamin C, beta carotene, lycopene, total sugar, reducing sugar and non-reducing sugars. It can be stored for more than 6 months under refrigerated conditions.

8) Expected Outcome/ Impact of the technology:
   8.1. Expected increase in area, production and net income  NA
   8.2. Others

9) Whether findings have been published? If so, give the citation and enclose copy of the publication.    Yet to be published
10) Any other information. 

Note: Use separate pro-forma for each technology

Attach photograph(s) relevant to the technology
Pro-forma 1
Details of Technologies Developed/ Validated/ Adopted
(Page limit: 3 pages/ technology)

1) Title of the sub-project: A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

2) Name of CPI/ CCPI: Dr R K Gupta, Er. R K Vishwakarama, Er. V E Nambi and Dr. Ramesh Kumar

3) Title of the technology: Custard apple pulp extractor

4) Information on existing farming systems, practices, productivity levels and income in the target area: NA

5) Key Intervention(s) introduced:

A pulper was designed, developed and evaluated for separating seed from custard apple pulp.

6) Results
Status of dissemination/ commercialization; and, extent of adoption and success, if applicable; with supporting data (with tables and photographs as annexure):
A machine was designed to separate custard apple pulp from seed. The machine comprises of a food grade stainless steel strainer of cylindrical shape. The cylinder is inclined at 10° from horizontal, which can be changed according to the requirement and raw material. A cutting blade is mounted on a food grade stainless steel shaft which is placed at the center of cylinder. The shaft rotates at 300-900 rpm depending upon the requirement of particle size for further processing. The lower speed results in separation of seeds with pulp whereas the higher speed results in pulp of smaller particle size.

A food grade stainless steel screen is fitted at the outlet end of cylinder to separate pulp from seeds. The machine is operated by 1 hp electric motor. The machine gives capacity of 60-100 kg/h depending upon the rotational speed of cutting blades.

The custard apple bulbs are fed to the machine. Rotating blades tear the bulb and seed is separated from the bulb. The whole mass is conveyed to the outlet due to gravity and falls on the screen. Pulp goes down whereas seeds are retained by the screen.

7) Brief description of technology for release:

Custard apple pulper was designed, developed and evaluated. It has a capacity of 60-100 kg/h and operated by 1 hp electric motor. All contact parts of the machine are made of food grade stainless steel. It is suitable for small entrepreneurs.

8) Expected Outcome/ Impact of the technology:
   8.1. Expected increase in area, production and net income  NA
   8.2. Others: This machine provides an option to manual pulping operation. The pulp obtained from this machine has about 70% intact pulp, which is suitable for canning for export.

9) Whether findings have been published? If so, give the citation and enclose copy of the publication.  Yet to be published

10) Any other information.

   NA

Note: Use separate pro-forma for each technology
   Attach photograph(s) relevant to the technology
Proforma -2

Validation of Developed/ Released/ Adopted Processing Technologies/ Innovations
(Page limit: 3 pages/technology)

1. Title of the sub-project: A Value Chain On Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

2. Name of CPI/CCPI: Dr. R. K. Vishwakarma

3. Title of the technology: Grader for oblong and round fruits

4. Information on existing farming systems, practices, productivity levels and income in the target area: Grading of underutilized fruits like ber is usually done using conventional graders (inclined rotating cylinders with varying clearance or belt type graders). Ber is delicate oblong shaped fruit, which is difficult to grade with conventional graders. Thus, the concept of developing grader for oblong fruits like ber was taken up.

5. Key Intervention(s) introduced: Grading is done by utilizing centrifugal force and orientation of fruits in a particular direction. Grading boards are placed at the periphery of the rotating disc. Clearance between rotating disc and grading boards is adjustable, then grading fruits on the bases of size.

6. Results

Status of dissemination/commercialization; and, extent of adoption and success, if applicable; with supporting data (with tables and photographs as annexure):

Grader for oblong and round fruits: Annexure-III
7. Brief description of technology for release:

Grading is done by utilizing centrifugal force and orientation of fruits in a particular direction. Grading boards are placed at the periphery of the rotating disc. Clearance between rotating disc and grading boards is adjustable, then grading fruits on the bases of size.

8. Expected Outcome/Impact of the technology:

(8.1) Expected increase in area, production and net income

(8.2) Others

The developed grader is a novel fruit grading option for oblong and round fruits like ber, aonla, tomato etc. The grading machine is compact with fairly good capacity (more than 300 kg/h) and suitable for on-farm as well as commercial applications. Properly graded fruits usually fetch more prices to the farmers for their produce. It is expected to increase the net income of farmer by 20%. The versatility of this machine makes it suitable for round the year utilization for grading.
9. Whether findings have been published? If so, give the citation and enclose copy of the publication.

The findings are not published. It is a new machine and information is submitted to office for filing a patent.

10. Any other information.
Pro-forma 2
Details of Technologies/ Innovations Commercialized
(Page limit: 3 pages/ technology)

1) Title of the sub-project:

2) Name of CPI/ CCPI:

3) Title of the technology:

4) Commercialization status with date of licensing/ MOU:

5) Brief description of intervention/ innovation:

6) Name and address of the firm(s) which has commercialized it:

7) Area (state(s)/ district(s)) covered:

8) Volume/ quantity of Annual production and approximate sale value:

9) Benchmark (existing similar product) and Consumer acceptance, particularly in case of food products:

10) Status of patenting, if patentable, trademark or any other IPR title, if applicable:

11) Status of publication and publicity:

Note: Use separate pro-forma for each technology
Attach photograph(s) relevant to the technology
Pro-forma 3
Details on Rural Entrepreneurships/ Rural Industries Developed
(Page limit: 3 pages/ rural industry)

1) Title of the sub-project:

2) Name of CPI:

3) Name of rural industry with address:

4) Contact: Phone and E-mail of rural industry:

5) Investment (Rs): NAIP Funds
   Industry/ Entrepreneur

6) Product(s) produced and marked:

7) Annual Production (kg or litre):

8) Raw Material(s) and Quantity used/ year (kg or litre):

9) Cost of raw material (per kg or litre):

10) Price of Product: In Whole Sale
    In Retail

11) Type of Beneficiaries:

12) Number of Beneficiaries:

13) How the Industry is beneficial to primary producers:

14) Estimate Employment Generation/ Year (person days):

15) CPI to explain whether the industry is approved by FPO/BIS or any other statutory body and how the food safety and quality assurance of end product are being ensured?

Note: Use separate pro-forma for each entrepreneurship/ rural industry
   Attach photograph(s) relevant to the industry/ entrepreneurship
Annexure 1
Guidelines for Citation of Publications from NAIP sub-projects

(Note: Give only those publications (under different categories) which are published during the project term)

1. **Research Article:**

2. **Book**

3. **Book Chapter**

4. **Thesis:**

5. **Popular Article:**

6. **Newspaper Article:**

7. **Seminar/Symposium/Conference/Workshop Proceedings**
8. **Technical Bulletin:**

9. **Manual**

10. **Seminar/Symposium/Conference/Workshop Presentation**

11. **CDs/Videos:**

12. **Popular article in other Language**

13. **Folder/Leaflet/Handout:**

14. **Report:**

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**Note:**

Name of CPIs and CCPIs to be given in *italics*

Journal name to be given in full
Annexure 2
General Guidelines for Developing Final Reports

1) The CPI will send the consolidated report to PIU-NAIP after compiling the progress reports received from all the consortium partners. The report should also list the constraints (if any) being faced by consortia partners.

2) The Final Report should not be a mere repetition of Annual Reports. The purpose of the final report is to link all findings from the sub-project so that the overall achievements are discussed in terms of scientific accomplishments, contributions to scientific, human capital development, the relevance of findings to development, and how the technology is to be disseminated.

3) The Executive Summary should review and summarize the entire Sub-project. The Executive Summary should clearly place sub-project accomplishments in the overall context of agricultural development.

4) Steps undertaken for post project sustainability. Plan should be developed in respect of 1) packaging of location specific technologies, 2) conservation of natural resources – water, soil, forest and bio-diversity, 3) formation of SHGs and VLCs, 4) creation of rural technology center/ community center, 5) access to market and credit, 6) establishment of rural industries and farm fresh outlets, 7) generation of sustainability funds and development of an institutional mechanism to internalize and sustain the gains once the project closes.

5) Summary in Hindi must be included.

6) Final Report should be of A-4 size and the total number of pages must not exceed 50-60 in any case.

7) The text of the Final Report should be in the following format:
   - MS Word document
   - Line spacing: 1.15
   - Font: Times New Roman
   - Main headings: 12 point bold
   - Running text: 12 point normal

8) Light pink #FF99CC color should be used for cover page (front & back) of the report.


10) The details of performance indicators claimed in the listing should be submitted as soft copy in CD in MS Word Format. A copy of each publication, film, knowledge products, patent application to be attached in a separate folder.

11) CPIs must strictly follow the guidelines while composing and printing the sub-project Final Report.

12) The draft of Final Report in soft copy be sent 15 days before sub-project closing date to concerned National Coordinator. Final printing be done after getting comments/suggestions on draft report.