2. REVIEW OF LITERATURE

The prerequisite of any research to be conducted is to make clear all concepts related to the problem followed by systemic and meticulous future planning. The knowledge of scientific literature in the related field of research problem is not only provides impetus in understanding the problem in a precise, clear and comprehensive manner, but also in gearing up and updating the research work.

The literature collected on the various aspects of present study, “Nutritional quality, functional properties and value addition of underutilized fruits of Himachal Pradesh” is reviewed under following heads/subheads:

2.1 Physico-chemical characteristics of underutilized fruits
2.2 Peel and juice extraction techniques
2.3 Functional properties of underutilized fruits
2.4 Formulation/Preparation/Development of value added products
2.5 Quality evaluation of value added products
2.6 Economics of the prepared products
2.7 Documentation of underutilized fruits with respect to medicinal as well as household uses

2.1 Physico-chemical characteristics of underutilized fruits
2.1.1 Physical characteristics

i. Fig (*Ficus palmate*)

Sharma and Badiyala (2006) studied variability in common fig of Hamirpur district of Himachal Pradesh with average fruit weight ranged from 11.6 to 36.8 g, fruit length (16.7 to 28.6 cm) and breadth (17.3 to 31.0 cm). However, Basavaraj *et al.* (2008) analyzed fig fruit (*Ficus carica* L) for physical characteristics. The fruit shape was observed as coniele and fruit weight was ranged from 40 to 41 g.
ii **Kaiphal (Myrica esculentum)**

Sood (2006) reported length and breadth for *kaiphal* fruit as 1.0 to 1.3 and 0.8 to 1.2 cm. While Patel *et al.* (2008) analyzed *kaiphal* fruit for their physico-chemical traits with fruit weight and length were observed as 3.63 g and 2 to 16 cm.

iii **Wild apricot (Prunus armenica)**

Sofi *et al.* (2001) observed fruit length and weight as 3.43 cm and 19.07 g. Whereas, Zaffar *et al.* (2004) analyzed 25 apricot genotypes for fruit length and weight. The fruit length was observed as (3.13 to 4.07 cm) and fruit weight as (7.06 to 36.24 g) for I - IV for different clusters.

iv **Beedana (Cydonia oblonga)**

Ahmad *et al.* (2004) worked on *beedana* and observed fruit colour as deep yellow with fruit weight varied from 25 to 310 g.

v **Wild Pomegranate (Punica granatum)**

Prasad and Baskar (2000) reported 6.10 cm fruit length and 170.6 g fruit weight for Jodhpur red variety of pomegranate fruit. While Jalikop *et al.* (2002) reported 4.74 cm fruit length and 82.50 g fruit weight for amlidana pomegranate with noted dull pink colour.

vi **Kainth (Pyrus serotina)**

Parmar and Kaushal (1982) while working on *kainth* fruit reported yellowish brown colour with rusty white spots on the outer surface having weight 67.3 g.

vii **Wild Peach (Prunus persica)**

Sharma *et al.* (1994) analyzed physical parameters of peach fruit at different days after fruit set. The fruit weight and length was noted as 19.51 g and 4.60 cm with fruit colour was noted as yellowish orange. Later on Kher and Dorjay (2001) evaluated some low chilling peach cultivars for physical characteristics and observed fruit length and weight for Shan- e- Punjab and Flordsun as 5.80 and 4.74 cm and 56.95 and 80.86 g, respectively.
2.1.2 Proximate composition

i  **Fig (Ficus palmate)**

Goel and Kumar (1989) while studying on composition of fig fruit reported per cent moisture, protein, fat, ash and carbohydrates as 79.40, 1.70, 0.77, 1.15 and 15.8, respectively. While Venu et al. (2005) reported per cent moisture, protein, fat and ash in Poona variety of fig as 82.0, 2.23, 0.50 and 0.80, respectively while the values for conadria variety of fig were reported as 89.0, 3.0, 0.20 and 1.50, respectively after 105 days of fruit set.

Sharma and Badiyala (2006) reported 72.7 to 78.3 per cent moisture content in fig fruit of Hamirpur district of Himachal Pradesh.

ii  **Kaiphal (Myrica esculentum)**

Goel and Kumar (1989) while working on composition of some uncommon foods and found that kaiphal fruit contained per cent moisture, protein, fat, ash and carbohydrates as 71.20, 4.58, 1.46, 0.67 and 21.0, respectively.

Rathore (2001) studied nutritive value of non-traditional fruits of arid and semi arid regions including kaiphal fruit with reported values for protein, ash and carbohydrates as 0.97, 0.39 and 12.65 per cent, respectively. While no fat content was observed for the fruit. Sood (2006) reported the per cent values of moisture (80.08), protein (0.98), fat (1.23), fibre (1.31) and ash (0.76), respectively.

iii  **Wild Apricot (Prunus armenica)**

Parmar and Kaushal (1982) while working on wild apricot fruit reported per cent protein (1.0), fat (0.3) and fibre (1.11). Whereas, Sharma et al. (1992) while working on physico-chemical characteristics of apricot fruit varieties with reported per cent moisture content for chulli was (85.7), Charmigaz (85.0), Kaisha (85.2) and Suffaida (84.5). Rathore (2001) while working on non-traditional foods including wild apricot reported 0.67, 0.1 and 0.70 per cent protein, fat and ash contents, respectively.
iv  **Beedana (Cydonia oblonga)**

Michal (2001) while working on quince fruit (*Cydonia oblonga*) reported fibre and ash contents in the range of 1.5 to 2.0 and 0.3 to 0.6 per cent. However, Ahmad *et al.* (2004) while studying on *Cydonia oblonga* reported per cent moisture, fibre and ash as 73.0, 1.60 and 0.48, respectively.

v  **Wild Pomegranate (Punica granatum)**

Patil *et al.* (2003) analyzed per cent moisture, ash, fibre, fat and protein contents and reported values as 82.85±0.69, 9.22±0.07, 5.67±0.08, 0.10±0.001 and 1.96±0.005, respectively for pomegranate fruit. However, Rao (2008) studied proximate composition of 20 unexploited fruits including pomegranate. The per cent moisture, protein, fat, ash, fibre and carbohydrate content were observed as 78.0, 1.6, 0.1, 0.7, 0.5 and 14.50, respectively.

vi  **Kainth (Pyrus serotina)**

Parmar and Kaushal (1982) reported the values of moisture and protein content present in *kainth* fruit as 72.50 and 3.16 percent, respectively.

vii  **Wild Peach (Prunus persica)**

Parmar and Kaushal (1982) while studying on wild fruits of Himachal Pradesh including wild peach reported per cent moisture, protein and ash content as 68.20, 2.0 and 1.63, respectively.

viii  **Crab apple (Malus sikkimensis):**

Singh *et al.* (1996) reported per cent protein and ash content as 0.247 and 0.314 for wild apple (*Malus baccata*). Gopalan *et al.* (2000) reported 1.20 per cent fibre in rose apple. However the values of moisture, protein, fat, fibre and ash contents for apple fruit were noted as 84.6, 0.50, 0.10, 3.40 and 0.50 per cent, respectively.

### 2.1.3  NDF and ADF

Sood (2006) while working on wild fruits of Himachal Pradesh including *kaiphal* fruit reported values of NDF and ADF as 23.16 and 18.17 per cent, respectively.
2.1.4 Chemical characteristics

i Fig (*Ficus palmate*)

Parmar and Kaushal (1982) reported TSS as 12.1 (0 B) while per cent acidity and total sugars were observed as 0.71 and 5.98. However, Venu *et al.* (2005) analyzed reducing and total sugars for Poona variety of fig as 10.00 and 12.00 while the values for Conadria variety of fig was reported as 14.93 and 16.00 per cent.

ii *Kaiphal* (*Myrica esculentum*)

Sood (2006) reported pH as 3.81 while acidity, reducing and total sugars were noted as 0.27, 7.20 and 12.68 per cent, respectively. Whereas, Patel *et al.* (2008) while analyzing *kaiphal* fruit reported range for TSS as 5.7 to 6.2 (0 B) whereas acidity, reducing and total sugars were observed as 2.44 to 4.83, 0.83 to 3.57 and 2.18 to 7.68 per cent, respectively.

iii Wild apricot (*Prunus armenica*)

Singh *et al.* (1992) reported 15.0 0 B TSS and 1.78 per cent acidity in Khochulli variety of apricot while per cent reducing and total sugars were observed as 3.26 and 12.06. However, Dwivedi *et al.* (2002) analyzed 12.0 (0 B) TSS and 0.13 per cent acidity in Shakarpura variety of apricot.

iv Beedana (*Cydonia oblonga*)

Ahmad *et al.* (2004) analyzed *beedana* (*Cydonia oblonga*) for different chemical constituents namely, TSS, acidity and total sugars with reported values as 13.0, 0.2 to 0.8 and 2.5 to 8.9 per cent, respectively.

v Wild Pomegranate (*Punica granatum*)

Singh and Kingsly (2008) analyzed different chemical constituents present in wild pomegranate with TSS, pH and acidity as 16.4 (0 B), 2.47 and 6.68 per cent, respectively. Whereas, Rao (2008) while studying on utilization of unexploited and underexploited agri resources opportunities in food processing industry reported 10 - 14 (0 B) TSS and 0.3 to 0.6 per cent acidity in pomegranate fruit.
Kainth (*Pyrus serotina*)

Parmar and Kaushal (1982) while working on *kainth* fruit reported TSS as 19.0 (°B) while acidity and reducing sugars were observed as 1.40 and 4.88 per cent, respectively.

Wild Peach (*Prunus persica*)

Parmar and Kaushal (1982) studied different chemical constituents in wild peach with reported values for TSS, acidity, reducing and total sugars as 6.11 (°B), 1.71, 2.40 and 5.20 per cent, respectively. While Sharma *et al.* (1994) reported chemical changes after 100 days of fruit set. The TSS, pH, ascorbic acid and total sugars were observed as 10.6 (°B), 3.98, 3.25 (mg/100g) and 5.21 per cent, respectively.

Srivatava and Arora (1994) analyzed different chemical constituents in different peach varieties. The Flordasun variety of peach contained TSS, pH, acidity and total sugars as 8.33, 0.65, 3.57 and 5.83 per cent, respectively.

Crab apple (*Malus sikkimensis*): Shrestha and Bhatia (1982) determined pH values for American, Maharaji, Ambri and Golden delicious varieties of apple as 4.20, 3.70, 4.00 and 4.30, respectively. However, Sahni *et al.* (1994) while studying on physico-chemical composition of fruits showed TSS 12.0 (°B) and pH 4.04 for apple fruit.

Singh *et al.* (1996) reported 0.53 per cent acidity in wild apple (*Malus baccata*). Whereas, Attri and Vaidya (1999) while analyzing different cultivars of apple reported that Ruspippin and Golden delicious were having TSS 12.08 (°B). The per cent acidity was observed as 0.50 and 0.40 for Ruspippin and Golden delicious, respectively.

2.1.5 Mineral composition

Fig (*Ficus palmate*)

Parmar and Kaushal (1982) while studying on wild fruits including fig determined mineral content with reported value for magnesium as 0.76 mg/100g. Whereas Goel and Kumar (1989) studied mineral composition of uncommon foods including fig reported iron, calcium and phosphorus content as 2.99, 88.40 and 35.80 mg/100g, respectively.
Venu et al. (2005) analyzed mineral constituents in poona and conadria varieties of fig with reported values for calcium, potassium and iron as 70, 320 and 1.78 for Poona and 81.33, 381 and 2.05 mg/100g, respectively for condaria variety of fig.

ii  **Kaiphal (Myrica esculentum)**

Goel and Kumar (1989) while working on mineral composition of some uncommon foods including *kaiphal* reported iron, calcium and phosphorus contents as 3.33, 19.0 and 91.4 mg/100g, respectively.

Sood (2006) studied mineral content in *Kaiphal* and reported calcium, phosphorus, potassium and iron contents as 14.69, 35.02, 21.03 and 186.31 mg/100g, respectively.

iii  **Wild Apricot (Prunus armenica)**

Parmar and Kaushal (1982) while working on wild fruits of Himachal Pradesh including wild apricot reported calcium, phosphorus and iron contents as 20.0, 25.0 and 2.20 mg/100g, respectively. Rathore (2001) reported the calcium, phosphorous and iron content present in wild apricot as 20, 25 and 0.30 mg/100g respectively.

Dwivedi and Dwivedi (2007) studied mineral constituents in fresh and dehydrate Indian apricots. The values of calcium, iron, potassium and phosphorus contents were 20, 0.54, 89 and 25 mg/100g for fresh apricots.

vi  **Beedana (Cydonia oblonga)**

Gopalan et al. (2000) reported 10.00 and 20.00 mg/100g calcium and phosphorus contents present in quince fruit. While Michal (2001) analyzed quince fruit (*Cydonia oblonga*) for mineral estimation with observed values for calcium (12.4), phosphorus (21.4), magnesium (8.04), iron (0.80) and potassium (204) mg/100g.

v  **Wild Pomegranate (Punica granatum)**

Rao et al. (2008) reported values of calcium, phosphorus and iron contents present in unexploited pomegranate fruit as 10, 70 and 1.79 mg/100g,
respectively. Gupta (2008) while working on wild pomegranate determined mineral constituents viz. phosphorus, potassium, magnesium and iron in wild pomegranate fruit and values were 575.00, 120.00, 7.30 and 2.60 mg/100g, respectively.

vi **Kainth (Pyrus serotina)**

Parmar and Kaushal (1982) analyzed some minerals in *kainth* fruit with reported values for phosphorus, potassium, calcium, magnesium and iron as 0.014, 0.217, 0.027, 0.017 and 0.015 per cent, respectively.

vii **Wild Peach (Prunus persica)**

Parmar and Kaushal (1982) while studying wild fruits of Himachal Pradesh including wild peach reported per cent values of phosphorus (0.057) potassium (0.566), calcium (0.039), magnesium (0.034) and iron (0.009), respectively.

viii **Crab apple (Malus sikkimensis)**

Singh et al. (1996) reported values of calcium and iron contents present in wild apple (*Malus baccata*) as 0.10 and 0.001 mg/100g. However, Anonymus (2011) reported calcium, phosphorus, magnesium, iron and potassium contents present in crab apple as 18.0, 15.0, 7.00, 0.36 and 194 mg/100g, respectively.

Gopalan et al. (2000) reported 7.0 and 75 mg/100g magnesium and potassium contents in apple fruit.

2.1.6 Antinutritional parameters

i **Fig (Ficus palmate)**

Venu et al. (2005) while studying on Poona and Conadria varities of fig reported total phenol as 3.16 and 5.00 mg/100g.

ii **Kaiphal (Myrica esculentum)**

Sood (2006) studied various antinutritional parameters in *kaiphal* fruit. The tannin, oxalates, phytate and phytate phosphorus were reported as 1.06, 0.00, 3.72 and 1.08 per cent, respectively.
iii  *Beedana* (*Cydonia oblonga*):

Michal (2001) while working on quince fruit determined per cent tannins as 0.60.

iv  *Wild Pomegranate* (*Punica granatum*)

Singh and Kingsly (2008) reported 9.30 per cent total phenols in pomegranate fruit.

v  *Kainth* (*Pyrus serotina*)

Parmar and Kaushal (1982) reported per cent tannins present in *kainth* fruit as 0.32.

vi  *Crab apple* (*Malus sikkimensis*):

Srestha and Bhatia (1982) reported 0.098 per cent tannins present in golden delicious apples.

2.2  **Peel and juice extraction techniques**

2.2.1  **Hot lye peeling**

Shah and Bains (1992) standardized hot lye peeling technique for juice extraction of peach and apricot. Boiling solution of 1.5 per cent concentration of NaOH for 1.5 minutes was appropriate for peeling of peaches.

Bayindirlic *et al.* (1996) reported that 12.0 per cent concentration of NaOH at 80 °C was found best for peeling of peaches with an average juice recovery was noted as 85 per cent. Later on, Sharma (2010) standardized different juice extraction techniques for extraction of pulp from sand pear and it was found from the study that hot lye peeling gave highest juice recovery (80.00 %).

2.2.2  **Cold lye peeling**

Shivani (2011) standardized juice and peel extraction techniques viz., hot lye peeling, cold lye peeling, blanching, steaming and manual method for
nectarine fruit. The highest per cent juice recovery was noted in hot lye peeling, followed by cold lye peeling and manual method with values ranged from 66 to 67, 63 to 64 and 55 to 56 juice recovery, respectively.

2.2.3 Blanching

Waskar and Garande (1999) standardized blanching method for extraction of ber fruit with per cent recovery noted as 64.00. Whereas, Jain and Khurdiya (2002) followed 12 juice extraction techniques for aonla fruit including blanching method with per cent juice recovery was noted as 70.00.

2.2.4 Steam blanching

Khurdiya and Anand (1981) recorded that heating of phalsa fruit at 50 °C gave the highest recovery i.e. 67.50 per cent. However, Saikia and Dutta (1995) developed method for increased recovery of fresh juice from ripe *Dillena* fruit by application of blanching in steam for 0, 2, 3, 4, 5 and 6 minutes and reported that increase in blanching time significantly yield the juice percentage from 25.0 to 41.67 per cent.

Bakshi et al. (2009) extracted peach pulp by using steam blanching process. The water was heated at 40±2 °C for 10, 20 and 30 minutes. The fruit heated for 10 minutes had increased juice yield with value of 26.68 per cent.

2.2.5 Hot pulping

Hoang et al. (1989) while studying on extraction of mango pulp by using boiling technique at 100 °C for 20 minutes yield 35 per cent juice and 20.13 per cent peel recovery. While Masoodi et al. (1992) obtained grape juice by hot break method with juice yield was noted as 73.00 per cent.

Sandhu et al. (2001) standardized hot pulping method for the extraction of guava pulp and it was revealed from the study that hot water boiling for 2 minutes gave 71.30 per cent recovery.
2.2.6 Cold pulping

Masoodi et al. (1992) obtained grape juice by using cold extraction method with per cent juice recovery was noted as 72.00. Whereas, Vyas and Kochar (1993) applied cold extraction technique for the extraction of juice from three varieties of apple viz., red delicious, golden delicious and golden + red with per cent juice recovery was noted as 80.00, 67.40 and 73.70 per cent, respectively.

Waskar and Garande (1999) followed cold extraction method for extraction of ber juice with per cent recovery was noted as 53.00. While Sandhu et al. (2001) standardized cold extraction method to obtain guava pulp and it was observed from the study that the technique yield 70.00 per cent juice/pulp.

2.2.7 Basket press

Khurdiya (1990) standardized juice extraction technique for phalsa fruit by using basket press. The fruit was crushed and heated to 50 °C and the juice was extracted in a hand operated basket press with average juice recovery was in the range of 56 to 67 per cent.

Waskar and Deshmukh (1995) extracted pomegranate juice by heating crushed mass to 40 °C and pressed in wooden basket to obtained juice yield. The per cent juice recovery was noted as 60.21.

2.3 Functional properties of underutilized fruits

i Ascorbic acid

Sharma et al. (1992) analyzed ascorbic acid content in chulli (wild apricot) as 7.30 mg/100g. According to Singh and Arora (2000) functional constituent i.e. ascorbic acid in peach fruit was noted as 3.47 mg/100g. Whereas 16.0 mg/100g vitamin C content was reported by Rathore (2001) present in wild apricot fruit.

Singh and Sethi (2003) analyzed ascorbic acid in 16 genotypes of pomegranate fruit. The ascorbic acid content was in the range of 21.73 to 29.41
mg/100g. Pandey et al. (2006) while studying on 6 cultivars viz., Prima, Rich–a-red, Oregon spur, Starkrimson, Hardi spur and Gold spur reported ascorbic acid content as 3.66, 4.32, 3.66, 2.33, 3.33 and 3.66 mg/100g, respectively. Patel et al. (2008) also analyzed kaiphal fruit for different chemical constituents with ascorbic acid content was in the range of 4.03 to 28.20 mg/100g.

ii  Pectin

Srestha and Bhatia (1982) analyzed pectin content in four apple varieties. The variety Ambri had highest pectin content i.e. 0.48 while lowest in Golden delicious variety of apple. Parmar and Kaushal (1982) while studying on pectin content of wild fruits of Himachal Pradesh reported per cent pectin as 0.90, 5.53, 2.52 and 0.20 for kainth, daru, wild apricot and fig, respectively.

Michal (2001) analyzed beedana (Cydonia oblonga) for different chemical constituents. The per cent pectin content was in the range of 1.0 - 1.5. However, Venu et al. (2005) reported 4.00 and 6.00 per cent pectic substance in Poona and Conadria varieties of fig.

iii  β- carotene

Singh and Arora (2000) determined 4626 mg/100g carotenoids in Saharanpur and Porbhat varieties of peach after 900 days of anthesis.

Rathore (2001) while studying on composition of some uncommon foods reported β- carotene as 153 and 412 (I.U/ 100g) for wild apricot and kaiphal fruit. Venu et al. (2005) while working on Poona and Conadria varieties of fig reported total carotenoids as 0.19 and 0.11 (mg/100g). While Dwivedi and Dwivedi (2007) analyzed β- carotene in apricot fruit and the value was reported as 2162 (I.U/ 100g).

iv  Anthocyanin

Singh and Sethi (2003) analyzed 6 genotypes of pomegranate for anthocyanin determination. It was found from the study that the anthocyanin content was ranged between 12.88- 39.72 mg/100g
2.4 Formulation/Preparation/Development of value added products

2.4.1 Beverages

Hoang et al. (1989) developed mango squash with reported TSS as 45.00 °B and acidity 1.00 per cent. Sethi (1993) prepared litchi squash and reported 45 °B TSS and 1.29 per cent acidity. Kotecha et al. (1995) prepared RTS beverage from custard apple. The beverage had a TSS (15 °B) and acidity (0.25 %) whereas apple was also utilized for the preparation of RTS and squash with TSS reported as 14.00 and 42.00 °B.

Roy et al. (1997) prepared RTS beverage and squash from ripe dushehari mangoes and stored at 4±1 °C, 28±2 °C and 38±2 °C for 30 days. Sogi and Singh (2001) prepared RTS beverage and squash from kinnow juice. Whereas jackfruit (Artocarpus heerophyllus) RTS beverage was prepared from two varieties of jackfruit with 10 per cent pulp, TSS 18 (°B) and 0.25 per cent acidity by Krishnaveni et al. (2001).

Kotecha and Kadam (2003) prepared RTS beverage and syrup from tamarind and stored for 180 days. Kannan and Thirumanan (2004) prepared jamun RTS, squash and syrup and studied storage stability up to 6 months of storage.

2.4.2 Ladoo (sweet balls)

Manan et al. (1998) standardized a method for the preparation of amaranthus seed based traditional sweet meat. While Arora and Srivastava (2002) prepared ladoo mix containing millet, roasted soyabeans, malted fenugreek seeds in the proportion of 65:10:20 and 65 g of jaggery/100 g of mixture. The popped amaranthus seeds were used for coating of ladoo. Later on, Sood (2011) developed chenopodium amaranth based ladoo in different proportions.

2.4.3 Chutney

Lal et al. (1989) prepared sauce and chutney from wild and cultivated apricot. However, the method for the preparation of sweet chutney from edible mushroom (Agaricus bisporous L.) was standardized by Joshi et al. (1991).
Awasthi (2007) prepared Kachnar chutney by using different blends of raw mango and stored for 6 months. Whereas, Mishra (2008) made an attempt of using aloe vera for the preparation of chutney. The chutney was prepared by blending of papaya and mango in different ratios/levels and also studied storage stability for 120 days.

### 2.4.4 Jam

Srivastava and Arora (1994) studied 7 low chilling and one temperate cultivars of peaches for their suitability in jam preparations. Sogi and Singh (2001) prepared jam from kinnow juice and had a TSS 70.0 °B and pH 3.10.

Katoch et al. (2006) made an effort of preparing jam by blending of seabuckthorn pulp with guava and apple pulp in different combinations. 25 per cent level of sea buckthorn pulp was found acceptable. While Prasad and Mali (2006) prepared ber jam and stored for 12 months. Shivani (2011) standardized a method for the preparation of nectarine jam with reported TSS as 69.67 °B and per cent acidity as 1.47.

### 2.4.5 Fruit bar

Gowda et al. (1995) prepared fruit bar from Alphonso fruit by addition of sugar 20 per cent, 0.2 per cent citric acid and 700 ppm KMS individually and or in different combinations. Protein enriched mango fruit bar from different combinations of mango pulp and soy slurry was formulated by Chauhan et al. (1997). However, Aruna et al. (1999) formulated papaya fruit bar by dehydration method and the TSS and per cent acidity was adjusted as 30 and 0.7.

Mir and Nath (2000) prepared protein enriched mango bar using soy protein concentrate and coconut powder. Whereas, Sandhu et al. (2001) developed leather from Banarasi Surekha variety of guava which had a TSS 20.0 °B and 0.4 per cent acidity and was dried at 50±5 °C for 4 hours.

Manimegalai et al. (2001) prepared fruit bar by using two varieties of jack fruit and packed in different packaging materials and stored at room temperature for 6 months. Later on, Cheriyan and Cheriyan (2003) prepared papaya and papaya mango blended leather in the ratio of 60:40 and stored for 8 months.
Singh et al. (2003) made an attempt of preparing mango bar from ripe and over ripe mangoes with sugar concentration varied as 30 and 65 per cent. However, Rao and Das (2003) standardized fuzzy logic based optimization of ingredients for the production of mango bar. Later on, Narayana et al. (2007) standardized a process for the preparation of banana fruit bar. Three treatments viz., T1 = 20 per cent sugar + 0.5 per cent pectin + colour, T2 =20 per cent sugar + 0.5 per cent pectin + colour + 0.3 per cent citric acid and T3= pulp alone without any additives were standardized.

### 2.4.6 Preserve

Sethi and Anand (1982) prepared carrot and amla preserve with TSS varied from 66.1 to 74.6 °B and 66.6 to 69.1 °B. Whereas, Singh et al. (1996) developed a method for the preparation of preserve from wild apple (Malus baccata) and amla.

Nigam (2002) prepared amla preserve and reported 70 °B TSS at fresh and studied storage stability for 90 days. While Garg et al. (2008) prepared aonla preserve with TSS recorded as 60.06 – 74. 0°B. However, Walia (2010) made an attempt to formulate bamboo shoot preserve with reported value for TSS (70 °B) and per cent acidity as 0.70.

### 2.4.7 Candy

Eswaran and Anuradha (1998) prepared 4 types of candies from 3 varieties of ber and evaluated for sensory scores. However, Unde et al. (1998) studied the effect of method of syruping (hot and cold) and drying (in shade, sun, solar, cabinet and try dryers) on the quality of ber candy.

Sharma et al. (1998) formulated candy from whole apple by using glass jars, polyethylene pouches and tins, respectively. However, Kachnar and Lesora candies were also prepared by Awasthi (2007). Walia (2010) prepared bamboo shoot candy with noted TSS as 41.08 °B and TSS content increased with the increase of storage days.
2.4.8 Toffee

Roy and Singh (1979) made an attempt for the preparation of bael fruit toffee. Mundhe et al. (2008) utilized custard apple pulp for the preparation of toffee with TSS recorded as 82.5 °B, respectively.

2.4.9 Specialty food product

Sagar and Islam (2006) standardized the process for production of amlidana and anardana powder to obtain a product of better sensory quality which can be further used in ayurvedic system of medicine and for churan preparation. Singh (2011) prepared hazmah from wild pomegranate.

2.4.10 Spread

Rao et al. (2009) standardized grapefruit spread by addition of pulp and sugar in the ratio of 45:55 and TSS was raised to 68 and 66.6-69.1 °B by boiling the contents.

2.4.11 Instant chutney powder

Chauhan et al. (1994) developed a method for preparation of instant dehydrated wild pomegranate chutney powder. Sharma et al. (1997) prepared instant chutney powder from wild apricot and the powder was diluted in the ratio of 1:3 to obtain a fine paste.

Satyanarayanan et al. (2001) standardized the procedure for preparation of instant chutney with pudina and gongura by using shade drying of leaves. Instant chutneys were reconstituted well in cold water. Later on, raw mango chutney powder was also standardized by blending of raw mango powder with purified chick pea powder and spices in the ratio of 60 and 40 percent by Rao et al. (2008).
2.5 Quality evaluation of value added products

2.5.1 Nutritional changes during storage

i RTS beverage

Roy et al. (1997) studied effect of storage on RTS beverages prepared from Dushehari mangoes. The TSS had no effect on storage while pH decreased from 4.0-3.82. The ascorbic acid content was also decreased from 32.50-17.90 mg/100g during storage of 30 days. Krishnaveni et al. (2001) studied storage stability of jack fruit RTS beverage. The storage study showed an increased trend in acidity and reducing sugars while decreased trend was observed in pH, total sugars and ascorbic acid.

Saravana and Manimegalai (2005) observed storage stability of whey based papaya juice blended RTS beverage and reported an increase in the acidity, reducing sugars and decrease in pH. total sugars and ascorbic acid with the increase of storage interval. The TSS remained constant and acidity increased with the enhancement of storage period of 90 days. Das (2009) studied storage stability of jamun RTS beverage and reported an increased trend in TSS and acidity while decreased trend in ascorbic acid content during storage of 6 months.

ii Squash

Sethi (1993) observed changes in physico-chemical characteristics of litchi squash during storage of 6 months at different temperatures. The TSS, acidity, reducing and total sugars increased with the increase of storage while pH decreased during storage. Roy et al. (1997) reported that pH and total sugars decreased with the increase of storage interval while acidity and reducing sugars increased with the increase of 30 days of storage period in dushehari mango squash.

Das (2009) studied storage stability of jamun squash with respect to TSS, acidity and ascorbic acid content. It was observed from the study that storage had profound effect on TSS and acidity. The TSS and acidity content was slightly
increased from 48.00 to 50.00 B and 1.20 to 1.39 per cent during storage of 6 months while ascorbic acid content decreased from 17.60 to 15.20 mg/100g for the same storage interval.

Shivani (2011) formulated nectarine squash and studied the effect of chemical constituents during storage of 6 months. The study revealed that the values for pH and ascorbic acid mg/100g decreases (3.01 to 2.66 and 3.67 to 1.04) while per cent acidity, reducing and total sugars increases (1.18 to 1.56, 27.55 to 28.77 and 42.61 to 43.31), respectively from initial day of storage to 9 months.

**Syrup**

Kotecha and Kadam (2003) reported that TSS, acidity and total sugars were increased slightly while ascorbic acid content decreased during storage interval of 90 days. However, Das (2009) while studying on jamun syrup reported changes in chemical constituents during storage of 6 months reported values for TSS as (65 to 65.88 0 B), acidity (1.20 to 1.37 %) and ascorbic acid (20.00 to 19.00 mg/100g).

Walia (2010) prepared and studied storage stability of bamboo syrup. The slight increase in TSS, acidity, total and reducing sugars were observed while pH and ascorbic acid content decreased with the increase of storage days.

**Ladoo**

Manan *et al.* (1998) reported 5.27 ± 0.87 per cent moisture, 8.3 ± 1.3 per cent reducing and 38.5 ± 3.4 per cent total sugars in amaranth seed based sweet meats. However, Yogita (2006) prepared amaranth buckwheat based *ladoo* in different proportions of amaranth, jaggery and coconut. The results showed that as the blends of amaranth increased, the protein, fibre and fat content decreased while ash content increased with the increase of blending proportions.

Sood (2011) formulated amaranth chenopodium based *ladoo* in different levels i.e. 100:00, 75:25, 50:50, 25:75 and 00:100 and reported that per cent moisture, protein, fibre and ash increases while fat content decreases with the increase of blending proportions.
v  Chutney

Lal et al. (1989) prepared chutney from wild and cultivated apricot pulp with reported TSS (°B), acidity (%) and pH as 60.50, 1.52, 3.22 for wild apricot chutney and 62.50, 1.70 and 3.19 for cultivated apricot pulp. While Joshi et al. (1991) reported 65.0 °B TSS, 1.25 per cent acidity and 3.90 pH for sweet chutney prepared from edible mushroom (*Agaricus bisporous* L.).

Kaur (2005) prepared chutney from chayote blended with mango in different proportions and the results showed that chutney prepared from mango had higher ascorbic acid as compare to chutneys containing viable amounts of chayote pulp. However, Awasthi (2007) prepared chutney from Kachnar buds with blending of mango and got evaluated for physico-chemical constituents. The chutney so prepared had increased effect on TSS and acidity, as the blending of mango increased whereas the per cent reducing and total sugars increased during storage of 6 months.

Mishra (2008) reported that ascorbic acid content and total sugar content decreased while reducing sugars increased with the increase of 120 days of storage period in aloe-vera mango based chutney. While Sharma (2011) made an attempt to prepare and studied storage stability of *dheu* based chutney blended with papaya in different concentrations. The results showed that the TSS content decreases while acidity increases with the increase of storage interval.

vi  Jam

Sogi and Singh (2001) observed effect of chemical constituents on storage of lye peeled kinnow jam under ambient conditions (16-20° C) and the results showed that TSS, acidity, total and reducing sugars increased significantly during 90 days of storage but ascorbic acid content decreased with the increase of storage period.

Kannan and Thirumaran (2004) while working on changes in the chemical constituents during storage of 6 months in jamun jam reported that TSS and reducing sugars were increased with the increase of storage days while pH, acidity, total sugars decreased with the increase of storage days.
Katoch et al. (2006) while studying on effect of blending on seabukthorn pulp with guava and apple on chemical constituents of jam reported that as the concentration/ blending of guava pulp increases the TSS content increased significantly while pH decreased.

Prasad and Mali (2006) studied physico-chemical characteristics in ber jam during storage of 12 months and reported that the TSS, pH, acidity, total and reducing sugars were increased with the increase of storage days. Later on, Kumari (2007) reported that the values of TSS, pH, acidity and ascorbic acid ranged from 69.37 to 69.35 °B, 3.11 to 2.50, 0.61 to 1.08 per cent and 20.42 to 15.16 mg/100g in whey based mango jam with the storage period of 90 days.

**vii Fruit bar**

Chauhan et al. (1994) observed that supplementation of mango with soy resulted in decreased trend in acidity, total sugars and ascorbic acid content. Whereas, Gowda et al. (1995) observed an increase of acidity i.e. 1.4- 1.50 per cent during 6 months of storage in tray dried mango fruit bar.

Aruna et al. (1999) observed nutritional changes during storage of 9 months in papaya fruit bar and the study revealed that the acidity was increased from 1.20-1.39 per cent while reducing sugars were decreased from 58.82-59.21 per cent during storage of 9 months. However, guava leather when stored for 3 months revealed that the TSS, reducing and total sugars increased with the increase of storage period as reported by Sandhu et al. (2001).

Sharma (2011) studied storage stability of dheu based bar blended with papaya and reported that the per cent acidity and reducing sugars increases while total and non – reducing sugars decreases with the increase of storage interval of 90 days.

**viii Preserve**

Mehta and Tomar (1979) reported values of acidity, reducing and total sugars in amla preserve as 0.48, 32.0 and 51.80 per cent, respectively. While Kaushik et al. (2002) observed biochemical changes in bael preserve during storage of 6 months. The TSS content was increased whereas acidity and ascorbic acid content was decreased with the increase of storage days.
Walia (2010) made an attempt of preparing bamboo shoots preserve and the TSS (°B), acidity (%), ascorbic acid (mg/100g), total and reducing and non-reducing sugars (%) were reported as 70 (°B), 0.70, 8.51, 46.51, 23.11 and 22.28, respectively.

ix Candy

Eswaran and Anuradha (1998) reported TSS, reducing and total sugars were in the range of 71 to 80°B, 60 to 64.31 and 42.00 to 46.21 per cent, respectively for different formulation of ber candies.

Sharma et al. (1998) showed that the TSS and pH contents increased from 71 to 75 °B and 5.70 to 6.28. The per cent acidity was decreased while reducing and total sugars were increased with the increase of storage months.

x Toffee

Mundhe et al. (2008) utilized bael pulp for the preparation of toffee by using different formulations. The chemical constituents for different formulations were varied between 0.20 to 0.29, 5.78 to 5.28, 79.3 to 77.20, 32.7 to 41.2 and 7.50 to 5.47 for acidity, pH, total sugars, reducing sugars and ascorbic acid content, respectively.

Shivani (2011) prepared nectarine based toffee from three varieties and studied storage stability of toffee up to 6 months. The overall mean values for acidity, total and reducing sugars were observed as 0.28, 65.28 and 39.92 per cent, respectively.

xi Anardana tablets

The literature regarding this product is not available after thorough investigation.

xii Spread

Rao et al. (2009) studied effect of storage on different chemical constituents in grapefruit spread. The TSS content was constant i.e. 69.0 ± 0.12 °B. The per cent acidity and total sugars were decreased while reducing sugars were increased slightly during storage of 6 month.
instant chutney powder

Chauhan et al. (1994) reported per cent acidity 4.80, ascorbic acid 20.20 mg/100g and total sugars 3.80 per cent prepared from wild pomegranate. Whereas 8.4±0.19, 5.9±0.25 and 9.1±0.06 per cent acidity, reducing and total sugars were observed in raw mango chutney powder by Rao et al. (2008).

Satyanarayanan et al. (2001) while studying on biochemical changes in instant pudina and gongura chutney powder revealed pH 3.85 and 2.90 at fresh, which increased to 3.86 and 2.94 at 3 month of storage. The per cent acidity remained constant in pudina chutney powder but incase of gongura, a slight decrease in acidity was recorded during 3 month of storage.

2.5.2 Organoleptic evaluation

i RTS beverage

Kotecha et al. (1995) showed that the beverage prepared from 20 per cent custard apple juice was most acceptable. Whereas Shivani (2011) prepared and evaluated nectarine based RTS beverage and the scores for colour, taste, flavour and consistency were slightly decreased with the increase of storage period of 6 months.

ii Squash

Roy and Singh (1979) evaluated bael squash organoleptically and reported that the squash was scored in the range of neither liked nor disliked to liked moderately.

Shivani (2011) formulated and evaluated nectarine squash organoleptically found that the scores for colour decreased significantly with the increase in storage period while taste, flavour and consistency decreased non-significantly with the increase in storage period of 6 months.

iii Syrup

Kotecha and kadam (2003) reported that the overall acceptability scores for tamarind syrup stored at both temperatures decreased gradually during the storage period of 180 days i.e. 8.17 to 7.11
Walia (2010) prepared and got evaluated syrup organoleptically and observed that the colour of the syrup went down to low scores after 120 days of the storage from original scores whereas taste, flavour and overall acceptability of the product decreased with the increase of storage days. Shivani (2011) made an attempt of nectarine syrup and organoleptically evaluated at different storage intervals i.e. 0, 3 and 6 months. The results showed that the overall acceptability decreased with the increase of storage interval.

iv  **Ladoo**

Manan et al. (1998) organoleptically evaluated amaranth seed based *ladoo* and found that the product had a good acceptable taste for amaranth seed based sweet meats.

v  **Chutney**

Lal et al. (1989) evaluated wild and cultivated apricot chutney for sensory scores and it was observed from the study that the product had good acceptability even after storage of 1 year at an ambient storage conditions. Whereas, the scores for overall acceptability of chutney prepared from chayote and its blends with raw mango suggested that all chutney samples were in the range of liked very much as reported by Kaur (2005).

vi  **Jam**

Kannan and Thirumanan (2004) while studying on storage stability of sensory scores for jamun jam reported that overall acceptability of the product was found to be good even after the storage of 6 months. Prasad and Mali (2006) while studying on organoleptic quality of ber jam stored at ambient temperature for 12 months and reported that the colour, flavour and taste decreased with the increase of storage days.

Shivani (2011) prepared nectarine jam and evaluated for different sensory parameters. The results revealed that the scores of colour, taste, consistency and flavour decreased with the increase of storage period.
vii  **Fruit bar**

Chauhan *et al.* (1997) got evaluated protein enriched mango fruit bar and it was observed from the study that the sensory scores decreased with the increase of storage months.

Manimegalai *et al.* (2001) evaluated jackfruit bars during storage and it was observed from the study that natural flavour of bar was retained up to 90 days except in bars stored in butter paper. While Cheriyan and Cheriyan (2003) found that papaya mango leather scored highest 4.70, followed by mango 4.20 and papaya 3.30.

viii  **Preserve**

Kaushik *et al.* (2002) got evaluated bael preserve for sensory scores. The sensory score for preserve was above the acceptable limits beyond 6 months of storage at room temperature. Walia (2010) prepared and evaluated bamboo shoots preserve for sensory scores and it was observed from the study that the product was scored for colour as (7.0), taste and flavour (7.5), texture (87.0). The product had a good overall acceptability with presented scores as 7.50.

ix  **Candy**

Unde *et al.* (1998) showed that the method of syruping had significantly affected the quality of ber candy. The scores for overall acceptability of cold syruping candy (8.2) were higher than hot syruping (6.7). Walia (2010) prepared and evaluated bamboo shoot candy and reported scores for colour, flavour, taste, texture and overall acceptability as 7.50, 7.00, 8.00, 7.83 and 7.83, respectively.

x  **Toffee**

Mundhe *et al.* (2008) evaluated custard apple toffee prepared by using different levels of pulp. The scores for colour and taste were noted as 7.50 while texture and flavour scored as 7.20 and 7.32.
Shivani (2011) prepared and evaluated nectarine based toffee from three varieties viz., Snow queen, May fire and Silver King and reported that the mean sensory scores for consistency and overall acceptability varied significantly with the variety. Whereas the scores for taste and flavour decreased with the increase of storage period.

xi Spread

Rao et al. (2009) found that the sensory scores of grape spread were decreased from 8.50 ± 0.47 to 7.50 ± 0.32 during storage of 6 months but the product had good acceptability during storage.

xii Instant chutney powder

Satyanarayanan et al. (2001) resulted a change in overall acceptability of Pudina and gongura instant chutney powder during 3 months of storage period. While Rao et al. (2008) got evaluated raw mango chutney powder and found that overall quality of the product decreased from 8.2±0.44 to 7.5±0.78 during storage of 6 months.

2.5.3 Microbiological analysis

Sethi and Anand (1982) encountered 6.0-12.0 and 2.8-3.8 million/g yeast in amla preserve. However Aruna et al. (1999) observed no microbial count during storage of 3 months but 2.0x 10^1 and 3.0x10^1 yeast and mould counts were observed during astorage of 6 and 9 months in papaya fruit bar.

Manimegalai et al. (2001) enumerated microbial count during storage of 180 days and it was found that microbial count in jackfruit bar was initially nil but increased slightly during storage. Cheriyan and Cheriyan (2003) enumerated periodical testing of microbial count in papaya mango blended leather on storage revealed complete absence of any contaminated micro-organisms up to 8 months of storage period.

Narayana et al. (2007) evaluated fruit bar for microbiological examination and it was reported that only few colonies of yeast (2.1 cfu/g) were noticed while mould and bacteria were totally absent. No yeast and mould growth was observed in market samples of amla preserve by Garg et al. (2008).
Chaudhary et al. (2010) analyzed karonda products viz., jam, candy and squash microbiologically and changes in bacterial count mg/g of sample was observed during different storage intervals i.e. 0, 30, 60, 90 and 120 days. The bacterial count was increased with the increase of storage days.

Shivani (2011) reported periodical testing of microbial count in nectarine based jam and RTS beverage as 1.20 and 1.30 during 3 and 6 month of storage. Whereas no microbial count was observed in toffee, squash and syrup. Prabha (2008) analyzed papaya based products viz. RTS beverage, squash, jam, and chutney for bacterial count (log cfu/ml) at fresh, 1, 2, 3, 4, 5 and 6 months of storage interval. The bacterial count was increased with the increase of storage months.

2.6 Economics of the prepared products

Sharma et al. (2002) determined 45 ₹/kg cost of production of instant chutney powder prepared from wild apricot. Aggarwal and Gill (2010) while studying on newly evolved antioxidant rich grape cultivars for processing into juice and RTS beverage and calculated economics for RTS beverage as 2.80 ₹/bottle.

Kumari (2007) calculated cost of RTS beverage, squash and jam blended with whey in different combinations. The cost of RTS beverage, squash and jam was increased with the increase of blending proportions. Whereas Kotecha et al. (1995) determined cost of RTS beverage prepared from custard apple as 9.15 ₹/litre of bottle.

Shivani (2011) while working on nectarine products calculated cost of products viz., jam, RTS beverage, squash, syrup and toffee as 30.00 ₹/kg, 9.31 ₹/lt, 22.53 ₹/lt, 27.36 ₹/lt and 62.33 ₹/kg, respectively.

2.7 Documentation of underutilized fruits with respect to medicinal as well as household uses.

Parmar and Kaushal (1982) studied medicinal properties of wild peach. It was observed from the study that the fruit act as a tonic for brain, enrich blood, and remove bad smell from mouth, useful in lessening thirst, biliousness disorders. It also acts as demulcent, antiscourbutic and stomachic. However the
peach kernels are used to treat cough and blood diseases. The oil from kernel is useful in piles, deafness and earache. In case of fig it is useful in constipation and in the diseases of lungs and bladder.

Maini (1997) reported household uses of wild apricot commonly called chulli. The fruits are extensively used for extraction of sweet and bitter oil from seeds. Fruits are also used for the preparation of wine and brandy.

Chauhan (1999) documented the household as well as medicinal uses of Myrica esculenta (kaiphal) and Punica granatum (daru). The fruit is used as refreshing drink and is considered as pectoral, sedative, stomachic and carminative. Whereas decoction of bark is useful in asthma, diarrohoea, fever, lung infection and dysentery. However the fruit Daru is used for wine making and fruit rind is used as an astringent in diaarrhoea and dysentery.

Chandra Prakash Kala (2007) observed common preferences for some of the wild edible fruits viz., Myrica esculentum, Berberis asiatica, Rubus ellipticus, Ficus auriculata and Ficus palmate by local people of Uttranchal. Kayang (2007) documented tribal knowledge on 110 wild edible plants of Meghalaya in which the fruit Myrica esculenta was eaten raw and also used in the form of pickle.

Verma and Chauhan (2007) while studying the indigenous technological knowledge on the uses of 36 medicinal plants reported that juice of roots of Ficus golmerata Roxb; (Umbru) with sugar and black jeera is given to treat gonorrhoea and the juice of green and dried fruit mixed with mishri is given in piles and diarrhea. Sarkhosh et al. (2007) reported that the pomegranate fruit is used in traditional medicine because of its antibacterial and anti-inflammatory properties.

Louba (2007) studied that pomegranate juice inhibits the progression of atherosclerotic lesions, improved stress, induced ischemia in patients with coronary heart diseases, decreased systolic blood pressure and improved post parandial hyperglycemia and lipid profile in diabetic patients. Pomegranate
extract promote regeneration of dermis as well as epidermis in human skin cells and inhibits slight pigmentation in human skin caused by ultraviolet radiations. It also possesses anti cancer properties in case of prostrate, breast, colon and skin tumor.

Samal et al. (2010) documented the indigenous medicinal practices of fruit *Myrica esculenta* (*kaiphal*) which involves the threshed dry outer layer of the fruit is inhaled before sleeping for getting relief from cough, cold and headache.